

**URBAN FOREST WASTE GENERATION AND  
UTILIZATION IN GEORGIA**

*A SURVEY STUDY OF CURRENT PRACTICES AND PERCEPTIONS*

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and Environmental Conservation*

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## ABOUT THIS REPORT

In this report are the results of a survey study conducted in 2015 for the Georgia Forestry Commission by the Virginia Tech Department of Forest Resources and Environmental Conservation. This study has not been peer-reviewed and should not be quoted or cited without permission of the principal investigator.

Funding for this study was provided by the USDA Forest Service. The survey was conducted with the oversight of the Institutional Review Board of Virginia Tech. All documentation for the survey is on file with Virginia Tech. Questions about the survey should be directed to the principal investigator. The authors thank Dru Preston and Susan Granberry with the Georgia Forestry Commission for their assistance with compiling the contact list for the municipalities and the Southern Chapter of the International Society of Arboriculture for providing the contact list for Certified Arborists.

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## EXECUTIVE SUMMARY

In 2015, a study was conducted to understand the current practices and perceptions of urban forest waste (UFW) generation and utilization in Georgia. A web-based survey was administered to two professional groups: (1) employees of select urban municipalities and (2) individuals who are Certified Arborists by the International Society of Arboriculture.

Overall response rate to the survey was 32% (municipal employees: 50%; Certified Arborist: 30%). Municipal respondents were primarily arborists, urban foresters, and public works administrators. About two-thirds of Certified Arborists were employed by a tree care company, landscape company, consulting firm, or electric service provider. Nearly three-fourths of municipal employees and just over half of Certified Arborists indicated that their local operation generates UFW. Of those operations, about two-thirds indicated that they could not provide an estimate of the amount of UFW they generate per unit time (weekly, monthly, yearly).

Over half of municipal UFW was reported as originating from municipal street rights-of-way (ROWS) and public greenspaces and another one-quarter came from private residential disposal. Tree pruning and removal on public lands accounted for about 55% of municipal UFW and another 40% comes from curbside pickup of citizen debris. About 70% of UFW generated by private operations originates from private residential and commercial lands and electric utility ROWs. About two-thirds of wood chips generated by municipalities are utilized in some fashion. Nearly three-fourths chips utilized in-house are processed into mulch. The sample size for municipalities that process logs and brush was too small to draw conclusions about where this material ends up or how it is utilized. Nearly three-fourths of logs and wood chips generated by private operations are utilized either in-house or by a third party. When utilized in-house, their UFW is most commonly processed into firewood or mulch.

There was no clear consensus within either group about the motives, incentives, and barriers to UFW utilization. On average, respondents expressed indifference to UFW utilization, but recognized that it is important to their clients and their industry. The strongest incentives for UFW utilization by municipal and private operations was avoidance of transportation costs and environmental sustainability. Nearly half of private arborists viewed the prospect of additional revenue to be an important incentive. Perceived barriers to UFW utilization were quite varied. About half of both groups cited lack of in-house stockpiling space and lack of local UFW processors as major barriers. Nearly half of private arborists cited the difficulty of handling UFW on job sites as a major barrier. Although lack of local processors of UFW was a common barrier, lack of local consumers for urban forest products was not commonly cited as a major barrier relative to other issues.

Respondents did not express a strong interest in self-education or training about UFW utilization and were indifferent about the quality of existing educational or training programs. No clear interest was evident in any particular educational medium or venue. However, in terms of technical assistance, there was strong interest in a centralized facility for stockpiling and processing UFW and an urban forest product cooperative. Private sector arborists also favored an online database to network themselves with enterprises that process UFW and create urban forest products.

# INTRODUCTION

## BACKGROUND

The mission of the Georgia Forestry Commission (GFC) is to provide leadership, service, and education in the protection and conservation of Georgia's forest resources. To this end, GFC closely monitors issues and trends in forest management and organizes education and technical assistance programs to address challenges and opportunities faced by the public and private sector. Because Georgia is a rapidly urbanizing state, there is increasing focus on forest resources in urban and interface areas.

An emerging issue in urban and community forestry is the disposal and utilization of tree debris that is a by-product of land clearing, storm damage, and landscape maintenance. In the study reported here, this material is collectively referred to as urban forest waste (UFW) and lies at the nexus between forest industry and forest sustainability. There is an industry dimension to UFW because there is both tremendous cost in handling and disposal of this material, yet there is also tremendous market opportunity to extract residual value from these often-underutilized raw materials. There is also a forest sustainability dimension to UFW because the practices employed in its handling and disposal has potential environmental impacts ranging from carbon sequestration to air pollution mitigation.

It is because of these economic and environmental implications of UFW that two of GFC's core programs—Forest Utilization and Sustainable Community Forestry—have come together to understand UFW practices and perceptions in the state and to target UFW education and technical assistance needs based on this newfound understanding. Their overall goal is to identify opportunities for outreach, education, and targeted messaging for communities, businesses, and other stakeholders with the aim of increasing awareness and subsequent utilization of wood resources that often end up in the waste stream rather than the wood supply stream. In 2015, GFC partnered with Virginia Tech's Department of Forest Resources and Environmental Conservation (VTFREC) to address their first need: understand UFW practices and perceptions in the state. To address this need, VTFREC worked with GFC to conduct a survey study of urban municipalities and private tree care contractors throughout the state. The results of the survey study reported here will provide baseline information for developing UFW outreach and technical assistance programs to advance the programmatic goals of GFC.

## JUSTIFICATION

Urban areas and populations of Georgia are growing. Although urban lands currently occupy only 8.3% of the state's land base, 75% of the state's inhabitants (7.3 million people) reside in urban areas (US Census Bureau 2010). In the 2000s, Georgia's population grew by about 1.5 million people (US Census Bureau 2011) and is projected to grow by about 4.6 million people between 2010 and 2030 (GA OPB 2010). The majority of these new inhabitants will likely reside in urban areas. This growth in urban population will bring with it growth of urban and interface forests.

Georgia has a substantial urban tree resource. There are an estimated 781 thousand hectares of urban and community tree cover in the state (Nowak and Greenfield 2012), comprising over 293 million trees (Nowak and Greenfield 2009). As urban areas grow, a substantial acreage of existing forest is urbanized and numerous trees are planted in new developments. In managed landscapes, urban trees are continually cut down and disposed as they die off, are destroyed by storms and pests, or are displaced by land development. As a result, there is the potential for substantial UFW generation in Georgia's urban areas.

UFW can be described collectively as the logs, brush, and wood chips generated by arboricultural practices on urban or community trees grown on residential or municipal lands (Tree Care Industry Association, Inc. 2013). Historically, much of this material has been shipped to and disposed in landfills rather than utilized as a renewable natural resource (NEOS Corporation 1994; Nowak et al. 2001; Bratkovich et al. 2008). Urban forestry experts have identified UFW utilization in particular as an essential component of sustainable urban forest management (Clark et al. 1997), but little is known about current practices and perceptions of UFW utilization within Georgia. It is believed that increased UFW utilization will improve the economic and environmental sustainability of the urban forestry industry, but more must be known about the status of UFW utilization in Georgia before that belief can be confirmed. Therefore, there is a need to compile baseline data on UFW generation and utilization in Georgia's urban areas.

There are two primary producers of UFW in Georgia: municipal operations and private arboricultural operations. Municipal operations vary, but are typified by departments and divisions tasked with maintaining municipal trees and/or collecting/processing UFW generated by citizens. Localities that operate solid waste disposal programs process UFW primarily from private landowners and private contractors and secondarily from their own municipal trees and forests. Although much of this material has been historically landfilled, anecdotal evidence suggests that municipalities are moving away from landfilling for various regulatory and economic reasons and instead are processing the material primarily into landscape mulch or compost. There are also some reports that these materials are finding their way into the forest products and biomass supply chains. However, there is no recent empirical data on any of these UFW utilization practices in Georgia.

Private arboricultural operations consist of tree care companies, landscape companies, electric service providers, and various institutions such as college campuses and arboreta. Private operations are often contracted by municipalities to perform work on municipal trees and by electric service providers to manage vegetation in their rights-of-way (ROWs). Private arboricultural operations make a substantial contribution to the UFW stream as they prune and remove trees on their clients' properties. Anecdotal reports indicate that most operations view this material strictly as a cost of doing business. At best, they break even by transferring the material to a third party that processes it for firewood, lumber, mulch, or compost. At worst, operations are paying exorbitant fees to dispose of material at either municipal or private facilities. There are occasional reports of companies that have developed auxiliary businesses to utilize UFW for various value-added products. At present, the amount and fate of UFW generated by commercial operations in Georgia is not known. Moreover, it is unclear whether these operations are aware of or interested in the possible business opportunities that UFW utilization might afford them. This information is foundational to

developing continuing education and technical assistance programs in UFW utilization and to managing the state's urban and community forests sustainably.

Given the inherent differences between municipalities and private arboricultural operations, it is important to distinguish between the two when investigating UFW practices and perceptions in Georgia. Municipal operations are government entities that must conform to regulatory and budgetary constraints, while private operations are largely focused on generating profit. The incentives and barriers to UFW utilization are thought to be different between each sector, as are the opportunities for outreach and education for them. As a result, the study findings reported here are sub-divided by and compared between municipal and private operations.

### **STUDY GOALS AND OBJECTIVES**

The goal of this study was to better understand current practices and perceptions of UFW utilization in urban areas of Georgia. Specific objectives of the study were to:

- Identify the origins and amount of UFW generated through municipal and private arboricultural operations in urban localities of Georgia.
- Characterize the fate of UFW generated through municipal and private arboricultural operations in urban localities of Georgia.
- Examine the perceptions of municipal employees and private sector arborists about the needs, opportunities, and barriers to UFW utilization in urban localities of Georgia.
- Identify opportunities to improve awareness, knowledge, and technical capacity of municipal employees and private sector arborists about UFW utilization.

## STUDY METHODS

### SAMPLING FRAME

This survey study focused on professionals whose work is related to generation and utilization of urban forest waste (UFW) in urbanized areas of Georgia. The sampling frame to which the survey was administered comprised two distinct groups: municipal governments and private arboricultural operations.

A total of 68 municipalities were hand-selected by GFC for inclusion in the survey sampling frame (Appendix I). These localities were chosen because they tend to be in urbanized areas of the state and are known to be involved in the generation or utilization of UFW to some extent. For each municipality, a list of employees responsible for managing municipal UFW (i.e., tree debris generated by arboricultural operations on municipal property or collected from private citizens) was obtained by GFC and given to VTFREC. In instances where GFC did not have an existing contact, an appropriate survey recipient with the most relevant job title—often the Director of Public Works or Director of Parks and Recreation. In the survey solicitation, all municipal contacts were asked to forward the survey to a colleague if they felt that they were not qualified to report on the municipality's generation or utilization of UFW.

The second group in the survey sampling frame was private arboricultural operations. Individuals holding the credential of Certified Arborist from the International Society of Arboriculture (ISA) were selected to represent private arboricultural operations. ISA Certified Arborists work in a variety of industries, ranging from tree care to landscaping to consulting. Although Certified Arborists do not account for all UFW generation in the private sector, they are a well-defined group that is easily contacted through the ISA and is easily engaged in education, outreach, and technical assistance programs. Contact information for Certified Arborists with a mailing address in Georgia (totaling 608 individuals) was obtained from the Southern Chapter of the ISA. To minimize double-reporting in the survey, Certified Arborists who responded to the survey were asked to be the sole respondent for their local operation (in the event that multiple arborists were employed by the same local operation).

### SURVEY INSTRUMENT

Municipal employees and Certified Arborists were administered the same web-based survey. There are several advantages to using electronic surveys instead of on-site, mail, or telephone surveys. Electronic surveys can be longer and more complex, yet still have high response rates and remain cost effective (Vaske 2008). The use of web-based survey software also makes data collection and analysis much more efficient (Griffis et al. 2003). Web-based surveys have been used successfully for conducting forestry research in the past (Poudyal et al. 2010; Fowler 2012; Kimball et al. 2014).

Before being distributed, the survey instrument was pilot-tested by both arborists and municipal employees in Virginia and subsequently revised for clarity and ease of use. The Georgia survey was administered in early spring 2015 using a modified Tailored Design Method (Dillman 2000). This



study was limited to three personalized contacts per recipient and did not include a financial incentive for participation. The Qualtrics online survey platform (Qualtrics, Provo UT) was used to generate an individual survey web link for each person solicited for the survey. Contrary to widely distributed anonymous links, individual links enable each survey response to be tied to that recipient's email address, thus reducing the chances of duplicate responses from an operation. Prospective survey respondents were pre-notified about the survey through an assortment of media (e.g., email listservs, newsletters, magazine advertisements, etc.) in the weeks prior to sending out the formal survey invitation. All individuals solicited for the survey received an email containing the formal invitation and a web link to the survey. Survey responses were monitored daily and individuals who opted-out of the survey were noted and removed from the mailing list. Email reminders were sent to non-respondents at two weeks and five weeks after survey opening, and the survey was closed for data collection after eight weeks.

Survey questions were presented in a variety of formats (Appendix II). First, respondents were asked to answer basic multiple-choice demographic questions about their age, gender, education, and professional experience. Further multiple-choice questions were used to classify the respondent's industry sector (e.g., municipality, business, institution, etc.) and position within their local operation. Respondents were then asked whether their local operation conducts tree work in-house and directly generates UFW or hires contractors to complete this work. Those who responded "Yes" were forwarded to questions about their operation's characteristics, the amount and fate of UFW produced, and trends in past and future UFW generation and utilization.

Survey questions about operational characteristics classified each respondent's operation based on number of employees and municipal location of their operation. Respondents were then asked to report about their operation's UFW generation in terms of the land use origin (e.g., private residential, public greenspace, etc.) and tree management practices (e.g., pruning, tree removal, curbside debris pick-up, etc.). Because operations often do not monitor or track their UFW generation, a screening question was first asked of respondents about their ability to report on UFW generation by their operation. If the respondents confirmed that they had knowledge of UFW generation, then they were asked to estimate the amount of logs, brush, and chips that their operations generate. If the respondents were unable to provide an estimate, then they were forwarded to a series of similar questions about the fate of their operation's UFW. If one of the UFW fates selected was "utilized in-house", then the respondents were asked to specify what types of urban forest products (UFPs) that they produce from their UFW utilization. Finally, respondents were asked to report on their operation's trends in past and future UFW generation and utilization.

Perception questions in the survey prompted the respondents to select their level of agreement with various statements about UFW utilization. The first group of statements proposed reasons for increasing UFW utilization, the second group of statements revolved around the importance of UFW utilization, and the third group of statements related to self-education and training opportunities on UFW utilization. Additional perception questions prompted the respondents to rank both incentives and barriers to UFW utilization as well as certain educational or technical programs based on their potential to increase their capacity for UFW utilization. Respondents were asked to identify and rank at least three incentives, barriers, and educational or technical programs from separate *a priori* lists

(see Appendix II). A fill-in-the-blank for “other” items was also provided to give respondents the opportunity to identify incentives, barriers, and programs not included in the *a priori* lists.

After closing the survey, data were exported from Qualtrics, screened for errors and omissions and analyzed using Microsoft Excel and SPSS Statistics 22 (IBM, Armonk NY). Descriptive statistics were then generated for the survey data to report on both respondent and operational characteristics. Further statistical analyses were used to examine the current practices and perceptions of UFW generation and utilization. For each survey question, responses from municipal employees and Certified Arborists were tested for significant differences using a Chi-squared test. For categorical questions resulting in ordinal data, the null hypothesis was that the distributions of responses across all answer choices were the same for both municipal employees and Certified Arborists. For percentage or fill-in-the-blank questions resulting in scale data, the null hypothesis was that the distributions of responses for each answer choice were the same for both municipal employees and Certified Arborists. In Tables 1–11 of the Study Findings section, a single *p*-value is reported for questions resulting in ordinal data, while *p*-values for questions resulting in scale data are reported in a separate column next to each answer choice. The null hypothesis (no difference in the response variable between study groups) was tested at the  $\alpha=0.05$  significance level.

## Study Findings

### **SURVEY RESPONSE**

Survey invitations were sent to 608 ISA Certified Arborists and to employees of 68 municipalities. Several of the email invitations were immediately returned because the email address of the recipient was invalid. No effort was made to find the correct contact information for Certified Arborists with invalid emails, but valid contacts were eventually located for all municipalities. Several of the Certified Arborists turned out to also be the primary contact for a municipality and were therefore moved over into the municipal respondent group. Of the 68 solicited municipalities, 34 eventually responded to the survey, resulting in a response rate of 50%. A few of the larger municipalities (e.g., Atlanta) had multiple employees respond to the survey. All of these responses were retained in the dataset because they cover such large geographic areas and having the additional responses boosted the statistical power of the survey. After these adjustments, the effective sampling frame for Certified Arborists was 601 individuals. Survey responses were received from 179 of these individuals, resulting in a response rate of 30% for Certified Arborists.

A screening question at the beginning of the survey asked both municipal and arborist respondents if they were directly involved in the generation of UFW or in a position to report on the generation of UFW by their local operation. If they answered “No”, they bypassed the UFW practices section of the survey and were forwarded to the UFW perceptions section. As a result, sample sizes for some of the survey questions about UFW generation and utilization are lower than the total respondent counts reported above. Sample sizes for other questions may also vary due to question forwarding (a respondent bypassing a particular question based on their response to a previous question) or respondents exercising their right to not answer particular questions.

### **RESPONDENT AND OPERATIONAL CHARACTERISTICS**

Responses to demographic and operational survey questions were used to characterize the municipal employee and Certified Arborist respondents (Table 1). These characteristics provide insight on the practices and perceptions of UFW utilization reported later. The majority of respondents were male, between 30 and 60 years of age, have completed some level of higher education, and have more than 10 years of professional experience. The municipal employee and Certified Arborist groups did not statistically differ for any of these characteristics.

In the arborist group, about one-third of respondents reported that they worked for a tree care company. An additional one-third reported employment by an institution (e.g., college campus, arboretum, etc.) or electric service provider. The remainder comprised consulting firms, landscape companies, and the GA Dept. of Transportation. About 10% of respondents indicated employment in sectors not listed in the survey; examples included state and federal agencies, non-profits, and engineering firms.

**Table 1:** Characteristics of municipal employees and Certified Arborists in Georgia who responded to a survey on urban forest waste (UFW) practices and perceptions. Where provided, *p*-values indicate the statistical probability that municipal employees and private arborists do not differ for the characteristic of interest.

<b>Age</b> ( <i>p</i> -value=0.445)	<b>Municipal</b> (n=56)	<b>Private</b> (n=179)
18-30	5%	13%
31-44	30%	29%
45-60	50%	43%
61+	15%	15%
<b>Gender</b> ( <i>p</i> -value=0.922)	<b>Municipal</b> (n=56)	<b>Private</b> (n=179)
Female	18%	18%
Male	82%	82%
<b>Education</b> ( <i>p</i> -value=0.336)	<b>Municipal</b> (n=56)	<b>Private</b> (n=179)
High school or equivalent	18%	17%
Associate degree	7%	14%
Bachelor's degree	57%	45%
Graduate degree	18%	24%
<b>Experience</b> ( <i>p</i> -value=0.304)	<b>Municipal</b> (n=56)	<b>Private</b> (n=179)
0-10	27%	27%
11-20	38%	26%
21-30	23%	25%
31+	12%	22%
<b>Industry Sector</b>	<b>Municipal</b> (n=56)	<b>Private</b> (n=179)
Municipality	100%	0%
Tree care company	n/a	34%
Landscape company	n/a	8%
Consulting Firm	n/a	14%
Institution	n/a	18%
Electric service provider	n/a	15%
GA Dept. of Transportation	n/a	1%
Other	n/a	10%
<b>Position within municipal sector</b>	<b>Municipal</b> (n=56)	<b>Private</b> (n=0)
Arborist	29%	n/a
Horticulturist	4%	n/a
Urban Forester	13%	n/a
City/Town/County Manager	2%	n/a
City/Town/County Planner	4%	n/a
Public Works Administrator	29%	n/a
Parks and Recreation Administrator	2%	n/a
Other	20%	n/a
<b>Position within private sector</b>	<b>Municipal</b> (n=0)	<b>Private</b> (n=69)
Manager of regional operation	n/a	17%
Manager of local operation	n/a	42%
Manager of production crew	n/a	16%
Member of production crew	n/a	6%
Other	n/a	19%

Among arborist respondents directly involved in UFW generation, just under half (42%) identified themselves as the manager of a local operation (e.g., a tree care or landscaping company) and about one-quarter (22%) reported being a manager or member of a field production crew. About 20% identified with other private sector positions such as sales person, landscape architect, or consultant. Although the Certified Arborist respondents were not exclusively private sector arborists, in this report the group is referred to as such for simplicity of reporting and to clearly distinguish them from the municipal employee group.

Municipal respondents reported holding a wide range of positions. Just under half (42%) identified as arborists or urban foresters and nearly one-third (29%) identified as public works administrators. Few respondents were in high-level administration outside of Public Works. About 20% of respondents identified with other occupations not listed in the survey such as landscape architect, engineer, or environmental compliance manager.

There was a strong dichotomy in the number of employees reported for local operations. In both the municipal and private sector, over half of respondents reported 10 or fewer employees in their local operation (Table 2). In contrast, about one-fourth of both municipal and private operations reported 21 or more employees. Operation size not only has an influence on the amount of UFW generated, but also may influence an operation's capacity to utilize UFW as high-value products. Larger operations may have better physical assets such as specialized equipment or greater real estate space, allowing them to stockpile and process UFW more readily than small operations. Likewise, larger operations may have more diversified and specialized skill sets amongst employees for processing UFW.

## **URBAN FOREST WASTE GENERATION**

### *Origins of Urban Forest Waste*

Nearly three-quarters of municipal respondents (73%) reported that their local operation generates UFW (Table 2). This was to be expected given how the municipalities were chosen for inclusion in the survey sampling frame. Surprisingly, two-thirds of these municipal respondents (66%) indicated that they could not estimate how much UFW their operations generate; however, most of them knew where their UFW originated and how it was generated (Table 3). On average, they reported that over half of their operation's UFW came from municipal street ROWs and public greenspace and an additional third came from private sources. Less than 10% of their UFW came from non-municipal ROWs. Over half of municipal UFW was the result of tree pruning (31%) and removal (24%) conducted by the operation and the bulk of the other half was the result of curbside pickup of UFW. Less than 10% of municipal UFW was generated from land clearing or logging.

Just over half of Certified Arborist respondents (52%) reported that their local operation generates UFW (Table 2). An initial assumption of the study was that the majority of arborist respondents to the survey would be employees of tree care or landscaping companies, which actually turned out to be just over one-third of respondents. Similar to the municipal respondents, 70% of arborists directly involved in UFW generation indicated that they could not estimate how much UFW their local operations generate.

**Table 2:** Characteristics of municipal and private arboricultural operations in Georgia that responded to a survey on urban forest waste (UFW) generation. Where provided, *p*-values indicate the statistical probability that municipal and private operations do not differ for the characteristic of interest.

<b>Number of employees in the local operation</b> ( <i>p</i> -value = 0.708)	<b>Municipal</b> (n=40)	<b>Private</b> (n=91)
0-5	32%	30%
6-10	30%	22%
11-15	10%	17%
16-20	5%	8%
21+	23%	23%
<b>The local operation generates UFW</b> ( <i>p</i> -value = 0.006)	<b>Municipal</b> (n=55)	<b>Private</b> (n=176)
Yes	73%	52%
No	27%	48%
<b>Ability to estimate amount of UFW generated by the local operation</b> ( <i>p</i> -value = 0.121)	<b>Municipal</b> (n=38)	<b>Private</b> (n=86)
Keep detailed records	13%	3%
Can provide an estimate	21%	27%
Cannot provide an estimate	66%	70%
<b>Ability to identify fate of UFW generated by the local operation</b> ( <i>p</i> -value = 0.102)	<b>Municipal</b> (n=36)	<b>Private</b> (n=84)
Keep detailed records	11%	5%
Can provide an estimate	31%	50%
Cannot provide an estimate	58%	45%

As expected, over half of private sector UFW originated on private residential (36%) and commercial (18%) lands (Table 3). UFW from electrical utility ROWs (16%) was another major contributor of private sector UFW. Just over one-quarter of private sector UFW came from public ROWs and greenspaces. The other 4% of UFW came from public-private lands such as college campuses, state parks, and arboreta. The only statistical difference between municipal and private sector operations was that much more municipal UFW comes from municipal ROWs and greenspaces.

Tree pruning and removal by far accounted for the majority of UFW generated by the private arboricultural operations, combined totaling 86% (Table 3). As expected, private arborists conduct very little curbside pickup of UFW—most likely only in circumstances such as private residential communities. Like the municipalities, very little of the private sector UFW is generated from land clearing and small woodlot logging. However, caution is urged not to misinterpret this finding to mean that land clearing and logging are a small percentage of overall UFW generation. It simply could mean that the individuals conducting these practices are not Certified Arborists. Nevertheless, it does indicate that Certified Arborists (at least those who responded to the survey) are not highly engaged in small woodlot logging and that this might be a growth opportunity for tree care companies.

**Table 3:** Generation of urban forest waste (UFW) by municipal and private arboricultural operations in Georgia (based on self-reported data). Where provided, *p*-values indicate the statistical probability that municipal and private operations do not differ for the item of interest.

<b>Land use origin of the UFW generated by the operation</b>	<b>Municipal (n=39)</b>	<b>Private (n=88)</b>	<b><i>p</i>-value</b>
Municipal street ROW	38%	8%	≤ 0.001
Private residential	26%	36%	0.111
Municipal greenspace	21%	14%	0.003
GA DOT roadside ROW	7%	4%	0.282
Private commercial	6%	18%	0.320
Electric utility ROW	2%	16%	0.119
Other	0%	4%	0.257
<b>Management practices that generate the operation's UFW</b>	<b>Municipal (n=38)</b>	<b>Private (n=87)</b>	<b><i>p</i>-value</b>
Curbside pickup	39%	6%	0.001
Tree pruning	31%	52%	0.334
Tree removal	24%	34%	0.947
Land clearing	4%	4%	0.507
Small woodlot logging	2%	3%	0.650
Other	0%	1%	0.727

#### Amount of Urban Forest Waste

As mentioned above, municipal employee and Certified Arborist respondents directly involved in UFW generation were asked if they could estimate how much UFW their local operations generate. Only about one-third of municipal operations reported that they could estimate their UFW generation; of that portion, only 13% indicated that they keep detailed records of UFW (Table 2). Even fewer private arboricultural operations keep detailed records (about 3%), and just over one-quarter could provide an estimate of UFW. Because it was not anticipated that respondents would have limited information about their UFW generation, the survey was not designed to examine record-keeping practices. Multiple reasons may exist: no incentive for tracking, no procedure for quantifying, or no willingness to divulge the information. Although not a statistically significant difference, municipalities may keep more detailed records of UFW for economic or regulatory reasons.

Because only about one-third of the municipal and arborist respondents directly involved in UFW generation indicated that they could estimate how much UFW they generate, the sample sizes used for quantifying the amount of UFW generation were fairly low and the data were quite variable, even after adjusting the data for the number of employees in each operation (Table 4). The coefficient of variation is reported for the UFW type generated by each operation type. This statistic is computed by dividing the standard deviation by the mean and multiplying by 100. In every case, the coefficient of variation was well over 100% and ranged as high as 315%. This statistic is an indicator of highly variable data; as a result, it is difficult to make any strong inferences about UFW generation.

Extreme variability could be a consequence of at least two different scenarios. First of all, if operations are rarely keeping detailed records of UFW generation, then the estimates provided in this survey were likely just a “best guess” based on memory and day-to-day experience. This situation is very susceptible to reporting errors. Second, tree management operations vary considerably in the blend of work that they perform. For example, municipal or private arboricultural operations that specialize in clearing vegetation on rights-of-way or hauling curbside debris would have a much higher UFW generation rate per employee than operations that specialize in pruning of street or residential trees, which is a very time-intensive process that generates relatively small amounts of debris per unit of employee time.

**Table 4:** Amount of urban forest waste (UFW) generated by municipal and private arboricultural operations in Georgia (based on self-reported data). Sample comprises only those operations that indicated they generate UFW and could provide an estimate. Where provided, *p*-values indicate the statistical probability that municipal and private operations do not differ for the item of interest.

	Logs		Wood Chips		Brush	
	----- tons year <sup>-1</sup> employee <sup>-1</sup> -----					
	Municipal Operations	Private Operations	Municipal Operations	Private Operations	Municipal Operations	Private Operations
	(p-value=0.587)		(p-value=0.469)		(p-value=0.189)	
Sample size (n)	11	23	11	23	11	23
Minimum	0	0	0	0	0	0
First quartile	0	0	0	51.3	0	0
Median	0	37.5	23.1	217.3	12.0	0
Third quartile	21.5	211.7	66.9	411.7	219.9	1.3
Maximum	187.5	936.9	650.0	1388.9	625.0	520.0
Mean	26.6	183.0	130.1	295.2	124.0	41.4
Standard Deviation	57.0	279.7	244.4	307.2	195.5	130.2
Coefficient of Variation	214%	153%	188%	104%	158%	315%
Avg. % of total UFW	10%	35%	46%	57%	44%	8%

Based on the total amount of UFW generated by operations on an annual basis, a percentage breakdown of these UFW types was calculated (Table 4). From the reported data, about half of municipal UFW is wood chips and about half is brush. This aligns with the finding above that about 70% of municipal UFW comes from curbside pickup of debris and from pruning of public



street/greenspace trees. It also appears that a lot of the municipal log debris is chipped on-site prior to hauling because tree removal comprises 24% of the tree management practices, yet logs are only 10% of the UFW.

Not surprisingly, wood chips account for over half (57%) of UFW generated by private arboricultural operations. For a typical tree care company, chipping tree pruning and removal debris is an efficient way to dispose of debris on-site or to pack it into a vehicle for transport off-site. Just over one-third (35%) of arborist UFW is logs. Often, log debris is too large to run through a chipper on-site and must be hauled off-site intact for disposal or further processing. While based on a small sample, this high percentage of log UFW may indicate that arborists either intend to utilize logs for products or that a sizeable raw material stream is available for utilization under the right circumstances.

## **URBAN FOREST WASTE UTILIZATION**

### *Familiarity with Fate of UFW*

Once UFW is generated, it can end up in a lot of different places (termed “fate” here), and these endpoints may or may not result in utilization of the UFW. In this survey, respondents were asked to report the percentage breakdown of their UFW to various endpoints. Two of these endpoints likely result in no or limited UFW utilization: (1) disposed at a solid waste facility, or (2) left on-site without utilization. Three other endpoints are known to result in UFW utilization: (1) utilized in-house by the operation, (2) utilized on-site by the landowner, or (3) transferred to a third party for utilization.

Respondents were asked if they could identify the fate of the UFW that their operations generate (i.e., where does their UFW end up and what happens to it). Overall, both municipal and private operations had a much better understanding where their UFW ends up compared to how much they are actually producing. Over half of both groups could identify where their UFW ends up, but only a small percentage of municipal (11%) and private (5%) operations actually keep detailed records on it (Table 2). Again, municipalities may be required by law to more closely monitor the fate of the UFW that they generate compared to the private sector.

### *Fate and Utilization of Logs*

Over two-thirds of logs generated by municipalities (68%) were reported as disposed at a solid waste facility and no municipalities reported in-house utilization of logs (Table 5). While it was surprising to see a high rate of log disposal, it was encouraging that 21% of logs were reported as transferred to a third party for utilization. Understandably, in-house utilization of logs can be fraught with difficulties and requires specialized, expensive equipment to carry out. So it would not be surprising that municipalities would shy away from log utilization due to costs or concern for liability. Also, municipalities may be required in some instances to destroy logs if there is a risk of spreading a noxious pest. However, there may be opportunity to increase third party transfers, barring issues with wood quality or legal/regulatory controls. Because few municipalities in the survey handle logs as UFW, the sample size for log utilization was very low (n=5), which makes it very difficult to interpret and generalize about these data.

Log utilization by private arboricultural operations conformed more closely with expectations (Table 5). Arborists clearly try to avoid the expense of disposing logs at a landfill (less than 20% ends up there), and over 70% of private operation logs are utilized in some manner. The most common fate of logs is transfer to a third party for utilization. About one-quarter of logs generated by arborists are utilized in-house, the vast majority of which end up being processed into firewood (63%) or lumber (21%). Arborists rarely reported utilizing logs directly for “high-value” products such as furniture or cabinetry, but this may be more so the purview of third-party processors who have specialized skills and equipment for these applications. Arborists also reported rarely leaving logs on-site for utilization by property owners, but this too is not surprising given that the typical tree care customer probably does not burn firewood or craft wood products. One positive observation is that both municipal and private operations rarely leave logs on-site unutilized. This may more so be a cosmetic consideration because logs left on site are often considered an eyesore or nuisance in urban areas.

**Table 5:** Fate of the log component of UFW generated by municipal and private arboricultural operations in Georgia and the urban forest products (UFPs) created from these logs when utilized in-house by the operation (based on self-reported data). Where provided, *p*-values indicate the statistical probability that municipal and private operations do not differ for the item of interest.

<b>Fate of logs generated by the local operation</b>	<b>Municipal (n=5)</b>	<b>Private (n=33)</b>	<b><i>p</i>-value</b>
Disposed at a solid waste facility or elsewhere	68%	19%	0.023
Transferred to a third party for utilization as urban forest products	21%	33%	0.951
Utilized in-house to produce urban forest products	0%	25%	0.896
Left on-site for utilization by property owner	0%	15%	0.886
Left on-site, resulting in no utilization	11%	8%	0.455
<b>UFPs created from logs utilized in-house by the local operation</b>	<b>Municipal (n=0)</b>	<b>Private (n=21)</b>	<b><i>p</i>-value</b>
Firewood	-	63%	n/a
Lumber	-	21%	n/a
Pallets	-	2%	n/a
Furniture	-	3%	n/a
Cabinetry	-	0%	n/a
Flooring	-	0%	n/a
Veneer	-	0%	n/a
Art/Novelty	-	5%	n/a
Other	-	6%	n/a

### Fate and Utilization of Wood Chips

Municipal operations reported a much higher rate of wood chip utilization: nearly two-thirds of wood chips are utilized in some capacity (Table 6). About a third of municipal wood chips are utilized in-house where the vast majority of them become mulch (73%), which is often used on landscape beds, walking trails, and playgrounds in public areas. A relatively small portion of wood chips is being used for compost (14%) or biomass for energy (11%), which suggests that some localities are having success with these alternative uses. Municipalities transfer 28% of their wood chips to a third party for utilization; presumably these chips are being distributed to citizens for use as mulch, which is a common practice by municipalities, but some may also be destined for processing into compost or bioenergy in the private sector. It was surprising that one-third of wood chips are reported as being disposed at a solid waste facility. The reasons for this are not clear, but could be varied. Some instances may be localities that do not have a system in place to stockpile and distribute wood chips for use as mulch. Or there may be legal/regulatory reasons that chips cannot be distributed in some places. And, some chips may not be suitable for use as mulch because they are contaminated with seeds or phytotoxins from noxious tree species. There may be opportunities to decrease the amount of municipal wood chip disposal through technical assistance or training.

**Table 6:** Fate of the wood chip component of UFW generated by municipal and private arboricultural operations in Georgia and the urban forest products (UFPs) created from these logs when utilized in-house by the operation (based on self-reported data). Where provided, *p*-values indicate the statistical probability that municipal and private operations do not differ for the item of interest.

<b>Fate of chips generated by the local operation</b>	<b>Municipal (n=11)</b>	<b>Private (n=39)</b>	<b><i>p</i>-value</b>
Disposed at a solid waste facility or elsewhere	33%	10%	0.097
Transferred to a third party for utilization as urban forest products	28%	33%	0.986
Utilized in-house to produce urban forest products	34%	26%	0.321
Left on-site for utilization by property owner	2%	21%	0.035
Left on-site, resulting in no utilization	3%	10%	0.736
<b>UFPs created from chips utilized in-house by the local operation</b>	<b>Municipal (n=8)</b>	<b>Private (n=23)</b>	<b><i>p</i>-value</b>
Mulch	73%	75%	0.257
Compost	14%	21%	0.530
Biomass for energy	11%	3%	0.142
Pellets for energy	0%	0%	-
Other	2%	1%	0.195

Private arboricultural operations have a very high utilization rate (about 80%) of their wood chips (Table 6). Most of these chips are transferred to a third party (33%), but about one-fourth is utilized in-house, being processed predominantly into mulch (75%). In-house processing and third party transfers probably provide a supplemental revenue stream for some private operations. At the very least, it is a conscious cost-control measure because arborists rarely reported disposing their chips at a solid waste facility (10%). Likewise, arborists leave a sizeable portion of their wood chips (21%) with customers, presumably to avoid disposal costs and improve customer service. Surprisingly, a good bit of wood chips (21%) is being processed into compost, which could be a high-value commodity for some companies. Wood chips are rarely left on-site without utilization (10%), which is probably most common for land clearing and ROW maintenance operations that run brush through a chipper and blow chips into natural areas rather than incur the cost of hauling chips to a disposal facility.

### *Fate and Utilization of Brush*

As with logs, over half of the brush generated by municipalities (60%) is disposed at a solid waste facility (Table 7). The remainder is transferred to a third party or utilized in-house with about the same frequency. Mulch is the most common product of in-house brush utilization, presumably being ground into mulch for use by the municipality and its citizens. No information was available about why so much of the brush ends up being disposed rather than utilized. It could be that this material is often unsuitable for mulch because it contains vines and briars or is contaminated with non-vegetative waste. What is clear from these data is that municipalities rarely generate and utilize brush, as evidenced by the very low sample size (n=5), so it is difficult to describe these practices and their implications.

Brush also appears to be difficult to utilize in the private sector. About 35% of private operation brush is disposed at a solid waste facility, which suggests that the material is cost-prohibitive to process or of poor quality for a saleable product. This also may be attributable in part to landscaping businesses that specialize in curbside collection of yard debris in private residential areas not serviced by the municipality. About 15% of brush is left on-site by arborists, which is probably most common in land clearing and ROW maintenance operations. Private operations utilize about one-quarter of their brush in-house, with the majority of it being processed into mulch (53%) or compost (32%). Interestingly, about 15% is being utilized as biomass for energy production. Because brush is a fairly low-value raw material and is difficult to handle, brush is rarely transferred to a third party (10%) or left on-site for use by the property owner (13%).

### *Perceptions of Urban Forest Waste Utilization*

As has been pointed out throughout this report, the respondents to this survey represent a diversity of individuals employed by municipal government and private arboricultural operations of varying scale and scope. As a result, analyzing their perceptions of UFW utilization in the aggregate may obscure some underlying attitudes or behaviors inherent to particular demographic groups. With that said, dis-aggregating the data into perilously small sample sizes can lead to bias or misrepresentation of sub-groups in the analysis. Because of this, the following sections treat the perceptions data in the aggregate, only distinguishing between municipal and private sector

respondents. Still, caution must be taken with interpretation of the aggregated analysis, being careful not to over-generalize the findings to demographic sub-groups that are not well represented in the respondent pool of the survey.

**Table 7:** Fate of the brush component of UFW generated by municipal and private arboricultural operations in Georgia and the urban forest products (UFPs) created from these logs when utilized in-house by the operation (based on self-reported data). Where provided, *p*-values indicate the statistical probability that municipal and private operations do not differ for the item of interest. For UFPs, *p*-values are not listed because of the inadequate sample sizes.

<b>Fate of brush generated by the local operation</b>	<b>Municipal (n=5)</b>	<b>Private (n=24)</b>	<b><i>p</i>-value</b>
Disposed at a solid waste facility or elsewhere	60%	35%	0.404
Transferred to a third party for utilization as urban forest products	21%	10%	0.270
Utilized in-house to produce urban forest products	18%	27%	0.807
Left on-site for utilization by property owner	1%	13%	0.095
Left on-site, resulting in no utilization	0%	15%	0.042
<b>UFPs created from brush utilized in-house by the local operation</b>	<b>Municipal (n=2)</b>	<b>Private (n=10)</b>	<b><i>p</i>-value</b>
Mulch	53%	53%	-
Compost	10%	32%	-
Biomass for energy	0%	15%	-
Pellets for energy	0%	0%	-
Other	37%	0%	-

### Motivations and Perceptions

Respondents were asked to indicate their level of agreement with several *a priori* statements about their operations' motivations for increasing UFW utilization. For the most part, municipal and private arboricultural operations did not express a high level of agreement or disagreement with these motive statements, which suggests that there is not strong overall interest in increasing utilization (Table 8). The average response of municipal employees to all motive statements fell between 3 and 4 on the rating scale, indicating a neutral to slight disagreement stance on the motives. Although not statistically significant, there was some evidence that private sector arborists tended to agree with these motive statements more than their municipal counterparts. Arborists tended to agree that logistical or financial reasons were motives to increase UFW utilization, which makes sense because handling and disposing of UFW can be a significant cost for tree care companies. All other motive statements were slightly disagreed with by both groups of respondents. It is important to note,

particularly with the private arborist group, that many of the respondents to this question were not directly involved with UFW generation and utilization, which may slightly skew the results.

Neither group agreed, on average, that UFW disposal is a major cost or a major revenue source for their operations (Table 8), which could be interpreted in several different ways. It is possible that UFW disposal in landfills remains relatively cheap compared to other operational costs or that these operations have streamlined UFW utilization to the point where they have minimized their UFW disposal costs to a tolerable level. Of course, for municipalities, UFW disposal is inherent to their community service mission and there isn't usually a profit motive, so costs and revenue are not as acute as for the private sector. Despite these viewpoints, both groups tended to agree that UFW utilization is currently a major issue in urban forestry and is important to their clients. This might reflect a general awareness and sensitivity to sustainability issues and social movements to reduce waste and landfilling. Interestingly, the only statistical difference between municipal employees and Certified Arborists was the perception of arborists that UFW utilization will be a major issue in the future. Perhaps arborists, as a group, are more concerned that impediments to UFW disposal will be greater in the future due to landfill fees or regulations. It is unclear why both groups feel that UFW utilization is more of an issue currently than it will be in the future.

**Table 8:** Perceptions of municipal employees and Certified Arborists about urban forest waste (UFW) utilization in Georgia. Respondents answered level of agreement questions using this scale: 1=strongly agree, 2=somewhat agree, 3=neither agree nor disagree, 4=somewhat disagree, 5=strongly disagree. Where provided, *p*-values indicate the statistical probability that municipal and private respondents do not differ for the item of interest.

<b>My operation seeks to increase UFW utilization...</b>	<b>Municipal (n=47)</b>	<b>Private (n=157)</b>	<b><i>p</i>-value</b>
...for logistical reasons	3.15	2.79	0.099
...for financial reasons	3.34	2.96	0.246
...for regulatory reasons	3.43	3.17	0.590
...for environmental reasons	3.72	3.60	0.640
<b>Urban forest waste...</b>	<b>Municipal (n=44)</b>	<b>Private (n=155)</b>	<b><i>p</i>-value</b>
...disposal is a major cost for my operation	3.18	3.14	0.854
...utilization is a major revenue source for my operation	3.80	3.65	0.809
...utilization is important to my clients	2.23	2.19	0.526
...utilization is a major issue for the urban forestry industry currently	1.98	2.01	0.703
...utilization will be a major issue for the urban forestry industry in the future	3.02	2.74	0.043

### Incentives and Barriers

Respondents were then asked to share their perceptions on both incentives and barriers to UFW utilization. They were presented with a list of *a priori* incentives and barriers and asked to rank them from highest to lowest importance based on the perspective of their local operations.

Over two-thirds of municipal respondents ranked avoidance of transportation costs and environmental sustainability as major incentives to UFW utilization (Table 9). Similarly, about half also rated client service highly. These rankings reflect the core mission of most municipal operations: provide a community service in a cost-effective and environmentally responsible manner. Just under half of respondents rated production of UFPs as an important incentive. This probably goes along with client service because citizens want to see materials being recycled and being made available for use as mulch and compost in their home landscapes and in public greenspaces. About one-quarter of municipalities viewed revenue generation and the support of local industries as being important incentives. In many localities, the UFW utilization market may be so underdeveloped that it is not seen as a viable revenue source for either the municipality or local businesses.

**Table 9:** Perceptions of municipal employees and Certified Arborists about incentives for further urban forest waste (UFW) utilization in Georgia. Incentives are reported based on the percentage of respondents who ranked each incentive in their top three. Where provided, *p*-values indicate the statistical probability that municipal and private respondents do not differ for the item of interest.

Incentives for further urban forest waste utilization	Municipal (n=45)	Private (n=143)	<i>p</i> -value
Avoidance of transportation or shipping costs	69%	61%	0.330
Environmental sustainability of the operation/community	67%	56%	0.203
Value-added service to clients	51%	41%	0.245
Opportunity to produce UFPs for use elsewhere within the operation/community	44%	38%	0.475
Additional revenue	27%	41%	0.093
Support local industries or businesses	24%	17%	0.301
Avoidance of disposal fees	18%	38%	0.010
Other	0%	7%	0.105

Certified Arborists favored similar UFW utilization incentives as the municipal employees (Table 9). The most highly ranked incentive amongst arborists (61% of respondents) was avoidance of transportation costs. The only other incentive that the majority of arborists ranked highly was environmental sustainability (56% of respondents). Notably, nearly half of arborists (41%) rated

client service and additional revenue as major incentives for UFW utilization. This suggests that many arborists view UFW utilization as an important facet of their business and might increase their utilization if markets and networks could be profitably developed. As expected, about one-third of arborists (38%) concurred that avoidance of disposal fees is a major incentive for UFW utilization, which was the only statistical difference observed with the municipal group. This is roughly half the frequency reported for avoidance of transportation costs, which suggests that moving UFW around is more problematic than paying for its disposal. Among the “other” incentives cited by arborists were regulatory compliance and controlling labor costs.

There was greater disparity amongst respondents about the most important barriers to UFW utilization, particularly within the Certified Arborist group (Table 10). The only barrier that the majority of municipalities (56%) ranked highly was lack of stockpiling space, which makes sense considering the volume of UFW that they handle from public and private sources and the scarcity of space in urban areas. About half of arborists (49%) also viewed lack of stockpiling space as a major hurdle to utilization. Interestingly, almost half of municipalities (47%) cited lack of knowledge about UFW processing or marketing as a major barrier, yet only about one-quarter of private arborists felt the same way. This could have implications for outreach and technical assistance. Municipalities may have greater need and be more receptive to technical assistance with UFW processing and marketing.

Around one-third of both groups noted that a lack of in-house equipment for processing UFW is a major barrier (Table 10). Processing equipment is expensive, has highly specialized uses, and requires specialized skills for operation. For these reasons, many municipal and private operations cannot justify owning and operating the equipment. And it appears that they would rather have third party processors handle this task because nearly half of respondents in both groups ranked lack of local UFW processors as a major barrier. Interestingly, less than one-third of respondents rated lack of local consumers as a major barrier. This does not necessarily mean that there are viable markets for UFPs, but rather that the logistical aspects of processing UFW are currently viewed as a greater hurdle than marketability *per se*. This is particularly the case for arborists, almost half of which (40%) ranked difficulties handling UFW on job sites as a major barrier. For most tree care companies, the cost of their services to their clients is predicated on the time it takes to complete the service. The longer it takes to complete the job, the more they will need to charge their customers to cover their costs and turn a profit. As a result, tree care companies often cannot take the time to handle UFW (particularly logs) in a way that makes it useful for UFPs. High-quality timber often ends up being run through a chipper because arborists don't have time to properly evaluate, buck, and load the timber. Moreover, the lack of space in urban landscapes often makes it impractical or unsafe to bring down trees in sections large enough to render good saw timber.

About one-quarter of both municipal employees and Certified Arborists cited lack of communication as a major barrier to UFW utilization. This could be a key issue and focal area for advancing utilization because it is evident from this data and from previous studies elsewhere that utilization markets are only viable when those who generate UFW are well networked with businesses that take this waste and create value-added products. Related to this, a few respondents noted that consumers are generally unaware of the benefits of recycling UFW and that UFPs are available to them in their local markets. Of course, this is the lynch pin, because without consumer awareness,



there will be no consumer demand for UFPs. It appears though that UFP markets might be developed with little regulatory hindrance because only about 20% of respondents cited regulations or permitting requirements as a major barrier to UFW utilization.

**Table 10:** Perceptions of municipal employees and private sector Certified Arborists about barriers to further urban forest waste (UFW) utilization in Georgia. Barriers are reported based on the percentage of respondents who ranked each barrier in their top three. Where provided, *p*-values indicate the statistical probability that municipal and private respondents do not differ for the item of interest.

<b>Barriers to further urban forest waste utilization</b>	<b>Municipal (n=43)</b>	<b>Private (n=139)</b>	<b><i>p</i>-value</b>
Lack of in-house space for stockpiling UFW	56%	49%	0.515
Lack of in-house knowledge or skill for processing UFW or marketing UFPs	47%	27%	0.024
Lack of local processors of UFW	42%	47%	0.446
Lack of in-house equipment for processing UFW	40%	33%	0.500
Lack of local consumers of UFPs	30%	27%	0.776
Logistical difficulties of handling UFW on tree service job sites	23%	40%	0.035
Logistical difficulties of transporting UFW to processors	23%	31%	0.296
Lack of communication between UFW producers and UFP consumers	21%	28%	0.318
Local regulations or permitting requirements	19%	11%	0.197
Other	0%	6%	0.375

Education and Technical Assistance

Respondents were asked to indicate their level of agreement with several *a priori* statements about their experiences with education and training on UFW utilization. Municipal employees and Certified Arborists had similar perspectives on these experiences. There was only a slight indication that respondents had sought self-education about UFW utilization in the past, with a bit more interest in such education in the future (Table 11). Respondents were largely ambivalent about their ability to find satisfactory education or training on UFW utilization when they sought it. This fairly neutral attitude towards education and training may result from the prevailing perception reported earlier that UFW utilization is not a major issue for urban forestry now or into the near future. Simply put, UFW utilization may not be an overall major concern for these professionals relative to other issues, and therefore, education on the topic is not a high priority for them.

**Table 11:** Educational experiences and preferences of municipal employees and Certified Arborists about urban forest waste (UFW) utilization in Georgia. Respondents answered level of agreement questions using this scale: 1=strongly agree, 2=somewhat agree, 3=neither agree nor disagree, 4=somewhat disagree, 5=strongly disagree. Preferences are reported based on the percentage of respondents who ranked each item in their top three. Where provided, *p*-values indicate the statistical probability that municipal and private respondents do not differ for the item of interest.

<b>Experience with education and training</b>	<b>Municipal (n=46)</b>	<b>Private (n=152)</b>	<b><i>p</i>-value</b>
I have engaged in self-education or training about UFW utilization in the past year	3.00	2.78	0.754
I will engage in self-education or training about UFW utilization in the coming year	2.50	2.64	0.156
I have found satisfactory opportunities for education or training on UFW utilization when I have sought it	2.96	2.95	0.478
<b>Preference for educational or technical programs about UFW utilization</b>	<b>Municipal (n=43)</b>	<b>Private (n=141)</b>	<b><i>p</i>-value</b>
A local, centralized facility for receiving, sorting, and stockpiling UFW	44%	40%	0.567
A cooperative business facility for selling and/or producing UFPs	44%	34%	0.205
An educational website	37%	28%	0.242
Cooperative Extension or Georgia Forestry Commission publications	35%	34%	0.874
Educational seminars or conferences	35%	33%	0.738
Hands-on workshops or field demonstrations	28%	32%	0.661
An online database that networks UFW generators, UFW processors, and UFP producers	26%	52%	0.004
Industry standards or best management practices	26%	23%	0.639
Online webinar	26%	22%	0.568
Other	0%	1%	0.431

Respondents were also asked to identify their preference for educational or technical programs on UFW utilization. Respondents were presented with a list of *a priori* programs and asked to rank them from highest to lowest importance based on their preferences. No clear preference was shown for any particular technical program by either group (Table 11). Just under half of municipal respondents (44%) showed a strong preference for a centralized facility to handle UFW and then produce and sell UFPs. Certified Arborists showed similar interest in such a centralized facility, but their greatest interest (52% of respondents) was for an online database to network all of the parties involved in the

generation and processing of UFW into UFPs. As reported earlier, many arborists view UFW disposal as a major cost for their operations or view UFW utilization as a potential revenue source for their businesses. As a result, they may view a networking system as a useful resource to curb their operational costs or increase their revenue.

No clear preference was shown by either group for a particular educational product or medium either (Table 11). About one-third of all respondents favored an educational website, publication, or conference. Just under one-third showed preference for hands-on workshops or field demonstrations. An online webinar was the least preferred product, which is understandable given the technical nature of UFW utilization. It is not surprising that such a wide range of education programs was preferred by both groups given the diversity in municipal and private arboricultural operations represented by the respondents. Additional investigation into educational preferences of these groups is warranted in order to better target and tailor educational programming to these diverse stakeholders.

It is interesting to note that the programs ranked most highly by both groups are related to market infrastructure and institutional support rather than to education and training. Technical assistance programs are much more complicated and expensive to implement than educational programs. However, if the interest and need for such programs is great, then time spent on educational programs might be better invested into panel discussions and work groups aimed at figuring out how to create infrastructure and institutional support mechanisms rather than engaging in passive education and training. Interestingly, only about one-quarter of respondents thought that industry standards or best management practices (BMPs) were important relative to other needs. Several professional organizations involved in urban forestry and arboriculture are currently crafting a national standard for UFPs (American National Standards Institute A300 Part 11 - Urban Forest Products). Standards and BMPs are usually a manifestation of market forces or regulatory compliance. Because Georgia markets for UFW utilization are in their infancy and few regulations currently exist compared to other parts of the country, there may not yet be a strong preference for standards and BMPs in Georgia.

## CONCLUSIONS AND RECOMMENDATIONS

This study has provided insight on the practices and perceptions of UFW generation and utilization by municipal and private arboricultural operations in Georgia. Few studies, if any, have ever investigated UFW generation and utilization in the state on such a broad geographic scale and in such depth. The findings in this study provide a useful foundation to build education and technical assistance programs aimed at improving UFW utilization by municipalities and private arboricultural operations throughout the state.

Many of the findings in this study corroborate long-held beliefs and anecdotal observations about UFW practices. For example, it was affirmed that tree pruning and removal on private residential and commercial lands account for the majority of UFW generated by private operations. And that firewood, lumber, mulch, and compost are the most frequent products of UFW utilization by both municipalities and private operations. Yet some findings were unexpected and contrary to the conventional wisdom about UFW. Perhaps most surprising was the limited grasp that municipal operations, and to a greater extent private arborist operations, have on the amount of UFW that their operations generate. One of the precursors for creating viable markets for UFW utilization and getting buy-in from industry is having a clear understanding of the raw material supply. It is evident from the data reported by respondents in this survey that there is much variability and uncertainty about the UFW being generated in Georgia's urban forests. A survey instrument is clearly an insufficient means of gathering this data and further work needs to be done quantify UFW generation in the state.

Perceptions of UFW generation and utilization by municipal and private arboricultural operations are difficult to summarize succinctly because no strong feelings seem to emerge about the subject in the data. There doesn't seem to be a single factor strongly motivating these operations to utilize UFW, but there is evidence that minimizing jobsite logistical difficulties and controlling transportation costs resonates with both public and private sector operations. These groups do not seem to be pre-occupied with UFW generation or utilization in their day-to-day jobs, yet it is "on their radar" and seems to be an issue that they are monitoring through self-education. The sustainability and customer service dimensions of UFW utilization also seem to be providing a bit of motivation for these groups. A challenge going forward is to figure out which incentives most clearly resonate within this diverse community of municipal employees and arborists so that proper programs can be put into place to further leverage those incentives.

Barriers to UFW utilization are even more difficult to pinpoint than incentives for municipal and private arboricultural operations. Their perspectives on barriers are quite varied and no single barrier rises clearly above the others. Lack of stockpiling space, local processors, and equipment are all logistical difficulties that seem to be the prevalent barriers. The take home message is that the barriers to UFW are numerous and none of them are particularly easy to overcome without significant investment in operational infrastructure and support systems. Education and training is another facet to breaking down barriers to UFW utilization. Yet the survey results do not show a clear consensus for education demand or programmatic needs. On average, education and training do not appear to be in high demand for these groups, but undoubtedly there are certain cohorts within this

population that are passionate about UFW utilization and would be responsive to outreach programs. Given that UFW utilization is not yet a “mainstream” enterprise in urban forestry, UFW outreach may remain a niche program for the foreseeable future. What does seem clear is that these professionals are more interested in mechanisms to connect the raw material that they generate with enterprises that create urban forest products and consumers that purchase urban forest products.

While surveys are an efficient means to collect data about practices and perceptions, there are inherent limitations that must be carefully considered when interpreting and applying information gleaned from them. A key consideration is always how well the respondents represent the population of interest and whether any bias has been introduced to the survey by a low sample size or a non-representative respondent pool. This survey is believed to be an overall robust assessment of UFW practices and perceptions for several reasons. First, the response rate for the survey met our expectations (50% municipal; 30% Certified Arborist; 32% overall response rate) and was consistent with typical survey response rates. Second, the distribution of respondents across industry sectors and operational positions was consistent with the perceived industry segmentation of the population as a whole. Although an evaluation of non-response bias was not performed for this survey, a prior iteration of this same survey in Virginia was evaluated for non-response bias and no evidence was found for bias there. Given the high response rate, representativeness of industry sectors and operational positions, and lack of response bias in the prior Virginia survey, the Georgia survey is viewed as a reliable instrument overall. With that said, there were certain survey items that had low sample sizes and/or high variance. For this reason, some survey items are less reliable than others and should be used with caution for drawing conclusions.

Based on the findings of this survey study, the following recommendations are made to Georgia Forestry Commission with regard to their urban forest waste (UFW) utilization program:

1. Additional data are needed to accurately quantify the amount of urban forest waste generated by municipal and private arborist operations. Because about one-fourth of municipal respondents and one-half of private arborist respondents effectively precluded themselves from reporting on UFW generation due to their lack of direct involvement in the activity, the data reported here are at very high risk for bias. The web survey format combined with elective reporting by respondents has been shown here not to be a reliable means to collect this type of data. Better options might include one-on-one intensive interviews with operations or an observational study in which a sample of operations is tracked over a period of time and their day-to-day UFW generation is documented through direct observation.
2. Underlying demographic trends in the survey data should be further investigated. Although two well-defined demographic groups were targeted as respondents for this survey, broad diversity in the underlying industry sectors and professional positions in the respondent pool was still evident. This was to be expected and represents one of the on-going challenges to making tangible progress with UFW utilization given the diversity of stakeholders. Moreover, there may be geographic or economic factors at play that could not be detected by the survey instrument. In planning this survey study, there was an *a priori* belief that municipal and private arborist operations would differ in their urban forest waste practices and perceptions.

Therefore, the instrument and the analysis were designed to disaggregate these two distinct groups. However, there may be further demographic sub-groups within these two groups that also differ. Because the study was not designed to evaluate these sub-groups, there may be insufficient sample size, and therefore statistical power, to analyze these data at a deeper level without risk of bias.

3. A clearer understanding is needed about the fate of UFW generated by municipal operations. In this survey, municipal respondents indicated that two-thirds of their logs, one-third of their wood chips, and over half of their brush are disposed at a solid waste facility. In the context of this survey question, this implies that the waste is not utilized in any way. It is possible that this survey question was misunderstood by municipal respondents, specifically those individuals who are not urban forestry professionals and are not familiar with the concepts and terminology of urban forest waste utilization. At the same time, there could be very real economic, logistical, or regulatory reasons why a large percentage of municipal UFW as reported as being disposed without utilization. Regardless, the data only lead to speculation about how much municipal UFW is being utilized and by whom, so this information warrants further study.
4. Opportunities for high-value utilization of logs need further study. Although the sample size was fairly small, the data suggest that when logs are being utilized in-house by private arborist operations, the utilization is primarily for firewood. Although this is certainly favorable utilization, some experts would argue that the log resource is being under-utilized for high-value products such as flooring, cabinetry, and veneer, which were rarely reported in the survey. Since no data were collected about the quality of the urban forest waste, it is hard to judge under-utilization since finished wood products require a high-quality raw material that may be scarce in urban areas. Moreover, markets for high-value urban forest products may be insufficiently developed in Georgia to make such enterprises viable at this time.
5. More information is needed about the larger context of UFW utilization and demand for UFPs in Georgia. Several of the survey questions pointed towards the conclusion that UFW utilization is not a pressing issue for municipalities or private arborist operations and that there is a general indifference to increasing UFW utilization. Undoubtedly there are certain municipalities, tree care companies, and urban forest product companies that are actively engaged and successful in this enterprise. These operations possess the local knowledge, experience, and insight to carry UFW utilization forward in the state. A plausible next step for Georgia Forestry Commission would be to assemble a task force comprising these key stakeholders to further clarify the dynamics of UFW supply and UFP demand in the state and to identify the infrastructure and programmatic support mechanisms that merit investment to empower municipalities and private arborist operations to increase UFW utilization.

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## APPENDIX I: MUNICIPALITIES SOLICITED FOR THE SURVEY

Listed below are the 68 localities in Georgia that were selected for the sampling frame of the survey on urban forest waste generation and utilization. Municipalities that completed the survey are denoted with an asterisk (\*). See “Study Findings” for details on survey response rate.

Acworth City*	Douglas County	McDonough City*
Albany City*	Douglasville City	Metter City*
Alpharetta City*	Duluth City	Milledgeville City
Athens–Clarke County	Dunwoody City	Milton City
Atlanta City*	East Point City	Newnan City
Augusta–Richmond County	Fayette County	Newton County
Brookhaven City	Forest Park City*	Peachtree City
Canton City	Forsyth County*	Powder Springs City*
Carrollton City	Fulton County	Rockdale County
Cartersville City	Gainesville–Hall County*	Rome City*
Chatham County	Glynn County	Roswell City*
Cherokee County	Griffin City*	Sandy Springs City
Clayton County	Gwinnett County	Savannah City*
Cobb County*	Henry County*	Smyrna City*
Columbia County	Hinesville City	Snellville City*
Columbus City*	Johns Creek City	St. Marys City*
Conyers City*	Kennesaw City*	Statesboro City
Covington City	Kingsland City*	Stockbridge City*
Coweta County	LaGrange City*	Union City
Dalton City*	Lawrenceville City*	Valdosta City*
Decatur City*	Macon–Bibb County	Warner Robbins City*
Dekalb County*	Marietta City*	Woodstock City
Doraville City*	Martinez City	

## APPENDIX II: SURVEY INSTRUMENT

Printed below is a transcript of the survey instrument. Note that the survey was administered in an online format that used skip logic and branching to route respondents through the questions based on how they responded to certain questions. Thus the transcript does not reflect the actual flow of the survey experienced by the respondents.

### Preamble

You are invited to participate in a survey conducted by Virginia Tech Department of Forest Resources and Environmental Conservation on the topic of urban forest waste generation, disposal, and utilization in Georgia.

Your participation is voluntary. All responses will be confidential and not associated with you individually in any public dissemination of the results. Results will be used for a graduate thesis and publication.

The survey should require about 20 minutes to complete. Please read each question carefully and answer to the best of your ability.

Should you have any questions, please contact Jon Matiuk ([jdmatiuk@vt.edu](mailto:jdmatiuk@vt.edu)).

This study is conducted under the guidance of the Virginia Tech Institutional Review Board. If you have any concerns about the study's conduct or your rights as a research subject, please contact IRB via Dr. Moore ([moored@vt.edu](mailto:moored@vt.edu), 540-231-4991).

Please read the following definitions. They will help clarify certain terminology used in the survey questions.

Urban forest waste (UFW) – any woody material (i.e., logs, chips, or brush) generated from the pruning, felling, or removal of a tree.

Urban forest product (UFP) – any product produced via the utilization of urban forest waste.

Generated – created from arboricultural practices (e.g., pruning, felling, removal, land clearing, etc.).

Utilized – used to produce an urban forest product.

Disposed – transported to a facility (e.g., landfill, dump site) or left on-site without the intention of producing an urban forest product.

Q1 Are you in a position to report on the urban forest waste (UFW) generated by the local operation of your business/organization/municipality? Local operation refers to an individual municipality, a locally-owned and operated business, or a local office of a larger company with multiple regional offices.

- Yes (1)
- No (2)

Please answer a few questions about yourself. Your answers are confidential and are intended to help us understand perceptions about urban forest waste utilization.

D1 What is your age?

- 18-30 (1)
- 31-44 (2)
- 45-60 (3)
- 61+ (4)

D2 What is your gender?

- Female (1)
- Male (2)

D3 What is your highest level of education attainment?

- High school or equivalent (1)
- Associate degree (2)
- Bachelor's degree (3)
- Graduate degree (4)

D4 How long have you worked in a profession related to trees or tree debris disposal?

- 0-10 (1)
- 11-20 (2)
- 21-30 (3)
- 31+ (4)

P1 Please indicate your level of agreement with the following statements:

	Strongly Agree (1)	Agree (2)	Neither Agree nor Disagree (3)	Disagree (4)	Strongly Disagree (5)	We do not generate UFW (6)
My operation seeks to increase UFW utilization for logistical reasons (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My operation seeks to increase UFW utilization for financial reasons (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My operation seeks to increase UFW utilization for regulatory reasons (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My operation seeks to increase UFW utilization for environmental reasons (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

P2 Please indicate your level of agreement with the following statements:

	Strongly Agree (1)	Agree (2)	Neither Agree nor Disagree (3)	Disagree (4)	Strongly Disagree (5)
UFW disposal is a major cost for my operation (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
UFW utilization is a major revenue source for my operation (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
UFW utilization is important to my clients (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
UFW utilization is a major issue for the urban forestry industry currently (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
UFW utilization will be a major issue for the urban forestry industry in the future (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

P3 Please indicate your level of agreement with the following:

	Strongly Agree (1)	Agree (2)	Neither Agree nor Disagree (3)	Disagree (4)	Strongly Disagree (5)
I have engaged in self-education or training about UFW utilization in the past year (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I will engage in self-education or training about UFW utilization in the coming year (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have found satisfactory opportunities for education or training on UFW utilization when I have sought it (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

P4 Please rank the most significant incentives (existing or potential) for increasing utilization of urban forest waste (UFW) by the local operation of your business/organization/municipality: Rank at least 3 Items by dragging and dropping Items into the Rank box.

Rank
_____ Additional revenue (1)
_____ Value-added service to clients (2)
_____ Avoidance of disposal fees (3)
_____ Avoidance of transportation or shipping costs (4)
_____ Environmental sustainability of the operation/community (5)
_____ Support local industries or businesses (e.g., "Buy local" initiatives) (6)
_____ Opportunity to produce urban forest products for use elsewhere within the operation/community (7)
_____ Other: (8)
_____ Other: (9)
_____ Other: (10)

P5 Please rank the most significant barriers (existing or potential) for increasing utilization of urban forest waste (UFW) by the local operation of your business/organization/municipality: Rank at least 3 Items by dragging and dropping Items into the Rank box.

Rank
_____ Local regulations or permitting requirements (1)
_____ Lack of local processors of UFW (2)
_____ Lack of local consumers of UFP (3)
_____ Logistical difficulties of handling UFW on tree service job sites (4)
_____ Logistical difficulties of transporting UFW to processors (5)
_____ Lack of in-house space for stockpiling UFW (6)
_____ Lack of in-house equipment for processing UFW (7)
_____ Lack of in-house knowledge or skill for processing UFW or marketing UFP (8)
_____ Lack of communication between UFW producers and UFP consumers (9)
_____ Other: (10)
_____ Other: (11)
_____ Other: (12)

P6 Please rank the following educational or technical programs as a potential means for helping you increase your capacity for utilization of urban forest waste (UFW) or production of urban forest products (UFP): Rank at least 3 Items by dragging and dropping Items into the Rank box.

Rank
_____ Cooperative Extension or VDOF publications (1)
_____ Industry standards or best management practices (2)
_____ An educational website (3)
_____ Educational seminars or conferences (4)
_____ Hands-on workshops or field demonstrations (5)
_____ An online database that networks UFW generators, UFW processors, and UFP producers (6)
_____ A local, centralized facility for receiving, sorting, and stockpiling UFW (7)
_____ A cooperative business facility for selling and/or producing UFPs (8)
_____ Other: (9)
_____ Other: (10)
_____ Other: (11)
_____ An online course or webinar (12)

P7a May we contact you with follow-up questions based on your responses to this survey?

- Yes, my email is: (1) \_\_\_\_\_
- Yes, my phone number is: (2) \_\_\_\_\_

P7b Thank you for your time spent responding to this survey. If there is anything else you would like to contribute to our study of urban forest waste utilization, please use the comment box below.

Q2 Does the local operation of your business/organization/municipality directly generate urban forest waste (UFW)? If your local operation hires contractors who generate UFW rather than using your in-house staff, please select No.

- Yes (1)
- No (2)



Q3a Please indicate your industry sector:

- I am employed by a municipality (city, town, county) (1)
- I am employed by a tree care company (including contractors for utility service providers or GADOT) (2)
- I am employed by a landscape company (3)
- I am employed by a consulting firm (4)
- I am employed by an institution (university, arboretum, estate, state/federal park, etc.) (5)
- I am employed by an electric utility service provider (6)
- I am employed by Georgia Dept. of Transportation (GADOT) (7)
- Other: (8) \_\_\_\_\_

Answer If: Please indicate your industry sector: I work for a municipality (city, town, county) is selected

Q3b Please indicate your position within your municipality:

- Arborist (1)
- Horticulturist (2)
- Urban Forester (3)
- City/Town/County Manager (4)
- City/Town/County Planner (5)
- Public Works Administrator (6)
- Parks and Recreation Administrator (7)
- Solid Waste Administrator (8)
- Other: (9) \_\_\_\_\_

Answer If: Please indicate your industry sector: I am employed by a tree care company (commercial, residential, utility) is selected Or Please indicate your industry sector: I am employed by a landscape company Is Selected

Q3c Please indicate your position within your business/organization:

- Manager/owner of a regional operation (1)
- Manager/owner of a local operation (2)
- Manager of a production crew (3)
- Member of a production crew (4)
- Other (5) \_\_\_\_\_

Q4 In the local operation of your business/organization/municipality, how many full-time employees are directly involved in activities that generate urban forest waste (UFW)?

- 0-5 (1)
- 6-10 (2)
- 11-15 (3)
- 16-20 (4)
- 21+ (5)

Q5a From the list provided below, select ALL of the localities in which the local operation of your business/organization/municipality generates urban forest waste (UFW). If you are employed by a larger company with multiple regional offices, please select only those localities where your local office operates and for which you can specifically answer questions about UFW generation. If you are employed by a municipality, please select only your municipality from the list.

- < 68 sample municipalities listed >
- None of these (1)

Answer If: Please indicate your industry sector: I work for a municipality (city, town, county) Is Not Selected

Q5b Please estimate the percentage of urban forest waste (UFW) that the local operation of your business/organization generates within each of your selected localities as a percentage of the total UFW generated in all of your selected localities: To set your percentages, drag each blue bar side to side or enter a specific percentage on the right side of the graph. Keep in mind your responses should add up to 100%. If you only selected one locality in the previous question, your percentage for that locality should be 100%.

< 68 sample municipalities listed >

Q6 Please indicate where the local operation of your business/organization/municipality generates urban forest waste (UFW) (as a percentage of total UFW generated): To set your percentages, drag each blue bar side to side or enter a specific percentage on the right side of the graph. Keep in mind your responses should add up to 100%.

- \_\_\_\_\_ Private residential (1)
- \_\_\_\_\_ Private commercial (2)
- \_\_\_\_\_ Public parks, grounds, and greenspaces (3)
- \_\_\_\_\_ Public street rights-of-way maintained by a municipality (4)
- \_\_\_\_\_ GADOT roadside rights-of-way (5)
- \_\_\_\_\_ Electric utility rights-of-way (6)
- \_\_\_\_\_ Other: (7)
- \_\_\_\_\_ Other: (8)

Q7 The following arboricultural practices generate urban forest waste (UFW). Please indicate which types of work the local operation of your business/organization/municipality conducts (as a percentage of total UFW generated): To set your percentages, drag each blue bar side to side or enter a specific percent on the right side of the graph. Keep in mind your responses should add up to 100%.

- \_\_\_\_\_ Tree pruning (1)
- \_\_\_\_\_ Tree removal (2)
- \_\_\_\_\_ Curbside pickup of tree debris (3)
- \_\_\_\_\_ Small woodlot logging (4)
- \_\_\_\_\_ Land clearing (5)
- \_\_\_\_\_ Other: (6)
- \_\_\_\_\_ Other: (7)

AF1 Urban forest waste comprises logs, chips, or brush generated from the pruning, felling, or removal of a tree. Please describe how the local operation of your business/organization/municipality tracks the amount of urban forest waste (UFW) that it generates:

- We keep detailed records of the amount of UFW generated and can report based on these records (1)
- I can provide an estimate of the amount of UFW generated (2)
- I cannot provide an estimate of the amount of UFW generated (3)

If I cannot estimate the amount... Is Selected, Then Skip To Please describe how your business/org...

AF2 Please report or estimate the average amount of urban forest waste (UFW) that your local operation generates per unit of time. For each type of material, enter an amount, followed by the unit of measure, followed by the unit of time. It is understood that waste generation can be highly variable during the year. Please provide your best estimate for a typical time period.

	Amount (1)	Unit of Measure				Unit of Time				
		Tons (1)	Cubic Yards (2)	Board Feet (3)	N/A (4)	Day (1)	Week (2)	Month (3)	Year (4)	N/A (5)
Logs (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Chips (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Brush (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

AF3 Please describe how the local operation of your business/organization/municipality tracks the fate of urban forest waste (UFW) that it generates: Fate refers to what happens to UFW after it is generated and may include disposal and/or utilization on-site, in-house, or by a 3rd party.

- We keep detailed records of the fate of UFW generated and can report based on these records (1)
- I can provide an estimate of the fate of UFW generated (2)
- I cannot provide an estimate of the fate of UFW generated (3)

If I cannot estimate the fate ... Is Selected, Then Skip To End of Block

AF4a Urban forest waste comprises logs, brush, or chips generated from the pruning, felling, or removal of a tree. Please describe the fate of the logs generated by the local operation of your business/organization/municipality: To set your percentages, drag each blue bar side to side or enter a specific percent on the right side of the graph. Keep in mind your percentages should add up to 100%.

\_\_\_\_\_ Utilized in-house to produce urban forest products (firewood, lumber, furniture, art/novelty, etc.) (1)

\_\_\_\_\_ Transferred to a 3rd party for utilization as urban forest products (2)

\_\_\_\_\_ Disposed at a solid waste facility or elsewhere (3)

\_\_\_\_\_ Left on-site, resulting in no utilization (4)

\_\_\_\_\_ Left on-site for utilization by property owner (5)

Answer If: Please describe the fate of the logs you generate (Keep in mind your percentages should add up to 100%): Utilized in house to produce urban forest products (firewood, lumber, furniture, art/novelty, etc.) Is Greater Than 0

AF4b Of the logs that your local operation utilizes in-house, what percent are utilized to produce each of the following urban forest products (UFPs)? To set your percentages, drag each blue bar side to side or enter a specific percent on the right side of the graph. Keep in mind your percentages should add up to 100%.

\_\_\_\_\_ Firewood (1)

\_\_\_\_\_ Lumber (2)

\_\_\_\_\_ Pallets (3)

\_\_\_\_\_ Furniture (4)

\_\_\_\_\_ Cabinetry (5)

\_\_\_\_\_ Flooring (6)

\_\_\_\_\_ Veneer (7)

\_\_\_\_\_ Art/novelty (8)

\_\_\_\_\_ Other: (9)

\_\_\_\_\_ Other: (10)

AF5a Urban forest waste comprises logs, brush, or chips generated from the pruning, felling, or removal of a tree. Please describe the fate of the chips generated by the local operation of your business/organization/municipality: To set your percentages, drag each blue bar side to side or enter a specific percent on the right side of the graph. Keep in mind your percentages should add up to 100%.

- \_\_\_\_\_ Utilized in-house to produce urban forest products (mulch, compost, biomass, etc.) (1)
- \_\_\_\_\_ Transferred to a 3rd party for utilization as urban forest products (2)
- \_\_\_\_\_ Disposed at a solid waste facility or elsewhere (3)
- \_\_\_\_\_ Left on-site, resulting in no utilization (4)
- \_\_\_\_\_ Left on-site for utilization by property owner (5)

Answer If: Please describe the fate of the chips you generate (Keep in mind your percentages should add up to 100%): Utilized in house to create urban forest products (mulch, compost, biomass, etc.) Is Greater Than 0

AF5b Of the chips that your local operation utilizes in-house, what percent are utilized to produce each of the following urban forest products (UFPs)? To set your percentages, drag each blue bar side to side or enter a specific percent on the right side of the graph. Keep in mind your percentages should add up to 100%.

- \_\_\_\_\_ Mulch (1)
- \_\_\_\_\_ Compost (2)
- \_\_\_\_\_ Biomass for energy (3)
- \_\_\_\_\_ Pellets for wood stove burning (4)
- \_\_\_\_\_ Other: (5)
- \_\_\_\_\_ Other: (6)

AF6a Urban forest waste comprises logs, brush, or chips generated from the pruning, felling, or removal of a tree. Please describe the fate of the brush generated by the local operation of your business/organization/municipality: To set your percentages, drag each blue bar side to side or enter a specific percent on the right side of the graph. Keep in mind your percentages should add up to 100%.

- \_\_\_\_\_ Utilized in-house to produce urban forest products (chips, mulch, compost, biomass, etc.) (1)
- \_\_\_\_\_ Transferred to a 3rd party for utilization as urban forest products (2)
- \_\_\_\_\_ Disposed at a solid waste facility or elsewhere (3)
- \_\_\_\_\_ Left on-site, resulting in no utilization (4)
- \_\_\_\_\_ Left on-site for utilization by property owner (5)

Answer If: Please describe the fate of the brush you generate (Keep in mind your percentages should add up to 100%): Utilized in house to create urban forest products (chips, mulch, compost, biomass, etc.) Is Greater Than 0

AF6b Of the brush that your local operation utilizes in-house, what percent is utilized to produce each of the following urban forest products (UFPs)? To set your percentages, drag each blue bar side to side or enter a specific percent on the right side of the graph. Keep in mind your percentages should add up to 100%.

- \_\_\_\_\_ Mulch (1)
- \_\_\_\_\_ Compost (2)
- \_\_\_\_\_ Biomass for energy (3)
- \_\_\_\_\_ Other: (4)
- \_\_\_\_\_ Other: (5)

Answer If: Urban forest waste comprises logs, brush, or chips generated from the pruning, felling, or removal of a tree. Please describe the fate of the logs generated by your operation (keep in mind your perc... Disposed at a solid waste facility or elsewhere Is Greater Than 0 Or Urban forest waste comprises logs, brush, or chips generated from the pruning, felling, or removal of a tree. Please describe the fate of the chips generated by your operation (keep in mind your per... Disposed at a solid waste facility or dump, resulting in no utilization Is Greater Than 0 Or Urban forest waste comprises logs, brush, or chips generated from the pruning, felling, or removal of a tree. Please describe the fate of the brush generated by your operation (keep in mind your per... Disposed at a solid waste facility or elsewhere Is Greater Than 0

AF7 Please report or estimate the average expense of disposal of urban forest waste (UFW) generated by the local operation of your business/organization/municipality per unit of time. It is understood that waste generation and disposal fees can be highly variable during the year. Please provide your best estimate for a typical time period.

	Amount	Unit of Time			
	\$ (1)	Day (1)	Week (2)	Month (3)	Year (4)
Disposal Fees (1)		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

PF1a In the past five years, the amount of urban forest waste (UFW) generated by the local operation of your business/organization/municipality has:

- Increased substantially (1)
- Increased moderately (2)
- Stayed about the same (3)
- Decreased moderately (4)
- Decreased substantially (5)
- I don't know (6)

PF1b In the past five years, the amount of urban forest waste (UFW) utilized as urban forest products (UFP) by the local operation of your business/organization/municipality has:

- Increased substantially (1)
- Increased moderately (2)
- Stayed about the same (3)
- Decreased moderately (4)
- Decreased substantially (5)
- I don't know (6)

PF2a In the next five years, the amount of urban forest waste (UFW) generated by the local operation of your business/organization/municipality will:

- Increase substantially (1)
- Increase moderately (2)
- Stay about the same (3)
- Decrease moderately (4)
- Decrease substantially (5)
- I don't know (6)

PF2b In the next five years, the amount of urban forest waste (UFW) utilized as urban forest products (UFP) by the local operation of your business/organization/municipality will:

- Increase substantially (1)
- Increase moderately (2)
- Stay about the same (3)
- Decrease moderately (4)
- Decrease substantially (5)
- I don't know (6)