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# Statewide assessment of street trees in New York State, USA

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ABSTRACT

In the United States, street tree management and planning occurs at regional, state, and local levels. However, state and federal officials charged with managing streets trees at the regional and state levels typically lack the comprehensive, detailed information available to local officials in a street tree inventory such as species composition and tree size distribution. Statewide street tree assessments employing a variety of methodologies have been conducted to fill this knowledge gap. This paper examines these past assessments and builds upon them in conducting a street tree assessment for New York State in which geographic variability in statewide street tree inventory data is accounted for through weighted averaging of estimates.



## Introduction

Street trees (trees growing in a street right-of-way) typically represent a minority of the urban forest (Dwyer et al., 2000), but often receive special attention due to their public function (Cumming et al., 2008). Effective resource management depends on managers having the information they need to make knowledgeable decisions. For street trees managed by a municipality, a street tree inventory provides local officials with the detailed information needed to manage and plan for pruning and maintenance, new plantings, and species diversity. However, management of the street tree resource occurs not only at the local level of the individual municipality, but also at broader geographic levels such as the state or region. In the United States, Farm Bills passed by Congress provide funding to the United States Forest Service (USFS) to partner with the individual states on managing urban and community forests including its street tree component (Hauer et al., 2008). Statewide management plans, reflecting regional and national priorities identified by the USFS, delineate goals and strategies for each state's urban and community forests. Local municipal management plans are encouraged to be consistent with the statewide plan. In comparison to officials in municipalities where street tree inventories have been conducted, state officials are at a disadvantage since most municipalities in a state, and particularly municipalities other than the state's larger cities, typically do not possess a street tree inventory (Green et al., 2002; Maco and McPherson, 2003). The resulting patchwork of street tree inventory data poses problems for street tree management and planning on a statewide basis. For example, it is difficult to gauge the impact of invasive pest species such as the emerald ash borer (EAB) or the Asian longhorned beetle (ALB) on a state's street trees when most municipalities in the state do not possess a street tree inventory. The need for more comprehensive, detailed information to manage street tree populations has also increased due to climate change's potential impact on street tree health and survivability (Roloff et al., 2009; Yang, 2009; Tubby and Webber, 2010).

To facilitate statewide street tree management, some states have made statewide street tree assessments based on data collated from municipalities possessing a street tree inventory. In California, inventory data for twenty-one Southern California cities indicated that species diversity was declining and more small statured trees were being planted than large statured trees, particularly in coastal communities (Lesser, 1996). In Connecticut, an analysis of inventory data for eleven cities and towns estimated statewide street tree species composition, and identified street tree species most likely to cause damage to property and infrastructure during extreme weather events (Ward, 2011). In Indiana, inventory data for twenty-three municipalities provided statewide estimates of street tree species composition (Davey Resource Group, 2010a) and the environmental services and economic benefits provided by street trees (Davey Resource Group, 2010b). In Kansas, the number of black walnut street trees statewide at risk to Thousand Cankers Disease was extrapolated from inventory data for 192 communities (Treiman et al., 2010). In South Dakota, thirty-four municipalities were surveyed for street tree genus and species composition

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and susceptibility to ash tree loss to the EAB (Ball et al., 2007). In Virginia, ash tree loss to the EAB and its impact on ecosystem services were assessed from inventory data for eight municipalities (Wiseman and Wright, 2010).

Besides extrapolating estimates from collated street tree inventory data, statewide street tree assessments have also been based on a sample of urban roadside plots. In Maryland and Massachusetts, 582 randomly selected plots generated estimates of the total number of street trees in each state and their genus and species composition (Cumming et al., 2004). In Michigan, data from 169 plots in 20 cities was used to estimate street tree species composition, tree condition, and tree size distribution statewide (Wildenthal and Kielbaso, 1994). In Minnesota, statewide estimates of the distribution, size, and condition of elm and ash trees within 66 feet of the roadside edge were extrapolated from samples in 789 communities (Minnesota Department of Natural Resources, 2007). In Missouri, data from randomly selected plots in 44 communities found increases in street tree numbers and species diversity compared to a similar survey conducted ten years previously (Gartner et al., 2002). In New Jersey, 432 randomly selected plots from 108 municipalities indicated an increase in street tree numbers, but a decline in street tree health compared to a similar survey conducted five years previously (NJ Forest Service, 2000). In Wisconsin, 891 randomly selected plots yielded statewide estimates for the total number of street trees, species composition, and tree size distribution (Cumming et al., 2008).

Additionally, statewide street tree assessments have been made on the basis of questionnaires in California (Bernhardt and Swiecki, 1993; Thompson, 2006; Muller and Bornstein, 2010), Illinois (Green et al., 2002; Sass et al., 2010), and Ohio (Sydnor et al., 2007). And, on a broader, regional scale, Raupp et al. (2006) evaluated street tree vulnerability to the EAB and ALB in the Eastern United States and Canada based on street tree inventory data collated from twelve municipalities and one college campus, and McPherson and Rowntree (1989) used inventory data from twenty-two municipalities nationwide to study stocking levels, trees per capita, and the planting of more small sized trees relative to large sized ones.

Thus, statewide street tree assessments have utilized a wide range of techniques, but most assessments have been based on either street tree inventory data collated from municipalities or data collected from a random sample of roadside plots. Each strategy has advantages and disadvantages. Street tree inventory data, particularly data from inventories where all street trees in a municipality have been surveyed, typically provide the most complete, accurate, and detailed information available at the municipal level. Additionally, obtaining previously collected data from municipalities can be less costly and time consuming than collecting data from hundreds of roadside plots statewide. However, street tree inventory data are often not kept up-to-date by municipalities and timeliness and standardization are concerns. Moreover, inventory data collated from municipalities statewide do not constitute a random sample of the statewide street tree population which raises questions about the generalizability of statistical analyses from the sample to the population as a whole. Data collected from a random sample of roadside plots satisfy the assumption of independent and identically distributed observations underpinning most statistical analyses. Timeliness and standardization of the data are also less likely to be a concern if data are collected as part of a systematic sampling effort and sample locations can be resurveyed on a periodic basis for longitudinal comparison. However, even a random sample of roadside plots can potentially contain bias since there is no absolute guarantee that random sampling will provide a sample representative of the population.

This paper details a statewide street tree assessment conducted in New York State utilizing street tree inventory data collated from municipalities statewide. The decision to use collated inventory data was based largely on the availability of such data in New York State and their broad geographic distribution. Potential limitations in the generalizability of findings due to the lack of a random sample are acknowledged. Nevertheless, the assessment was conducted in the belief that, if a sufficient number of inventories are assembled, if these inventories are broadly distributed geographically, and if geographic variability in inventory data is identified and accounted for through weighted averaging of estimates, then bias contained in the data due to a lack of random sampling can be mitigated and collated inventory data may still provide a reasonably accurate assessment of street trees statewide.

## Methods

New York State is the thirtieth largest state in the United States with a land area of 122,284 $km^2$ (47,214 square miles); it is also the third most populous state with an estimated population of 19,378,102 in 2010 and the seventh most densely populated state with a population of 158.5 per $km^2$ (410.4 per square mile) of land area (US Census Bureau, 2011a). The state is divided into 62 counties which are subdivided in turn into cities, towns, and Indian reservations. Towns may contain villages and hamlets; unlike a village, a hamlet is an unincorporated named place without defined boundaries, but may contain large numbers of people living in close proximity (New York State Department of State, 2011). The 2000 US Census identified for New York State 62 cities and 556 villages with defined boundaries and 435 Census Designated Places (CDPs), unincorporated concentrations of population with defined boundaries identified by a name; in the 2010 US Census, the number of cities remained the same, the number of villages declined slightly to 555, and the number of CDPs increased to 572 (US Census Bureau, 2012). Methods utilized in this assessment were based on Census geographies and data generated prior to the 2010 US Census.

Between 2008 and 2011, 586 New York State cities and villages, or 94.82% of all villages and cities statewide, were contacted and asked about the presence or absence of a municipal street tree inventory. Cities and villages were prioritized rather than towns based in part on surveys conducted in 2004 and 2009 by the New York State Urban & Community Forestry Council (NYSUCFC), a volunteer group organized in 1999 to advise and assist the New York State Department of Conservation (DEC) in executing its Urban and Community Forestry program. These surveys indicated that New York State cities were more likely to have a street tree inventory than villages, and towns were much less likely to have an inventory than villages. Inventories were obtained from 26 of 62 cities (41.94%) and 97 of 556 villages (17.47%). In addition, inventories were obtained from two towns and thirteen CDPs; eleven of the CDPs, comprising portions of towns, were located on Long Island in the southern part of the state where the town, rather than the city or village, is the predominant civil administrative unit. Data for New York City were assigned to the city's five boroughs, each of which is a county. The number of collated inventory datasets totaled 142 (Fig. 1).

Comparisons were made between municipalities where street tree inventory data were obtained and all New York State Census Places (cities, villages, and CDPs) to assess possible bias associated with collated inventory data. Paired $t$-tests and Mann–Whitney $U$ tests found no statistically significant differences ($\alpha = 0.05$) for median age and percent population with a college degree. Statistically significant differences were found for housing unit density, median household income, median year structure built, percent population below the poverty line, percent owner occupied housing, percent rural population, and population density such that municipalities where street tree inventory data were obtained were characterized by less housing unit density, lower median household income, older median structures built, a higher percentage of