Municipal Forest Program Management in the United States of America: A Systematic Review

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Abstract: Municipalities across the United States have varied available resources to manage urban forests, resulting in substantial differences in urban forestry services and outcomes. This article reviews 32 survey-based studies that characterize U.S. municipal urban forest management program dimensions, including program components; needs and barriers; knowledge of and attitudes toward urban forests; and plans and priorities for future management. Such information is critical for agencies that support local urban forest management efforts but has not previously been systematically gathered and condensed. Based on the limited national, regional, and state-level data published in peer-reviewed journals, we find that the number of municipal urban forestry programs appears to be increasing, many communities have at least one tree ordinance, and larger communities are more likely to have an official program. However, evidence suggests that few municipalities have an urban forest inventory or management plan, and most require additional financial, political, public, or educational support. More research on urban forestry program status, needed support, and local knowledge is needed as knowledge gaps remain regarding the influence of metropolitan areas and resident demographics on the presence and extent of municipal urban forestry programs. Additionally, few studies have investigated future municipal urban forestry-related intentions and priorities.

Keywords: awareness; barriers; municipal forestry; needs assessment; systematic review; urban and community forestry

1. Introduction

Urban forests are the trees in our built communities. They grow along our streets, around our homes and business, and in our parks and greenspaces. Urban forests provide a multitude of environmental and social benefits. Trees reduce energy use by casting shade and buffering winds and can reduce urban heat island effects [1]. Canopies capture air pollutants and particulates and intercept rainwater [2]. The presence of urban trees can reduce crime rates, encourage human physical activity, and provide places for recreation [1,3]. Trees can also reduce stress and improve health outcomes [1,4]. These benefits are amplified when urban forests are managed [5], and that management primarily happens at the municipal level.

Municipal urban forest management programs are influenced by a complex network of local factors, including municipal budgets, political and resident support, dedicated personnel and volunteers, infrastructure and design considerations, income levels, relative location, and demographics [6–8]. As a result, local urban forestry programs offer a spectrum of services generating a range of outcomes. Understanding the interrelationship among influencing factors, program structures, and urban forest outcomes is critical to ensuring that local programs have the necessary resources and support. Information on the character of existing programs is also central to the effective design and implementation

of technical assistance, educational programs, and funding opportunities by agencies and organizations responsible for building and supporting municipal programs for urban forest management. This article reviews the scientific literature and selected technical documents that describe municipal urban forest management programs in the United States.

Urban forests themselves are highly variable in scale, ranging from the seven million trees that comprise the urban forest of New York City [9] to the many small urban forests, which may include only a few dozen trees [10]. There is no national policy on how urban forests should be managed. A few states (Massachusetts, Connecticut, Rhode Island, New Hampshire, Vermont, and Maine) have legislation that requires municipalities to have a tree warden who is responsible for tree care, but the scope of their work varies. Other states have no such requirement [11]. Some urban forests are managed reactively by one designee, while others are closely and systematically planned and monitored by scores of urban forestry professionals and citizen scientists with sophisticated tools and software [12,13]. The extent of this management is initially determined by the citizens and elected officials of that place, either by recognizing the need to support regular tree maintenance and planting [11] or as a response to an emergency or acute event (e.g., weather or invasive pest) [10,14].

The range of urban forest program services also varies by community. Smaller programs typically provide only basic services such as collecting yard waste or planting and pruning trees. More extensive programs might include pest monitoring and control, urban tree inventories, planting site assessment, and tree risk assessment [12,15]. Some municipalities have formal management plans and scheduled operations based on comprehensive tree inventory data, while others only react to maintenance needs [8,16]. Management plans can include practices, policies, and timelines for planting and pruning trees. More comprehensive plans may include larger-scale considerations, such as the impacts of climate change on biodiversity [17] and storm readiness [18]. Communities without a proactive urban forest management plan may find themselves less able to respond quickly to critical issues, avail themselves of funding opportunities, or efficiently allocate resources.

There is significant variation associated with the position of "urban forest manager". The municipal urban forest manager's training and expertise also play a role in the quantity and quality of the services offered by that community [19–23]. Some communities employ formally trained/educated urban foresters or city arborists who oversee planning and operational activities. These communities may also have crews of trained arborists and professionals who perform tree maintenance [12,24]. In other, often smaller communities, the role of the urban forester may be essentially "assigned" to an individual who may have primary responsibilities elsewhere—typically in planning, parks and recreation, or the highway department [25]. Many municipalities contract out the majority of their arboricultural work [12,26]. Elected officials or volunteers may spearhead some community urban forestry programs, which may be limited in scope due to a lack of resources and skills [20,27,28]. Communities may also feature shade tree committees, or tree boards, that assist with policy creation or conduct volunteer maintenance and planting activities [14,22,27,29].

The United States Department of Agriculture Forest Service (USDA-FS) Urban and Community Forestry Program (UCFP) provides technical, financial, research, and educational services directly and through state Urban and Community Forestry (UCF) partners to municipalities and urban forestry organizations and agencies [30]. State UCF programs are often housed within the agency responsible for natural resources monitoring and management. Most state-level programs provide technical and educational assistance to municipalities, coordinate volunteers and partnerships, and facilitate state urban and community forestry councils [31,32]. In addition, many provide funding either as a pass-through from the USDA-FS UCFP, state dollars, or both [33]. The activities of the state UCF programs have been generally found to improve local urban forest outcomes [34]. Many states also have an urban forestry extension program supported by the USDA Cooperative Extension System, which delivers technical assistance and educational training to professionals and citizens [35]. Community urban forest managers and volunteers can

access these resources to improve their urban forests [12]. Awareness of and access to government agencies and non-governmental organizations that provide education, technical assistance, and funding to communities have contributed to better urban forest program outcomes [34,36–38].

To improve the development and progress of municipal urban forestry programs, fine-tune federal and state technical assistance, and develop effective educational programs, researchers and statewide urban forest program managers have attempted to describe the characteristics of local urban forestry programs and their management needs. The assessment of the factors that influence urban forest management in the U.S. does not have a long history. The earliest journal articles and technical reports relating to urban forest management status and needs appeared in the 1970s. Cool, Kielbaso, and Myers' 1973 study explored the urban forestry needs of Michigan cities, and Miller and Bate published a similar survey of Wisconsin communities in 1978. In 1976, Ottman and Kielbaso released a technical report based on a 1974 nationwide survey of community-based municipal tree care programs. Urban forest management guidance documents also first appeared in this timeframe, including the 1978 USDA-FS *Urban Foresters Notebook*.

This article reviews the available research that describes the status, priorities, needs, and barriers of urban forest management programs at the national, regional, state, and sub-state levels in the United States. Though the breadth of urban forest program management research has increased over time, there is still a lack of available data, and critical knowledge gaps remain [39]. We reviewed articles both geographically and thematically, followed by analyses of those themes and a discussion of potential knowledge gaps that, when addressed, can be most helpful for policy designers, program managers, and support organizations.

2. Materials and Methods

2.1. Search Strategy

This article focuses on peer-reviewed journal articles with national, regional, state, and sub-state level urban forest program management-related data in the United States. Our literature search employed PRISMA and other accepted systematic review guidelines [40–42]. Major databases (i.e., Agricola and Web of Science) were searched using the phrases: "urban forest management" AND assessment; "urban forest management" AND needs; "urban forest management" AND barriers; "municipal tree" AND management; "urban and community forestry"; and "urban forestry program" to locate peer-reviewed journal articles. We also conducted those keyword searches directly in the online repositories of Arboriculture & Urban Forestry (previously Journal of Arboriculture), Arboricultural Journal, Cities and the Environment, Forest Science, Journal of Forestry, and Urban Forestry & Urban Greening. The USDA FS Treesearch website was also searched with those terms. Popular search engines (i.e., Google and Bing) were employed to locate national-level technical documents. Finally, literature cited lists of found articles and national-level technical reports were reviewed (backward chaining). Articles published through December 2021 were included.

Articles were considered for inclusion if they met the following criteria:

(1) Described community urban forest program needs and barriers, municipal urban forest program components, perceptions of urban forestry by municipal managers, and factors affecting urban forest management. Articles that measured tree canopy cover or urban canopy structure and condition were excluded (e.g., [43,44]).

(2) Covered a geographic area larger than one municipality (i.e., metro-area, state, group of states, or national) and were part of the United States.

(3) Relied upon a survey(s) or interviews with municipal officials, administrators, program employees, or key municipal volunteers. Some studies also linked available data (i.e., U.S. Census data, aerial imagery) with survey or interview data to draw conclusions about management conditions. These studies were included. Surveys of residents or the general public were excluded (e.g., [45]). We also excluded articles that solely covered third-party urban forestry programs (e.g., [46]).

(4) Examined or described how community conditions (i.e., size, relative location, demographics) affected responses and findings.

(5) Sub-national articles had to be published in a peer-reviewed journal. Though technical reports add considerably to the urban forest program management body of knowledge, we decided to include them only at the national level and exclude them at other geographic levels in this review. Some state-level reports are not accessible due to the lack of available digital versions and/or distribution. Additionally, research reported in technical documents is conducted with varying degrees of rigor due to the needs of the agency and demands on the author's time and thus may not be comparable with peer-reviewed articles.

2.2. Search Results

Initial searching netted 1275 articles, including 466 duplicates. All 809 articles were reviewed for the criteria above; 46 met Criteria 1, 30 met Criteria 2, 18 met Criteria 3, and 17 met Criteria 4 and 5.

The literature cited lists in the 17 articles were reviewed, in alphabetical order, for additional journal articles and national-level technical reports (backward chaining). They contained a total of 414 citations. We found 11 additional peer-reviewed journal articles that met criteria 1 and 2, but only eight met criteria 3, 4, and 5. Five national-level technical reports were found. Numerous state technical reports were among the reference lists. The references cited lists for the additional 11 journal articles and the five national technical reports were also reviewed, netting 158 additional references with two additional journal articles.

This process uncovered 32 studies: 27 peer-reviewed articles (national, regional, and state-level) and five national technical reports.

2.3. Coding Strategy

The identified articles were downloaded, stored, and organized in citation software (Zotero). Each paper was read by at least one author and coded for basic information using an Excel spreadsheet. Coded information included study structure (i.e., year published, authors, sample size, methods, and geographic area) and review data variables (i.e., community comparators, program components, knowledge and awareness topics, needs, barriers, and intentions).

3. Results

3.1. National-Level

Five studies were identified, in both peer-reviewed articles and technical reports, which provide nationwide information on the general state of urban forestry programs. Each of these studies was based on a national survey assessing the structure, services, and procedures of urban forest management programs across the U.S. These surveys were conducted in 1974–75 [47], 1980 [48,49], 1986 [50,51], 1993 [52], and 2014 [12] (Table 1). Many of the same questions were asked in the 1974, 1980, and 1986 surveys and were also included in the 2014 survey. The questions on the 1993 survey, however, are generally not directly comparable to those on the prior surveys, though some were included in the 2014 survey to facilitate comparisons. Three other nationwide studies which use surveys to investigate specific topics of interest were also identified (Table 1). Below, we summarize the state of urban forestry management in U.S. cities and briefly describe the latest nationwide survey and the four focused studies with national scopes.

Although now almost a decade old, the Hauer and Peterson 2014 general survey provides the most up-to-date national picture of the state of urban forestry management in the U.S. The survey featured 109 questions (long form) covering eight topical sections [12]. Responses were collected from 667 communities ranging from 2500 to over one million residents. Analysis was presented by geographic region and population size. Results indicated that more than 90% of communities had or were developing a tree ordinance, 50%

of the responding communities had an urban tree plan, and 67% of the communities had partial or complete tree inventories. Approximately two-thirds of the communities were aware of their state UCF program, but only about half received financial or educational assistance, and about 40% received technical assistance. Eighty-one percent of respondents reported public funding of tree care, though the services provided varied considerably. Across all population sizes, 0.52% of the 2014 municipal budget was allocated to tree-related work, and communities between 25,000 and 49,999 residents spent the most per capita. Spending per tree was the highest in the Midwest, potentially attributed to the effects of the emerald ash borer (*Agrilus planipennis* Fairmaire) outbreak. Communities in the South spent more per tree than those in the West, Northeast, or Midwest. Communities with populations greater than 10,000 residents are more likely than municipalities with fewer than 10,000 residents to employ the American National Standards Institute (ANSI) A300 tree and shrub management standards to guide practices, 67% to 10% [12].

Table 1. Key details for national urban forest management articles and important technical reports, U.S. 1973–2021.

Author(s) and Year Published	Year of Data Collection	Sample Size	Citation
Ottman and Kielbaso 1976 *#	1974–75	*n* = 991	[47]
Beatty and Heckman 1981	1977	*n* = 72	[53]
Giedraitis and Kielbaso 1982 *#	1980	*n* = 1534	[48]
Johnson 1982	unknown	*n* = 12	[54]
Kielbaso et al., 1982 #	1980	*n* = 1534	[49]
Kielbaso et al., 1988 *#	1986	*n* = 1062	[50]
Kielbaso 1990 #	1986	*n* = 1062	[51]
Tschantz and Sacamano 1994 *#	1993	*n* = 419	[52]
Clark and Matheny 1998	unknown	*n* = 25	[55]
Hauer and Peterson 2016 *#	2014	*n* = 667	[12]

* Indicates technical report (not found in scientific journals). # Iterative nationwide survey.

In 1977, Beatty and Heckman (1981) asked program managers to complete a survey and to submit paper copies of their tree master plans, ordinances, and guidelines for planting and management documents for review. Seventy-two cities from across the country from a spectrum of population sizes responded. Findings conveyed administrative priorities, citizen demand for services, and social issues related to trees. Thirty percent of the responding cities reported having tree commissions, 42% did not know the number of trees in their urban forest, and 60% indicated the need for substantial budget increases to meet their operational requirements. Information pertaining to urban tree species composition (urban tolerant, weed trees, and native trees) and commonly reported tree problems were also included in this survey [53].

Johnson (1982) explored the policy environment, institutional setting, program activities, and political environment in 12 large cities across the U.S. through interviews with each city's lead urban forester. Due to the limited scale of this method, the results only provide a snapshot of these cities' urban forest management issues. Findings included that successful programs were often housed within the public works department and had at least one well-trained staff member. Also, staff members focused much of their time on daily tree care rather than urban forest management and decision-making. Johnson determined that most programs were underfunded and lacked political and agency support.

Clark and Matheny (1998) sought to score urban forestry in larger cities relative to several dimensions of sustainability: knowledge or opinions of the existing tree resource (Vegetation Resource), interaction and cooperation with stakeholders and partners (Community Framework), and resource management practices (Resource Management). Based on 25 survey responses from larger cities spread across the country, they found no systematic relationship between scores and city population or area. The respondents' average score for the Vegetation Resource criteria was 53%, while Resource Management was 62%,

and Community Framework was 64%. Specifically, 64% had a management plan, 60% knew the size of their street tree population, and 64% knew their urban tree canopy cover percentage. The article also reviewed the importance and involvement of constituent and community groups [55].

3.2. Regional-Level

Two papers described urban forest management conditions in specific regions of the United States. One focused on the Intermountain West, the other on the Southeast (Table 2).

Table 2. Key details for national and regional urban forest management articles, U.S. 1973–2021.

Region/States	Author(s) and Year Published	Year of Data Collection	Sample Size	Citation
Intermountain West: Arizona, California *, Colorado *, Idaho, Montana *, Nevada, New Mexico *, Oregon *, Utah, Washington *, Wyoming *	Kuhns 1998	1997	*n* = 21, 11 states	[56]
Southeast: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia	Lewis and Boulahanis 2008	unknown	*n* = 504, 13 states	[57]

* Portions of those states

Kuhns (1998) surveyed 21 state and federal urban and community forestry staff, extension educators, and utility arborists with responsibilities in an 11-state region to gather information on Intermountain West urban forests. Questions explored the quality, strengths, and weaknesses of local urban forests, as well as perspectives regarding the future, regional differences, research needs, and urban forest-related challenges. Shortcomings identified by the respondents included insufficient agency support and a lack of community awareness. Respondents generally described a region that was challenging for urban forest growth, with its harsh growing conditions and rapid population growth, though they also indicated that they remained hopeful for the future of urban forestry in the Intermountain West [56].

As described in Lewis and Boulanis's (2008) paper, mayors from 504 small towns (5000 to 25,000 residents) in 13 southeastern states were surveyed about tree maintenance, municipal organizational structure, community support, and the knowledge and characteristics of the mayor. Census data pertaining to education, affluence, and population were paired with the survey results. Ninety percent of communities performed routine maintenance (prune, mulch, fertilize, or remove trees). Sixty-one percent had conducted a significant tree planting within the previous five years or planned one for the future. Only 66% of the responding mayors knew of their state urban forestry program. Dedicated staff was found in 59% of communities, and 49% had a tree-related ordinance. Most mayors understood that trees provided benefits, though the importance of tree maintenance was rated below many other city issues. A multivariate analysis concluded that the presence of a designated urban forest staff member, department, or budget was positively correlated with routine tree maintenance. The model also indicated that tree maintenance was correlated to the mayor's awareness of their state's urban forest program [57].

3.3. State- and Sub-State Level

Twenty articles published between 1978 and 2019 described municipal urban forest program management conditions at a state or sub-state level (Table 3) within the U.S. These articles described the characteristics, needs, barriers, awareness, and/or intentions of municipal urban forest program management. Most focused on urban forest management conditions, and one reported on management outcomes [58]. Other early publications pro-

vide information on initial statewide program outcomes or individual cities (i.e., Herberger (1984) [59] and Skiera (1978) [60]) but read more like popular articles promoting specific projects or status reports rather than research articles.

Table 3. Key details for twenty state and sub-state urban forest management articles, U.S. 1973–2021.

State/Region	Author(s) and Year Published	Year of Data Collection	Sample Size	Citation
Alabama	Zhang and Zheng 2012	2003	n = 797 respondents, 336 cities	[7]
Florida	Hilbert et al., 2019	2014, 2015, 2018 #	n = 43	[58]
Illinois	Schroeder et al., 2003	1995, 1999 #	n = 636	[25]
Massachusetts	Harper et al., 2017	2013	n = 50	[22]
Massachusetts	Rines et al., 2011	2006	n = 143	[61]
Massachusetts	Rines et al., 2010	2006	n = 143	[62]
Michigan	Cool et al., 1973	1970	n = 141	[63]
Mississippi	Grado et al., 2013	2011	n = 159	[37]
Mississippi	Grado et al., 2006	2004	n = 163	[36]
Missouri	Treiman and Gartner 2004	2003	n = 387	[16]
New Jersey	Tate 1984	1983	n = 329	[64]
Oregon	Ries et al., 2007	1992, 2004	n = 123	[31]
Oregon/Washington: Portland/Vancouver Metro Area	Driscoll et al., 2015	Unknown ~2014	n = 96	[8]
Pennsylvania	Reeder and Gerhold 1993	1991	n = 988 stage 1 survey, n = 161 stage 2 survey	[65]
Pennsylvania	Stevenson et al., 2008	2005	n = 528 respondents, 356 municipalities	[6]
Pennsylvania	Still et al., 1996	Unknown ~1994	n~101 grant recipients, 51 unfunded, 332 non-applicants	[66]
Pennsylvania: Northeast region	Elmendorf et al., 2003	2000	n = 188 stage 1 survey, 56 stage 2 survey, 12 focus group	[27]
Texas	O'Herrin and Shields 2016	2012	n = 79	[67]
Utah	Kuhns et al., 2005	2002	n = 138	[68]
Wisconsin	Miller and Bate 1978	Unknown	n~42, 53	[19]

\# Indicates data collection was expanded and added to the original data set.

Table 3 summarizes the characteristics of 20 articles with a state or sub-state scope. We have further grouped these articles into five categories based on the dimensions of the urban forestry programs. These categories are attributes (descriptors used to compare one municipality to another), components of urban forestry programs (services and activities provided by the municipality), awareness and knowledge of urban forestry concepts and assistance programs, needs of and barriers to urban forestry programs, and future intentions or priorities.

Some of the studies reviewed below focused in-depth on one topic, while others covered many topics. Those that were exemplary of the category or provided interesting comparative data were selected for inclusion and are presented in chronological order.

3.3.1. State and Sub-State Level Attributes

All of these investigations used at least one community attribute to compare municipalities within a state or sub-state region. Nineteen of the journal articles compared or categorized the communities in their state by resident population size. One intentionally surveyed small municipalities [27], a second only surveyed communities with over 500 residents [63], and a third only those over 5000 [67]. Most studies compared only one or two factors with urban forest program status; only one study, Zhang and Zheng (2012), delved deeply into conditions that describe differences among communities and potentially lead to better services by UCF support programs (Table 4).

Table 4. Categories of attributes found in state and sub-state studies, U.S. 1973–2021.

Comparator	Number of Studies	Citations
Community by population size (or density)	20	[6–8,16,19,22,25,27,31,36,37,58,61–68]
Urban forest program budget relative to program or outcomes	8	[6,7,16,19,31,63,67,68]
Relative community location in the state or proximity to metropolitan areas	5	[16,22,61,62,66]
Community affluence	4	[7,19,61,62]
Education level of residents	3	[7,61,62]
Race (% Caucasians)	1	[7]
Poverty level of community	1	[7]
Home Value	1	[58]
Housing Density	1	[58]

The earliest paper in this collection is Cool et al. (1973) which provides a fairly comprehensive comparison of key urban forestry program components in Michigan cities, including staffing, ordinances, beautification committee, planting, and inventory by municipal population, municipal budget, and forestry budget. Their survey found that urban forestry services and infrastructure increased as municipal and county population sizes increased. The authors also found that the education level of the manager increased as municipal forestry budgets and populations increased [63].

Miller and Bate (1978) examined the effects of community characteristics on urban forestry programs, the needs of communities without programs, and research directions anticipated to have the most significant benefits in Wisconsin. Municipalities were grouped by those with a program and those without a program. Municipalities with larger populations were more likely to have an urban forestry program, as were communities experiencing population growth. Community affluence and the presence of a college were each positively related to program existence in municipalities with more than 10,000 residents. Large programs also tended to have city foresters with more education or experience. Communities without programs primarily focused on elm (*Ulmus* spp.) replacement activities [19].

Reeder and Gerhold (1993) found that while only 17% of municipalities in Pennsylvania had a street tree program in 1991, the breakdown by size was more complex. Seventy-seven percent of cities (n = 27), 30% of boroughs (n = 397), and 6% of townships (n = 564) had programs [65].

In Zhang and Zheng's (2012) Alabama study [7], municipal officials (mayors, administrators, and council members) were surveyed for their perspectives on their community's urban forestry programs. The authors modeled nine variables to predict funding spent on planting, tree maintenance, tree debris removal, and tree removal. The variables included municipal population, percent white, education, median household income, and poverty rate. The authors also found that tree planting increased by 0.74% for every 1% increase in municipal population. The percentage of whites in a community was associated with higher levels of tree planting and funds available for removals, but the rate of high school graduates did not affect tree-related funding. Household income strongly correlated with tree planting funding. For every 1% increase in household income, tree planting funds increased by 3.73%. Alternatively, high poverty levels had strong, negative correlations with urban tree programs.

3.3.2. State and Sub-State Level Components

All twenty studies reported on the services provided by community urban forest programs (Table 5). These studies generally included an abundance of questions regarding tree boards, ordinances, management plans, and staff. This is not surprising given that those factors are the main program components reported by states to the USDA-FS UCFP

Community Accomplishment Reporting System (CARS) database [61,62] or the Staff, Ordinance, Advocacy, and Plan (SOAP) report [67]. Eleven studies inquired whether a community had a forester or other individual in charge of municipal trees. This speaks to the perceived importance of having an individual responsible for a municipal urban forest program [62].

Table 5. Categories of urban forest program components found in state and sub-state studies, U.S. 1973–2021.

Urban Forest Program Component	Number of Studies	Citations
Tree related ordinance (at least one)	16	[6,7,16,19,25,27,31,58,61–68]
Tree board/commission	15	[6,7,16,22,25,27,31,58,61–65,67,68]
Municipal staff who care for trees	14	[7,16,19,25,27,31,36,58,61,63–65,67,68]
Tree inventory	14	[6,7,25,27,31,58,61–68]
Plant trees	13	[7,19,25,27,31,36,37,62–66,68]
Conduct tree maintenance	12	[7,19,22,25,27,31,36,37,62,64,65,68]
Municipal forester (on staff or contracted)	11	[16,19,25,36,37,61–63,65,67,68]
Management plan	10	[6,16,27,31,61,62,65–68]
Received urban forest grants	9	[6,7,16,25,31,61,66–68]
Used volunteers	7	[6,7,25,27,31,65,66]
Conducted public education on urban forest benefits	6	[25,27,31,62,66,68]
Employed or contracted individuals with International Society of Arboriculture (ISA) or Tree Care Industry Association (TCIA) certifications	6	[6,25,27,31,58,61]
Celebrated Arbor Day	6	[6,27,31,36,37,68]
Obtained Tree City USA status	3	[6,61,62]
Had a supporting or partnering non-profit group	3	[7,22,67]

In this paper, the term tree board encompasses the variety of names used for tree advisory and advocacy commissions, committees, and boards directly linked to an individual municipality. Some communities also had non-municipal partner organizations that advocated for or advised on urban forestry issues. There is terminology overlap in the literature, but they are often called citizen advocacy groups, non-profit advocacy groups, or community organizations [7,22,67].

Tate (1984) reported on New Jersey municipal tree care agency budgets and services by community size. Three-quarters of cities had tree-related ordinances; however, many larger communities stated they needed revision. The prevalence of tree boards increased as community size decreased. Ten percent of cities with over 50,000 residents had a board compared to 75% of cities with under 5000 residents. Only a third of the municipalities had inventories. Cites had tree maintenance employees, but 70% hired contractors to fill gaps. Funding and technical expertise were noted as barriers. Tree-related budgets, especially in larger communities, had decreased in the preceding five years [64].

In 1991, 28% of Pennsylvania cities and boroughs reported having a tree management program. Of the municipalities with a tree care program, 57% had a tree commission, 73% had a tree-related ordinance, and 28% had an inventory. Additionally, 44% planted trees at least yearly, 7% planted trees only after trees were removed, and 5% not at all. The number of municipal tree staff was low, with 36% having one or more employees assigned to trees, though they may not have any formal training. Twenty-four percent employed or contracted a trained forester or arborist, and 6% had a full-time person in that position.

Thirty-eight percent of municipalities reported having at least one trained employee or volunteer actively maintaining trees [65].

The combined 1995 and 1999 surveys of Illinois municipalities [25] collected data on all communities and compared small communities, fewer than 25,000 residents (n = 579), and large communities, greater than 25,000 residents (n = 57). They found that 8% of smaller communities had an urban forester compared with 72% of larger communities. Sixty percent of the respondents reported having staff assigned to tree care. Larger communities were more likely to have staff with a college or technical degree, ISA Certification, or other professional training. Sixty-one percent of larger communities had an ISA Certified Arborist or Certified Tree Worker on staff. In contrast, the person responsible for public tree management in 63% of smaller communities lacked formal training, with only seven percent holding an ISA Certification. Tree ordinances were also disproportionate, with 95% of larger communities and 32% of smaller communities confirming at least one. Twenty percent of all responding communities had a tree board, 20% had a tree inventory, and 11% had updated tree inventories. Between 45 and 65% of communities conducted cyclic pruning, performed pest control, recycled landscape waste, or provided tree-related education to the public. All of these services were conducted more frequently by larger communities.

Treiman and Gartner's (2004) 2003 survey of Missouri community officials found that 22% of communities had a "comprehensive tree ordinance," 54% reported an underfunded program, and 10% had a management plan. A full-time employee dedicated to urban forestry was found in 25% of the communities, but only seven percent had a full-time employee with a related four-year degree. The likelihood of a degreed, full-time employee increased with population size. Municipalities with full-time tree care employees were more likely to apply for cost-share programs [16].

A 2004 survey in Oregon found that larger cities, with 25,000 residents or greater, were more likely than smaller communities, with 5000 residents or fewer, to have urban forest programs (73% versus 23%). Cities that received assistance from the state UCF program, versus those which did not, were more likely to have tree ordinances (81% vs. 57%), have a tree board (63% vs. 16%), plant trees (67% vs. 12%), or to be aware of Tree City USA (89% vs. 56%) [31].

Kuhns et al. (2005) characterized Utah's urban forest components and development status. While approximately 66% of responding communities had an urban forestry program on some level, 40% were only at the project (lowest) level and 8% at the sustained (highest) level. Communities under 1000 people only had project and formative (second lowest) levels. Of the significant urban forest program components, 54% had an employee in charge of municipal trees, 30% had a management plan, 57% had a tree ordinance, and 45% had an inventory. In general, rates of these components increased as community population size increased. Also, while only 23% had a tree board, many were interested in forming one. Arbor Day was celebrated by 26% of municipalities [68].

Massachusetts Tree Wardens, the local officials responsible for urban forests in Massachusetts, were surveyed in 2006 [61] on their CARS urban forestry program components: a management plan, professional staff, a tree-related ordinance or policy, or an advocacy or advisory organization. Ninety-nine percent of the 143 responding communities met at least one of the four CARS parameters. However, the Massachusetts Shade Tree law (MGL 87) serves as a functional municipal urban forestry ordinance, so in theory, all Massachusetts communities have that component. Twenty-seven percent reported meeting just one CARS parameter. Fifteen percent of communities met all four CARS parameters. Sixty-two percent had an inventory, 41% had an advocacy group, and 36% had a management plan. Thirty-seven percent reported they obtained a state grant. Grant funding rates increased as the community population increased. Communities with an advocacy group or qualified staff received more state funding than those without such support. Overall, there was a direct relationship between increasing funding levels and the number of CARS components that had been met [61].

In 2013, interviews with Massachusetts tree wardens uncovered trends in organizational structure, resources, services, and needs. There was an increase in funds as population sizes increased. Almost all interviewees (98%) conducted pest monitoring [22].

O'Herrin and Shields' (2016) survey of Texas communities with at least 5000 residents measured program components, expenses, and services received from the state UCF. Program components included staff, ordinances, plans, inventories, and budgets. Smaller communities (5000 to 29,999) averaged 1.5 tree-related staff, while mega communities (greater than 500,000) averaged 28.8 staff. Overall, 58% of communities had a tree ordinance regarding the planting and maintenance of trees on public property, and 43% had an ordinance that required a tree board or staffing. Tree boards were found in 41% of responding cities, and 40% had a tree-related non-profit organization. Only 13% had a management plan, while 20% had an inventory of street trees, and 22% had an inventory of park trees. Per capita spending on urban forestry varied by community size. Smaller and mega communities spent $7.10 and $2.06 per resident, respectively, which equated to 0.62% and 0.08% percent of their city budgets. Texas has a relatively small state UCF program compared to its population. Nevertheless, 14% of responding communities had received financial assistance, 52% received technical assistance, and 49% received educational assistance [67].

Hilbert et al. (2019) paired Florida data from the 2014 National Survey [12] with both U.S. Census data and aerial imagery to predict the effects of specific urban forestry program components and community characteristics on urban tree cover. They determined there was a negative relationship between housing density and urban tree cover and a positive relationship between heritage tree ordinances and urban tree cover. Their model concluded that 78% of responding cities had an ISA Certified Arborist on staff, 72% had a tree board, and 64% had an inventory [58].

3.3.3. State and Sub-State Level-Awareness, Knowledge, and Attitudes

A community's lack of awareness about the benefits of trees or urban forest maintenance can lead to poor program outcomes and support [7]. Fourteen studies asked at least one question about the respondent's knowledge or awareness regarding urban forests, urban forest benefits, or state, federal, or non-profit assistance and support programs (see Table 6). Awareness or knowledge about a particular support organization does not indicate participation with that organization. However, municipal knowledge of urban forestry assistance programs indicates community connectivity and awareness of potentially helpful outreach programs [7].

Table 6. Categories of awareness, knowledge, or attitude questions found in state and sub-state studies, U.S. 1973–2021.

Awareness, Knowledge, or Attitude	Number of Studies	Citations
Awareness of state or federal assistance programs (technical, education, or financial)	9	[6,7,25,31,36,37,64,66,67]
Awareness of state urban forestry council	4	[7,36,37,64]
Awareness of Arbor Day Foundation or Tree City USA	4	[7,31,36,37]
Knowledge of urban forestry or the benefits of trees	7	[6,7,25,27,31,36,37]
Understanding of urban forestry	2	[36,37]
Knowledge of perceived tree condition	3	[16,25,65]
Attitude towards urban forestry concepts or management components	9	[6,7,16,25,27,31,62,66,68]

Additionally, this section includes nine surveys that assessed respondents' attitudes toward different urban forestry concepts or management components (Table 6). Understanding respondents' attitudes can lead to insights into the willingness of communities

to undertake urban forestry projects. We assert that attitudes infer a degree of knowledge or awareness of these topics. State urban forestry support programs need to continually educate elected officials and the public regarding the benefits of trees and urban forests. Topics returning a low attitude rating may need more promotion or explanation to increase both knowledge and attitude of those topics.

Still et al. (1996) surveyed Pennsylvania communities and volunteer organizations that obtained, applied for but did not obtain, or did not apply for a tree planting grant between 1991 and 1993. The goal was to determine the success of those grants, compare attitudes toward the benefits of trees among the three groups, and gather community characteristics data. Municipalities already engaged in urban forestry practices (e.g., ordinance, inventory, or management plan) were "more willing and better prepared to apply for grant funds" and more likely to have obtained a grant. Thirty-seven percent of the grantees without a current inventory stated they were likely to conduct one, compared with four percent of the non-applicants without a current inventory. Non-applicant communities generally had smaller populations and greater forest cover in their counties. In comparison, grant applicants were more likely to have higher populations and were more likely to be located near Philadelphia or Pittsburgh. Successfully funded communities also reported high amounts of public support, and that public support increased as a result of their tree planting project. Non-applicants reported much lower rates of public support [66].

Awareness of support services and state and federal grants was an issue for smaller communities in Illinois [25]. Larger communities were more likely to have applied for and been awarded grants. Many communities desired technical assistance on a variety of topics that included grant application assistance, assistance accessing a professional urban forester, employee and volunteer training, and assistance conducting an urban tree inventory.

Elmendorf et al. (2003) inquired about the personal attitudes of tree commission members toward urban forest management practices and paired it with a survey of municipal managers' execution of those practices in northeastern Pennsylvania [27]. Eighty-three percent of the commission members responded that tree inventories were necessary, but only 43% of municipalities had completed one. Tree plans were deemed necessary by 90% of commission members, but only 29% of municipalities had one. Ninety-three percent reported that street tree ordinances were important. Seventy-eight percent of municipalities had an ordinance, but 20% said they do not enforce it. Two tree commissioner focus groups were conducted to explore the differences between tree commission members' attitudes and municipal managers' practices. The resulting themes included a lack of volunteer time and energy, a lack of public and political support and understanding, the need for more assistance, poor organizational structure, governmental barriers, the need for more education, and a lack of funding [27]. The study primarily included small towns, and the responding tree commissioners were volunteers. Additionally, there were few professional urban foresters or arborists in the area (northeastern Pennsylvania), and access to technical support was limited [27].

To describe Mississippi municipal officials' understanding of urban forestry issues, Grado et al. (2006) sent a survey to all municipalities in 2004 [36] and again in 2011 [37]. In 2004, 62% of municipalities were familiar with the concept of urban forestry. In the 2011 survey, 78% of community officials were familiar with urban forestry, though only 72% of smaller communities (less than 2000 residents) were familiar, compared with 97% of larger communities (greater than 10,000 residents). Awareness of other urban forestry concepts also increased between 2004 to 2011, including erosion reduction, wildlife habitat, recreation, and air quality. However, only 28% of respondents had an urban forestry program or project in 2011 compared to 31% in 2004. Also in 2011, few communities employed an urban forester or professional (12%), and even fewer planned to hire one in the future (2.5%). Additionally, the 2011 survey asked respondents about partnering organizations and funding. National Arbor Day Foundation, Mississippi Forestry Commission, the Mississippi State University Extension Service, and Earth Day each garnered over 50% awareness. Approximately 39% of respondents were aware of Tree City USA. Less than one-third of

the responding communities were aware of tree planting and urban forestry funds that were available through the state. Again, the larger communities were considerably more aware of support agencies and funding opportunities than were smaller communities.

Stevenson et al. (2008) sought to determine if there was a difference in attitudes among three groups of Pennsylvania respondents (elected chief officials, public works administrators, and municipal solicitors), among the three scales of urban forestry programs (sustained, developing, and undeveloped), and whether population size affected attitudes. Sustained programs had the highest response rates. There were knowledge gaps among the three respondent groups, with solicitors reporting lower rates of awareness of management plans, inventories, and budget information than elected officials and public works administrators. There was also evidence that respondents in the same category (i.e., administrators) from the same community had differing knowledge about the services their community offered. This lack of agreement points to the complexity of using surveys to gather this data. Respondents from municipalities with sustained programs generally agreed to these statements at a higher rate than those from communities with developing programs, who in turn agreed at higher rates than those from communities with undeveloped programs. Similar trends were seen with statements on the importance of tree care practices and street tree pruning. Additionally, respondents were asked to rate the helpfulness of different sources of assistance, including the municipality's budget, grants, volunteers, technical assistance from the state Cooperative Extension System, and technical assistance from the state bureau of forestry. All sources of assistance were regarded as more helpful to communities with sustained programs than those with developing or undeveloped programs [6].

In Alabama, municipal officials (mayors, administrators, and council members) were more aware of trees' socioeconomic benefits than ecological benefits. Many municipal officials were unaware of their urban forestry funding levels or available funding and technical assistance programs. While over two-thirds of the respondents were aware of the Alabama School of Forestry & Wildlife Science and American Forests, only about half knew of the USDA-FS. Less than one-third were aware of the Alabama Urban Forestry Association or National Arbor Day Foundation. Officials aware of local tree agencies and the Alabama Forestry Commission were from communities with higher tree program funding. Additionally, the respondent's opinions of whether they favored trees or not had little effect on the level of funds allocated to tree programs [7].

3.3.4. State and Sub-State Level-Needs and Barriers

Thirteen of the statewide studies asked municipalities about the perceived program needs or barriers to proper management (Table 7). Many studies found similar answers to needs questions and barriers questions, and often a question could be read as either defining a need or a barrier. An example of a need is "more public support", while the barrier is "lack of public support". Therefore, needs and barriers have been combined in this paper.

The most frequently asked needs and barriers questions pertained to educational training and technical assistance, with eleven studies having at least one question regarding these two connected topics. Educational training and technical assistance questions not only relate to needs and barriers but also to knowledge and awareness of urban forestry topics and services.

In 2004 and again in 2011, Mississippi municipal officials listed lack of funding, budget restrictions, and staff limitations as their top three most significant barriers and needs. Respondents from mid-sized communities, between 2000 and 10,000 inhabitants, rated these obstacles more highly than the smaller (<2000) and larger (>10,000) communities in both 2004 and 2011 [36,37].

Table 7. Categories of Needs and Barriers found in state and sub-state studies, U.S. 1973–2021.

Need or Barrier	Number of Surveys	Citations
Training and technical assistance	11	[6–8,19,22,25,27,31,64,65,68]
Political support	7	[6,8,19,27,36,37,68]
Sufficient funds	7	[6,8,27,36,37,64,68]
Grant writing or fund development	6	[7,25,36,37,65,68]
Public support	5	[6,8,27,36,37,68]
Lack of municipal staff or limitations on staff	5	[6,8,27,36,37,68]
Canopy condition concerns	5	[8,19,25,31,68]
Urban forestry program creation	4	[31,36,37,65]
Community outreach	3	[8,27,68]
Ordinance development	3	[25,65,68]
Management plan creation	2	[8,27]
Maintenance concerns	2	[6,8]

In addition to identifying program components, tree-related budgets, and program development level, Kuhns et al. (2005) looked at the support, strengths and weaknesses, and training and information needs of Utah communities [68]. Twenty-one percent of the respondents reported weak support from the community, and 13% reported weak support from town officials and staff. Overall, 80% of the respondents felt they had at least some support from their citizens, officials, and employees. Dedicated funds (public and private) were present in 64% of represented communities. Average tree budget levels were relatively low at $2.58 per capita. Communities with fewer than 500 residents reported the highest at $6.26 per person, and the largest communities, with over 50,000 residents, reported $2.40 per person. The smallest communities relied more on grants and donations than the larger communities. The communities with the lowest per capita spending were in the 1000 to 3000 and 3000 to 10,000 population categories, with $1.35 and $1.08, respectively.

In Stevenson et al. (2008), Pennsylvania officials (elected officials, public works administrators, and solicitors) were asked to rate the importance of barriers to starting or improving a street tree program. "Insufficient funding" received the highest rating, with 86% of all three respondent groups considering it an important barrier. "Personnel lacking" rated 70%, "inadequate equipment" rated 67%, and "low public support" followed close behind with 62% [6].

Municipal officials and program managers were surveyed to understand the potential of an urban forestry initiative in the Portland, Oregon, and Vancouver, Washington region by Driscoll et al. (2015). The survey results indicated a significant demand for expanding local urban forestry programs, with 49% of community officials and 67% of program managers responding that they were "interested". Thirty-nine percent of respondents ranked sustainable funding as their greatest community need. Increased political support and community outreach and education garnered 20% and 11%, respectively. Respondents also ranked barriers. Insufficient funding ranked the highest with 41%, low public support and interest earned 14%, a history of conflicts surrounding urban trees was 12%, and lack of political support was 12% [8].

3.3.5. State and Sub-State Level-Future Intentions or Priorities

Understanding what municipalities prioritize and intend to do is important to urban forestry agencies in order to project education and technical assistance needs. Also, communities with defined intentions may have more budget funds dedicated to tree-related activities. For example, municipalities with tree planting plans for the next five years have been found to have substantially more funds for planting, maintenance, debris removal, and tree removal [7]. Eight studies had at least one priority or intention question, but only two studies asked more than three such questions: Driscoll et al. (2015) with ten [8] and Stevenson et al. (2008) with eight [6] (Table 8).

Table 8. Categories of intentions and priorities found in state and sub-state studies, U.S. 1973–2021.

Future Intention or Priority	Number of Studies	Citations
Hire an urban forester or ISA Certified Arborist	4	[6,8,36,37]
Create or revise a management plan	3	[6,8,66]
Develop an ordinance	3	[6,8,66]
Complete an inventory	3	[6,8,66]
Create an urban forestry program	3	[31,36,37]
Gain Tree City USA status	2	[6,8]
Celebrate Arbor Day	2	[6,8]
Establish a tree board	2	[6,8]
Conduct community education	1	[8]
Increase program budget to $2 per capita (Tree City USA standard)	1	[6]
Reach urban tree canopy cover goals	1	[8]
Conduct tree plantings	1	[7]
Increase community recreation	1	[8]

Rines et al. (2010) asked Massachusetts Tree Wardens to rate their current priorities. Ninety-six percent prioritized (high or moderate priority) removing hazardous trees, and 63% prioritized work inspections, but only 31% prioritized public education and outreach, and 28% prioritized addressing policy issues. Tree planting and preventative maintenance each garnered 49% prioritization. Tree wardens also rated the importance of urban forestry performance parameters, including CARS criteria and inter-department communication. Eighty-eight percent "agreed" or "strongly agreed" with inter-departmental communication's importance, 67% with the need for qualified staff, and 57% with the need for management plans. Many tree wardens who "highly agreed" with a parameter came from a community that met that parameter [62].

Often questions do not include a timeframe for implementation or do not separate current/ongoing practices from new initiatives. However, Stevenson et al. (2008) did ask Pennsylvania respondents whether a component currently existed and the likelihood of adding it within three years. Of the public works administrators who responded to the survey, 28% reported having a management plan, and 43% reported it was likely to be added. Sixty-four percent reported the existence of an ordinance, with 19% projecting that they would create one in the future. In municipalities between 10,001 and 20,000 people, 37% already had Tree City USA status, while 17% indicated a desire to obtain that status [6].

In addition to asking about needs and barriers, the Portland, Oregon, and Vancouver, Washington survey explored management priorities. When asked for their highest priority, 30% of the respondents indicated increased community education, followed by the creation or revision of a management plan with 18% and the creation or revision of tree ordinances with 16%. These "highest priorities" were followed by obtaining Tree City USA status, inventory completion, achieving urban tree canopy cover goals, hiring an urban forester or ISA Certified Arborist, increasing recreational opportunities, and Arbor Day observance, all with less than 10%. No respondent chose the creation of a tree board as their highest management priority [8].

4. Discussion

Associations among urban forest program components (i.e., ordinances, staff, and tree planting programs) and community size, location, or resources are found across articles at all geographic levels. Communities with higher-level urban forest management programs were more likely to have professional staff and apply for grant funds [66]. Officials aware of local tree agencies and their state's urban and community forestry program (UCF), and thus with access to technical support, are more likely to be from communities with higher tree program funding [7].

Educational needs were queried in a few studies. Half of the Massachusetts Tree Wardens interviewed in 2013 indicated they needed opportunities for training and continuing

education [22], as well as 77% of Utah municipal respondents in 2002 [68]. Central themes were safety, pests, inventories, tree selection and planting, and hazard assessment [22,68]. The need for training related to insect and disease identification and arboriculture practices was reported by Miller and Bate (1978) [19]. Other studies indicated that municipalities were interested in technical assistance pertaining to writing management plans, crafting ordinances, and conducting inventories, as well as cost-share information, developing program funding, and increasing program support [8,65,68]. Driscoll et al. (2015) high-lighted the dire need for public and political support, which can be achieved through public education regarding the benefits of trees and targeted messaging for elected officials [8].

Where communities source their information is important. In Utah, 57% of the communities responded that they consult a local nursery or tree care business, and 53% used the Utah Cooperative Extension system. The state forestry agency was only used by 36% of communities [68]. In rural Pennsylvania, professional urban foresters or arborists were few in number; thus, access to local technical support may be limited in similar locales [27].

The smallest communities relied more on grants and donations than the larger communities in order to manage their urban forests [68]. While these key themes are prevalent, each state's urban and community forestry program (UCF) differs based on the needs of that state and the type of services the state provides [67]. To successfully support urban forestry in their state, each UCF program staff should thoroughly understand their municipalities' status and management factors [69]. Annual USDA-FS UCFP CARS reporting can provide the number of communities with management plans, ordinances, staff, and tree boards, but that is still only part of the picture. Additionally, limited data and varying sampling methods and analyses make intra- and inter-state evaluations difficult.

National periodic surveys can provide trend data on many urban forestry management-related topics. However, these surveys are infrequently conducted [12] and are at such a scale that often only regional results are available. A complete report comparing the data among the 1974, 1980, 1986, 1993, and 2014 results has yet to be published. Though details relating to funding sources, budgets, expenditures, and whether communities use systematic or reactive management are included in an International Society of Arboriculture 2015 Conference paper [70]. Data on the findings related to street tree diversity [71] and risk management [72] were also published. Additionally, with low sample sizes, the Johnson (1982) and Clark and Matheny (1998) studies were limited in scale and only provided a snapshot of urban forestry conditions across the country within selected parameters [54,55].

There are only 20 state and sub-state articles and two regional articles in the scientific literature spanning 48 years. Thirteen states have at least one state-level urban forest program management analysis (AL, FL, IL, MA, MI, MS, MO, NJ, OR, PA, TX, UT, and WI). Three states have sub-state data focusing on a major urban complex or portion of the state (OR/WA and PA). This leaves 36 states unrepresented at the state level in the peer-reviewed literature. Additionally, no studies were found for U.S. territories or protectorates. See Figure 1.

Only a few states have multiple studies in the scientific literature (Figure 1), and only two have thoroughly presented comparison data: Mississippi and Oregon. This lack of replication was also noted in the Ordóñez et al. (2019) review of global urban forest governance and decision-making journal articles, which included twelve of the U.S. studies we reviewed [73]. Mississippi's trend data found that community leaders were more aware of the concept of urban forestry, with 78% aware in 2011 versus 62% in 2004, and related urban forest benefits, with 42%–47% in 2004 versus 52%–56% in 2011. However, community leader awareness of different urban forestry support organizations and funding sources was lower in 2011 than in 2004 [37]. These results suggest that communities may have heard of the benefits of urban trees, but they did not know how to access resources to support their local programs and projects. Grado et al. (2013) also noted that funding and staffing were the most significant barriers and needs for all sizes of Mississippi communities in 2004 and 2011, indicating that these challenges remained significant [37].
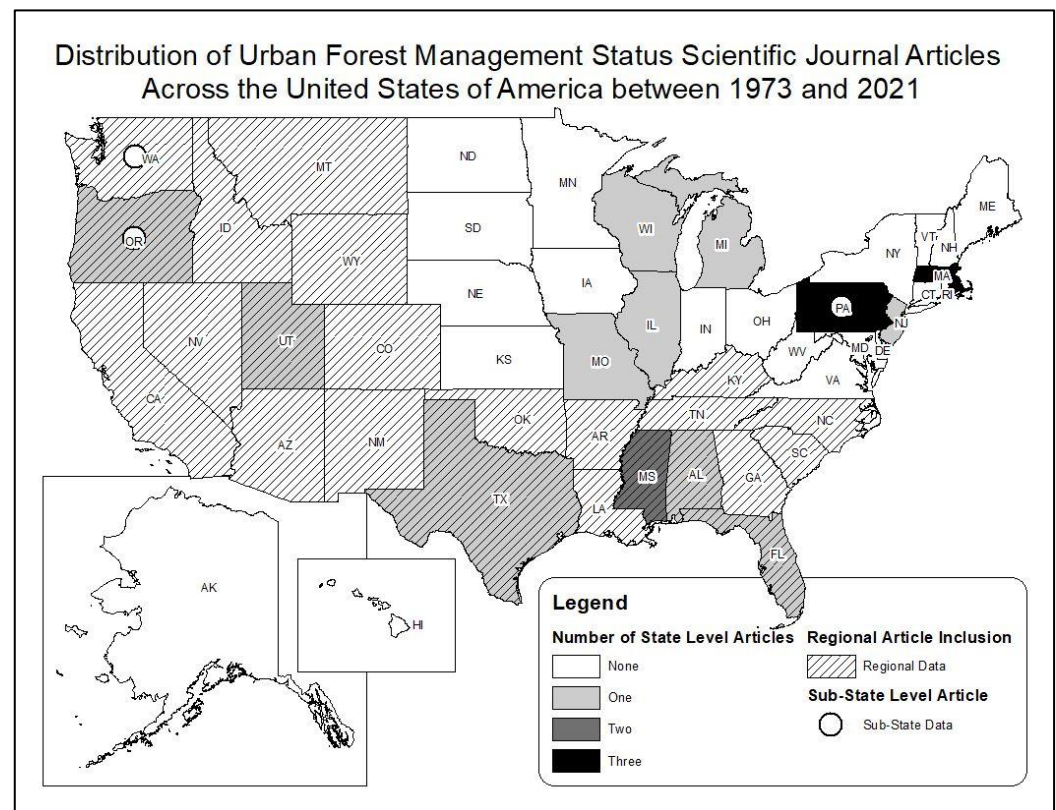
Figure 1. Map of States with Regional, State, and Sub-State Journal Articles.

Ries et al.'s 2004 survey replicated many questions from a 1992 survey of Oregon cities completed by the Oregon Department of Forestry and a 1994 survey conducted through Portland State University [31]. Key measurements increased across the board. Tree planting and care programs increased from 26% in 1992 to 37% in 2004. The incidence of tree ordinances grew from 46% of cities in 1992 to 62% in 2004. Inventories increased from 46% to 56%. Cities participating in Tree City USA grew from 8% in 1992 to 15% in 2004. The perceived importance of tree-related outcomes also changed between 1992 and 2004. In 1992, the top three tree-related values were "Promote business development", "Improve community appearance", and "Increase community infrastructure value". The 2004 survey results found that "Improve community appearance" had moved into the number one slot, "Promote business development" had dropped to number three, and "Decrease hazards from trees" had moved from number nine in 1992 to number two. This may reflect an increased awareness of tree condition and risk as well as a potential reaction to a significant ice storm that had recently affected the state [31].

Treiman and Gartner's (2004) 2003 survey of community officials in Missouri was at least partially replicated in 2011, and the results were presented in a short technical document [74]. The 2011 survey found increases in the percentage of communities with an ordinance, with an inventory, that conducted maintenance, performed tree planting, and removed hazardous trees. The document outlined many of the questions asked in the survey but only provided a brief summary of the results [74].

Cool et al.'s 1970 Michigan data [63] appears to have asked municipalities to reflect on the previous few years for questions relating to staffing, contractors, and planting. Neither details on these questions nor a thorough comparison of their results were presented in the paper.

Temporal differences across the papers highlight changing management foci. Johnson's (1985) article reflected on the Dutch elm disease origins of urban forestry programs and the costs of fighting that disease [54]. Many communities had Dutch elm disease-specific ordinances and management concerns and often had larger budgets to accommodate

responding to the disease [15,22,70]. With the onset of the emerald ash borer, communities are seeing significant impacts on the composition of their forests as well as their municipal budgets. Some communities reacted to this pest by adding specific budget lines related to emerald ash borer [12,70] and amending planting lists.

Many authors reported response biases. Clark and Matheny (1998) felt there was self-selection in that communities with positive feelings about urban forests were more likely to respond, and the communities they surveyed were not chosen at random but rather deliberately selected from a list of cities with known urban forestry programs [55]. Stevenson et al. (2008) also found higher response rates from municipalities with more developed urban forestry programs [6]. Rines et al. (2011) noted that responding communities in Massachusetts tended to have larger and denser populations with higher median incomes [61]. Authors of a related study similarly noted that cities which responded to their survey were more likely to have professional staff, tree-related ordinances, and tree boards [75].

Additionally, the state-level studies explored slightly different urban forest program management aspects or used different methods and question formats (Table 9), limiting the ability to compare the results [67,73]. For example, two Pennsylvania studies, Reeder and Gerhold (1993) and Stevenson et al. (2008), asked a few of the same basic questions about the presence of a tree commission, a tree ordinance, and an inventory [6,65]. However, Stevenson et al. (2008) explored differences in knowledge and attitude based on respondent type, program development, and population size, while Reeder and Gerhold (1993) did not divide their results similarly; as such, only limited comparisons between the results of the two studies is possible. Some studies asked communities to rank needs and barriers by those most pressing [8]. Others asked communities to provide the degree to which each was identified on a scale of 1 to 5 [6,36,37]. The results of these two types of questions, while similar in some ways, are ultimately difficult to compare. Additionally, only a few studies used advanced or multivariate data analyses to identify relationships between municipal attributes and urban forest management program components and needs.

Table 9. State and sub-state urban forest management studies methodology summary, U.S. 1973–2021.

Survey Methodology	Respondent Group	Frequency	Study
Surveys	Municipal Officials	7	[7,31,36,37,66–68]
	Municipal Officials and Tree Board Chairs/Members	1	[65]
	Municipal Officials and Program Managers	3	[6,8,19]
	Program Managers	4	[16,25,61,62]
	Municipal Survey, respondents unclear	2	[63,64]
	Subset of National Survey Data	1	[58]
Interviews	Program Managers	1	[22]
Mixed Methods	Survey of Municipal Managers and Tree Board Members followed by Focus Group with Tree Board Members	1	[27]

5. Conclusions

The collection of studies presented here provides insight into programs and management needs. Their results indicate that communities have different urban forestry management needs depending on their size, income levels, staffing, location, residents' expectations, and the forest's size and composition. Some common themes across the reviewed studies include that the number of urban forestry programs is increasing, larger communities are more likely to have an urban forestry program and have urban forestry staff, and communities that are predominantly white or of higher income are more likely to have an urban forestry program. Many municipalities have at least one tree-related

ordinance, but few municipalities have a tree inventory, and fewer still have a management plan. Communities report that they need more public and political support and urban forest management funding and that there is an overall lack of trained urban forest managers. Communities with staff and a budget generally have more advanced urban forestry programs. Additionally, awareness of statewide urban forestry assistance programs is moderate to low and inconsistent between respondent types. The proximity of a community to an urban area seems to affect local urban forest services and support. Communities with more advanced programs are more aware of statewide support programs and are more likely to receive grants.

Substantial shortcomings exist in the available studies. Nationally collected data can provide status updates on a wide range of urban forest management aspects and is suitable for reporting on the National Urban and Community Forestry Council goals. However, the infrequency of data collecting results in substantial lapses in information availability. There are also few data points per state, making it difficult to draw more detailed conclusions regarding local trends in most areas.

There is a shortage of state-level data on urban forest program management in the scientific literature. No data was found for thirty-six states, and 48 states do not have trend data in scientific journals. While more states have technical reports, many are out-of-date, inaccessible, or completely unavailable. The creation of a centralized, accessible repository for state technical reports and data from academic studies could help maintain data and facilitate comparability across time and studies.

Also, some data collected through urban forest program management analyses are directly comparable, while others are not due to different data collection methods, question formats, or presentation of results. Furthermore, only five of the reviewed state-level studies gathered data in the last decade.

Only one study provided considerable insight into how local demographics may affect an urban forestry program, and few studies use modeling or multivariate data analyses. Studies such as these may be able to help sort out the root causes of poorly performing programs.

Detailed information on the educational needs of municipal staff was only present in a few studies. Additionally, most state-level papers only provided details regarding urban forest program components' current or past status, with less than half of the studies asking whether managers plan to continue or commence urban forestry services in the future. This presents a gap in understanding where communities are heading, which is key information for agencies designing technical and educational assistance and grant programs.

This review has underscored the dearth of studies cataloging local urban forestry programs, supports, and knowledge within and across states while highlighting such studies' value. State UCFs and urban forestry agencies work to develop and deliver the technical, educational, and financial support their municipalities need. Therefore, these agencies need to have timely, comprehensive analyses of the current local urban forest programs and resources, as well as an understanding of future program goals. Local managers need data to gauge their progress and consider management hurdles. More scientific literature on urban forest management programs is needed at all geographic levels. Those studies should include examinations of a wide range of program aspects, including the program status, needs, and time-bound future intentions. Such studies are critical to the continued spread and improvement of local urban forestry programs in the United States.

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