

URBAN TREE RESIDUES: RESULTS OF THE FIRST NATIONAL INVENTORY

by Jack Whittier, Denise Rue, and Scott Haase

Abstract. The volume and characteristics of urban tree residues associated with tree pruning and other urban forestry activities have never been well documented, yet disposal of this residue is subject to increasing regulatory actions. The regulatory actions have a considerable impact on the activities of commercial, utility, and municipal tree care operations. This paper reports the results of the first national inventory of the volume and characteristics of urban tree residues. Residues are classified as follows: chips, logs, mixed wood, tops and brush, leaves, lawn clippings, and stumps. Generators of residues include the following: commercial tree care firms, municipal park and recreation departments, municipal tree care divisions, county tree care divisions, electric/telephone utility power line maintenance departments, nurseries, orchards, and landscapers. The national inventory assesses volume, characteristics, and disposal of the residues on both a regional basis as well as by size of metropolitan area. Finally, irregular residue inputs associated with natural disasters are discussed.

Yard waste, including tree and landscape residues, is estimated to account for approximately 18 percent of municipal solid waste (MSW) and is the second largest contributor to the United States MSW load. For purposes of this report, urban tree and landscape residue is defined as "green" material such as tree limbs, tops, brush, leaves, stumps, and grass clippings. Henceforth, all of this material will be referred to as urban tree residue. Although commonly referred to as "urban wood waste" in the literature, several sources are not included in this study. Excluded sources include: home and commercial construction and demolition debris; residue from saw mills and paper plants; wooden pallet and reel residue; and residue from the secondary wood products industry (e.g., furniture makers). The wood residue types reported in this study include 1) chips: all wood chips including stump chips, 2) logs: unchipped wood usually with a diameter greater than 12 inches, 3) tops and brush: unchipped wood residue other than logs, 4) mixed wood: combination of logs, whole tops, and brush, 5) leaves: seasonal leaf collection, and 6) stumps:

pulled stumps only(1).

Accurate and comprehensive data on urban tree and landscape residue have been either difficult to obtain or non-existent. To date, only highly localized studies have been conducted and none of the studies has been performed on a consistent or uniform basis. The goal of this project is to address the lack of data by developing national estimates of urban tree and landscape residue generated by urban forestry-related businesses.

In this study, the urban forestry industries include commercial tree care firms, municipal tree trimming businesses, electric utility power line maintenance departments, parks and recreation departments, orchards, and landscapers.

This national resource assessment of urban tree and landscape residue is designed to provide important baseline data to assist the arboriculture and urban forestry industries in meeting increasing social and regulatory pressures. Twenty-three state legislatures plus the District of Columbia have banned the disposal of tree and landscape residue in landfills in one form or another (2). Further, an additional eight states are scheduled to implement bans by the end of 1996. Legislation of this form greatly affects both the financial health and disposal practices of urban forestry-related businesses.

Project Approach

A mail and telephone survey was performed of arboriculture and urban forest industries to determine the quantity and characteristics of urban tree and landscape residues. The arboriculture and urban forest industry is comprised of the following groups, or generators of residue: Commercial Tree Care Firms; Municipal/County Park and Recreation Departments; Municipal Tree

Care Divisions; County Tree Care Divisions; Electric Utility Power Line Maintenance; Landscape Maintenance / Landscaper / Nursery firms; and, Excavator / Land Clearance firms.

The methodology used in this effort involved identifying representative populations for each of the generator groups, obtaining mailing lists from multiple organizations, preparing and administering the survey form, and collecting and analyzing the data. Because the survey effort was based on random sampling, it was important to establish statistical significance for each of the various categories of generators and residue forms. Statistical significance provides assurance to data users that the information is reliable and can support policy decision-making.

The analytical undertaking was a two-part effort. The first phase focused on analyzing and reporting the survey data. The second phase was a scale-up effort that provided estimates of national values for each of the generator and residue types for each region identified based upon the survey-obtained statistics. Each of these two efforts are reported separately below.

To facilitate the analysis and use of the survey data, it was useful to group the country into specific geographic subdivisions. Data were obtained on a state-by-state basis and were subsequently aggregated to the same geographic regions utilized by the U.S. Department of Energy's Regional Biomass Energy Programs. These established programs have been collecting information on regionally important biomass resources since the early 1980s, and a considerable knowledge base

currently exists that facilitates comparative analysis.

The mail survey requested information regarding the quantity and characteristics (e.g., chips, logs, brush, etc.) of the annual tree and landscape residue generated by organizations. Other survey questions were related to methods and costs of residue disposal. Finally, questions regarding the influence of natural disasters such as hurricanes and ice storms were also included on the survey form. With regard to natural disasters, respondents were asked to provide information for a 10-year period rather than a single year.

National Survey Results

The tabulation of survey results by generator group for the nation are illustrated in Table 1. For all generator categories, 3,878 organizations were identified and mailed at least one survey document. Also, for all generator categories, 1,710 (44 percent) surveys were returned. The number of organizations that were either "out-of-business" (186) or "declined to answer" (11) was 197 or approximately six percent of the total. Thus, there were 1,513 useful surveys. Of the total useful surveys, 181 organizations (12 percent) reported that they did not generate any residues. In all, there were 1,331 useful surveys that provided information about residue generation.

Table 2 summarizes the survey results of residue generation by region for all generators. Note that all of the information reported in Table 2 is actual survey results and not extrapolations or projections. For the United States, the generators reported

Table 1. National results, urban tree and landscape survey

Generator group	Number surveyed	Number returned	Response rate
Commercial tree care	2,277	638	28%
Municipal/county park and recreation	206	128	62%
Municipal/county tree care division	202	100	50%
Electric utility line clearance	603	285	47%
Orchard	201	35	17%
Landscape maintenance/nursery	199	124	62%
Excavator/land clearance	190	21	11%
Total/average	3,878	1,331	34%

Table 2. Survey results of urban tree and landscape residue generation by type (cubic yards/year).

Residue	Northeast	Southeast	Great Lakes	Western	Northwest	USA*	Row %
Chips	2,559,096	5,132,286	1,688,060	1,563,874	558,677	11,751,992	67%
Unchipped logs	980,029	950,367	398,525	278,881	38,585	2,652,338	15%
Unchipped tops & brush	95,877	711,726	208,689	346,519	13,415	1,376,227	8%
Unchipped mixed wood	84,303	609,735	49,716	219,656	4,477	967,889	5%
Fall leaf collection	80,742	46,347	191,252	67,684	9,125	394,150	2%
Grass clippings	66,312	114,187	107,195	104,055	14,714	406,462	2%
Whole stumps	78,970	30,182	62,725	14,579	2,405	188,861	1%
Column %/total	23%	43%	15%	15%	4%	17,737,919	

* The national total is greater than the sum of the regions because some generators did not indicate the region where they are located.

slightly over 17.7 million cubic yards per year of residue produced. As shown in Table 2, most tree and landscape residue is generated in the form of chips. Over 11 million cubic yards of chips, or 67 percent of total residue, are produced every year. Unchipped tops and brush follow at 1.3 million cubic yards per year or nine percent of the total. Unchipped mixed wood, followed by grass clippings and fall leaf collection, are next with over 968,000, 406,000 and 395,000 cubic yards produced, respectively, each year. The least amount of urban tree and landscape residue comes in the form of whole stumps and unchipped logs. According to survey responses, the greatest volume of residues are generated in the Southeastern region, representing 43 percent of the national total, followed by the Northeast region.

The types of natural disasters that produce urban tree and landscape residue are presented

Table 3. Survey results, natural disaster frequency.

Natural disaster	Frequency	%	Cubic yards	Volume %
Wind/storm	795	61%	1,238,122	52%
Hurricane	164	13%	617,950	26%
Ice	129	10%	204,313	9%
Other	64	5%	20,438	1%
Tornado	44	3%	91,780	4%
Snow	35	3%	6,797	<1%
Drought	30	2%	15,255	1%
Freeze	28	2%	164,292	7%
Flood	6	<1%	38	<1%
Hail	2	<1%	5	<1%
Total	1,297	100%	2,358,990	100%

in Table 3. Strong winds and storms constitute the dominant factor in contributing to tree residues, accounting for 61 percent of the reported natural disaster types. Hurricanes and tornadoes constitute separate categories and, when combined with strong winds, these three categories represent approximately 78 percent of the total natural disaster types. The volume of residue associated with natural disasters mirrors the frequency distribution except for the category referred to as "freeze." For freezing conditions, considerable volume of residue is produced albeit on an infrequent basis.

Table 4 presents information on methods used

Table 4. Survey results, disposal methods of urban tree and landscape residue.

Residue disposal method	Yards (cu.yds./yr.)	%
Give away	7,115,233	42%
Landfill	2,916,751	17%
Sold	2,103,695	12%
as mulch	899,382	5%
as firewood	469,618	3%
as boiler fuel	349,086	2%
as wood products	166,175	<1%
as compost	197,925	>1%
other	21,509	<1%
Leave on site	1,866,479	11%
Send to recycling	1,060,969	6%
Burn for energy	443,959	3%
Stockpile/use on site	757,821	4%
Incinerate, no energy recovery	49,018	>1%
Other	571,768	3%

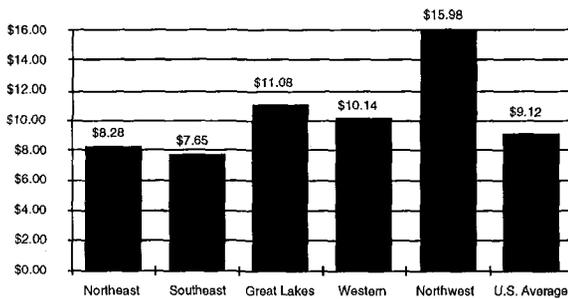


Figure 1. Survey results, regional landfill disposal costs per cubic yard for tree and landscape residue.

to dispose of urban tree and landscape residue in the United States. As indicated, a large quantity (42 percent) is given away. Seventeen percent of the residue is landfilled, while 12 percent or two million cubic yards per year is sold. The highest percentage of that which is sold is used for mulch or sold as firewood.

Figure 1 shows the average regional and national costs for landfilling tree and landscape residue. Of the 17 percent of respondents who landfill their residue, landfill costs to dispose of the residue are reported highest in the Pacific Northwest (\$15.98 per cubic yard) and lowest in the Southeast (\$7.65 per cubic yard). Overall, the national average is \$9.12 per cubic yard. Using a rough approximation of three cubic yards equals one ton, the disposal costs per ton range from \$23 to \$48. The national average is approximately \$27 per ton.

National Residue Generation Estimates

The survey results were used to calculate na-

tional estimates for annual production of urban tree and landscape residues. The scale-up methodology followed accepted statistical procedures and is documented to allow for independent calculation of the national estimates.

In Table 5 the estimated values for the national production of urban tree and landscape residues are presented. The annual residue production is estimated to be 200.5 million cubic yards of green residue per year. Commercial tree care firms and Lawn and Garden/Landscapers produce the greatest amount of residue, almost 147 million cubic yards or 72 percent of the national total. Even though the mean annual production from Lawn and Garden Services/Landscapers is low, this sector has the largest population and therefore is a significant contributor.

Also shown in Table 5 are a variety of statistical parameters for each generator category and the nation. The data for the commercial tree care sector are illustrative of the other generators. The overall population, adjusted to remove firms that do not produce residue, is estimated to be 10,414 firms. These firms, on average, produce 7,004 cubic yards per year of all residue types. The bound on the mean production value represents the 95 percent confidence interval for commercial tree care firms. The bound on the overall estimate (also at the 95 percent confidence interval) for total residue production of 72,937,000 cubic yards is $\pm 27,137,000$ cubic yards. This represents a margin of error of 37 percent.

Figure 2 illustrates the distribution of urban tree residues for all generators on a state-by-state

Table 5. National estimate of urban tree and landscape residue (cubic yards/year).

Generator group	Overall population (N)	Sample mean	Bound on mean	Residue production (000s)	Bound on generator (000s)	% Error
Community tree care	10,414	7,004	3,177	72,937	27,137	37%
Utilities	1,916	4,872	661	9,334	841	9%
Municipalities	2,662	5,883	2,041	15,527	5,375	35%
Parks & Rec. Depts.	4,460	5,018	4,117	22,382	8,171	37%
Land clearance	1,316	4,229	4,662	5,565	2,325	42%
Lawn/garden/landscapers	35,100	2,130	330	74,780	11,570	15%
Total/mean	55,868	3,588	744	200,525	31,178	16%

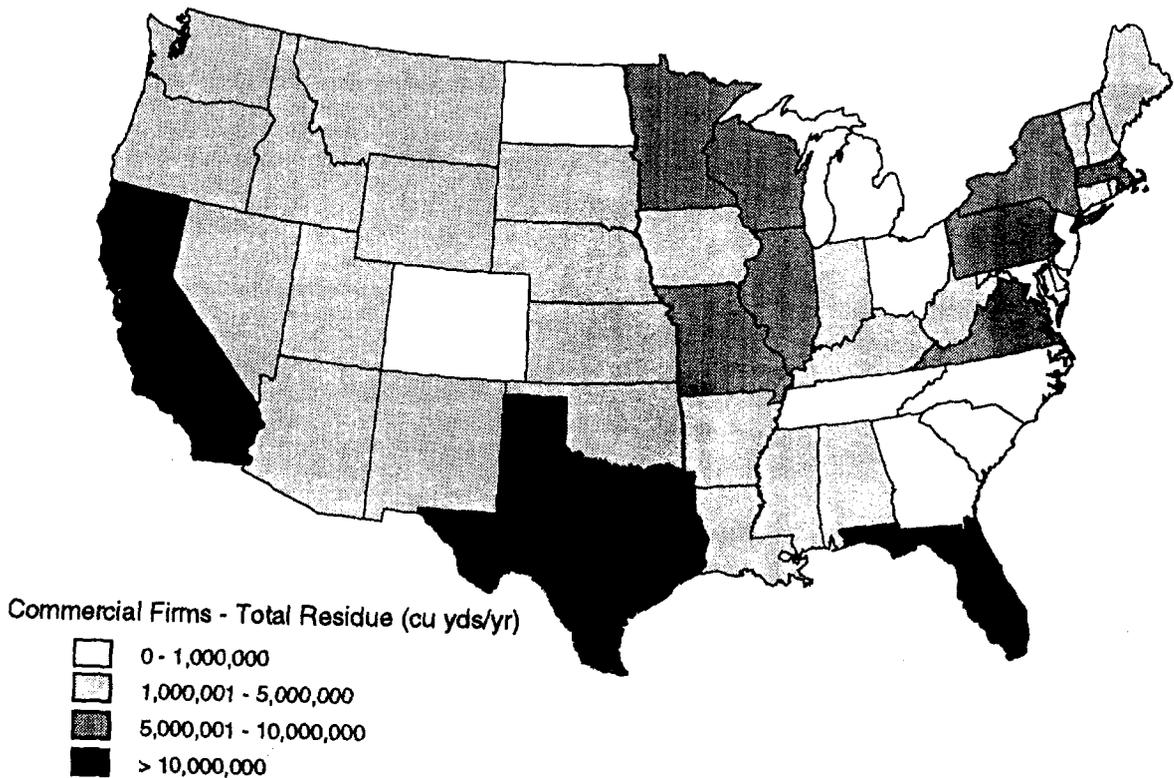


Figure 2. National estimate of urban tree and landscape residue.

basis. The top five states in residue production, from highest to lowest, are: California, Florida, Illinois, Texas, and Pennsylvania. Several states in the Midwest, Southeast, and Northeast also have large volumes. As anticipated, large areas of the West do not contribute significantly to residue production.

Conclusions

Important baseline information has been developed that provides insight into the volume and characteristics of green residues. Regional trends have been illustrated as well as patterns concerning the form of residues. The data in this report offer policymakers insight into important regional or business sector considerations that have only previously been addressed with poor or anecdotal data.

For instance, the significance of the lawn and garden service sector contribution to the national residue total has previously been underestimated. Another significant contributor is the municipal park and recreation departments. Although it was recognized that considerable segments of municipal budgets are devoted to tree care, no prior studies have identified this sector as having such a prominent role in the generation of urban green residues.

In many ways the diversity of the industry was confirmed in multiple fashion throughout the survey effort. Beginning with the difficulty in identifying a population estimate for each generator category and carrying through to variation between mean residue generation rates, the industry in general and the individual generator categories each exhibited lack of homogeneity.

It was revealing to discover the lack of knowledge by industry personnel on the actual volume and characteristics of the residue that they generate. Ninety-five percent of the data reported on the survey forms was estimated by the respondents. The lack of formal accounting methods for monitoring residues is an important missing parameter for obtaining the residue information. Because of the regulatory concerns and budgetary significance associated with residue disposal, firms should track patterns, characteristics, and quantity of residues.

A disappointing result of this study was the level of accuracy to attribute to key parameters. The survey effort was well conceived and received assistance from many individuals and organizations. The survey response rate was sufficient to suggest that statistical accuracy could be maintained. The difficulty arose in the variation in responses received from the generators combined with considerable population discrepancies. Large data variations rippled through the computational effort and led to undesirable error margins. Efforts to minimize the confidence intervals without disrupting the integrity of the data were unsatisfactory.

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NEOS Corporation
 165 South Union Boulevard, Suite 260
 Lakewood, Colorado 80228.

Résumé. Cet article fait état des résultats du premier inventaire national sur le volume et les caractéristiques des résidus d'arbres produits en milieu urbain. Les résidus sont classés comme suit: copeaux, billots, bois mélangé, branchages et broussailles, gazon coupé, et souches. Les producteurs de ces résidus sont regroupés parmi les catégories suivantes: entreprises commerciales d'arboriculture, services municipaux de parcs et de loisirs, divisions municipales d'entretien des arbres, divisions régionales d'entretien des arbres, services d'entretien des réseaux publics d'électricité et de télécommunication, pépinières, vergers, paysagistes. L'inventaire national est composé de données sur le volume, les caractéristiques et le mode disposition des résidus, à la fois sur une base régionale que sur une base locale selon la population. La question des apports irréguliers de résidus à la suite de catastrophes naturelles est aussi traitée.

Zusammenfassung. Dieser Bericht enthält die Ergebnisse von der ersten bundesweiten Bestandsaufnahme über die anfallende Menge und die Eigenschaften von Abfallprodukten städtischer Bäume. Die Abfälle sind wie folgt klassifiziert: Hächselgut, Stammholz, gemischte Holzabfälle, Baumspitzen, Blätter, Strauchschnitt und Stubben. Zu den Verursachern von Abfällen gehören folgende Gruppen: Baumpflegefirmer, Stadtgartenämter, Angestellte von öffentlichen Parks, Strassenmeistereien, Abteilungen zur Pflege der Aussenanlagen von Elektrizitäts- und Telefongesellschaften, Baumschulen, Obstplantagen und Landschaftsbauer. Diese bundesweite Bestandsaufnahme bewertet die Menge, Eigenschaften und die Entsorgung der Abfälle auf regionaler Ebene sowie in der Größenordnung von großstädtischen Flächen. Der unterschiedliche Anfall von Rückständen in Verbindung mit Naturkatastrophen wurde hier dargestellt.