Arboriculture & Urban Forestry 2020. 46(3):197–209

Tree Crew Perspectives on Wood Product Recovery from Utility Vegetation Management

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Abstract. Utility vegetation management generates large quantities of wood that require disposal. To explore opportunities for reducing wood waste and promoting wood recovery, we evaluated the perceptions and experiences of utility-contracted tree crews regarding a wood recovery program. We conducted interviews with tree crew members both involved ($n = 24$) and not involved ($n = 58$) with the pilot program. Interview questions focused on workflow, interactions with homeowners and the public, and opportunities for implementation of a wood recovery program from the crew member perspective. Participants generally had positive attitudes toward a wood recovery program, wanting to provide benefits for communities through revenue from log sales and to reduce wood waste. Potential challenges associated with such a program included: (1) increased time required for tree removal; (2) safety concerns for removing larger logs; (3) physical obstacles such as mailboxes and stone walls; (4) homeowners wanting to keep the wood; and (5) low-quality wood (i.e., containing rot or metal). The protocol was modified to address such concerns. With the input of tree crew members, our findings suggest that a wood recovery program has the potential to be successful in reducing wood waste from utility vegetation management and generating benefits for communities, particularly in urban environments.

Keywords. Interviews; Tree Pruning; Tree Removal; Utility Vegetation Management; Waste Wood Recovery; Wood Products.

INTRODUCTION

Trees in the urban forest and residential environment are generally considered amenities or assets to the community, providing numerous benefits including aesthetics, strengthened community ties, stress relief, and improved property values (Ulrich 1979; Kweon et al. 1998; McPherson et al. 2005; Nowak and Dwyer 2007; Donovan and Butry 2010; van den Berg et al. 2010). However, if trees are removed due to death, disease, construction, or utility line clearance and risk management, they are considered a liability requiring disposal rather than an asset (Bratkovich 2001; Bratkovich et al. 2014). Alternatively, trees removed from a community could continue to provide benefits in the form of wood products (Bratkovich 2001; Bratkovich et al. 2014).

Several programs and companies have pursued opportunities to use wood products from urban trees. For example, the Sustainable Wood Recovery Initiative at Michigan State University is a campus-wide program for trees removed due to poor health, damage, safety issues, or construction. The wood is milled, dried, and provided to artisans for use in marketable products (http://www.canr.msu.edu/for/programs/swri). City Bench, based in New Haven, Connecticut, converts trees removed from urban centers and college campuses into high-value furniture (http://www.city-bench.com). Other programs facilitate information exchange or markets for reclaimed urban wood. One example is the Urbanwood Project, a wood marketplace that originated from efforts to encourage utilization of emerald ash borer-infected trees killed in southeast Michigan (http://urbanwood.org/about/). Elsewhere, the Southeast Urban Wood Exchange provides resources for municipalities and arborists to connect with potential end users, encouraging the highest and best use of urban wood (http://www.urbanwoodexchange.org/about.php).

One driver of tree removal in urban and residential environments is utility vegetation management, which produces large quantities of wood that require disposal or utilization. In the northeastern United States

(US), utility companies are tasked with managing trees that could threaten utility infrastructure (i.e., trees within a certain distance of transmission and distribution lines; Hansen 2011). In Connecticut, the focus of this study, recent major storms resulted in widespread power outages from trees or tree limbs falling on the power lines; in response, utility companies have engaged in more-intensive tree pruning and removal to reduce the risk of future outages (McGee et al. 2012; State Vegetation Management Task Force 2012). Some of the wood from pruned or removed trees is used as firewood and mulch by property owners and other end users. However, utility companies and arborist contractors assume responsibility for disposal of remaining wood waste, representing a significant cost (Fratanduono et al. 2013). Therefore, there is an interest on behalf of utilities and municipalities in Connecticut to minimize the costs of waste wood disposal, as well as a realized opportunity to generate benefits for communities through wood product recovery (Donnelly and Doria 2014).

To explore the potential for wood recovery in a utility vegetation management context, a wood product recovery pilot program was initiated in the town of North Haven in southwestern Connecticut in 2015. The program was a collaboration with The United Illuminating Company (UI), one of the two main electrical utilities in the state. Trees were selected for removal based on UI's ongoing utility vegetation management program protocol. To implement the pilot program, utility-contracted tree crews were trained to remove trees using a modified protocol that allowed recovered logs to be sold as wood products (e.g., saw logs, tie logs; Figure 1A) and ensured marketability of wood chips generated (i.e., by keeping trash and debris out of chips). For trees located on private property, property owners were asked if they wanted to donate their tree(s) to the program. Accumulated logs and chips were stored on town property until sale to a local wood products company. Revenue from the sale of wood products was returned to the town for tree planting programs or other community initiatives.

Our objective was to evaluate the perceptions and experiences of utility-contracted tree crews regarding a wood recovery program, including the perspectives of crews involved in the pilot program and crews not engaged in wood recovery at the time of the study.

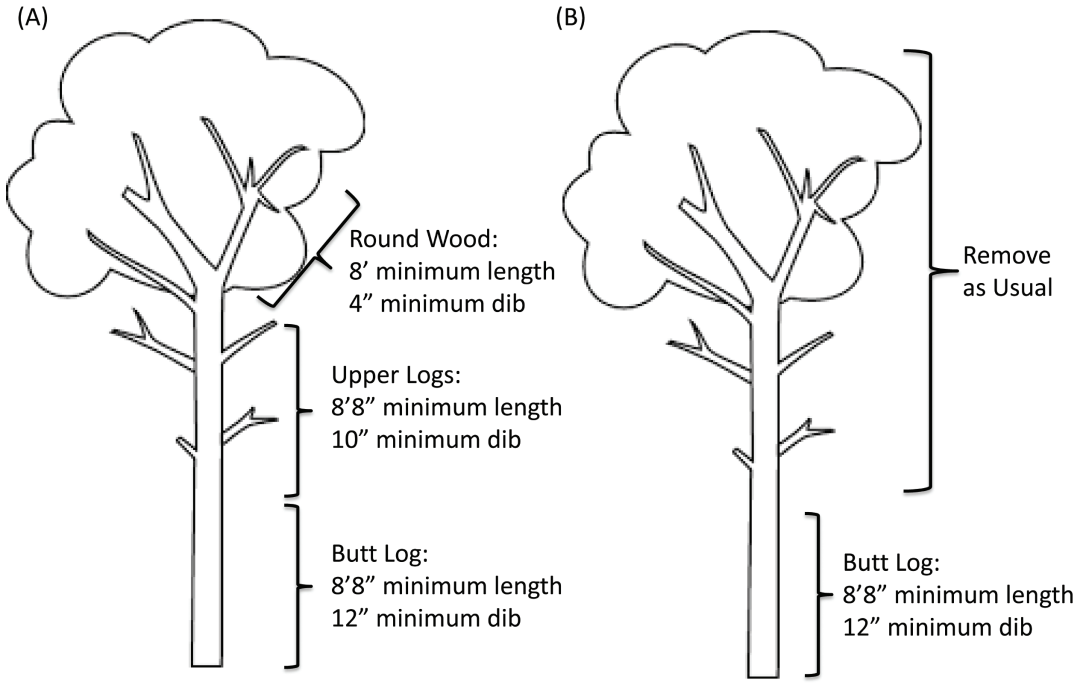

Figure 1. Protocol for tree crews in the wood recovery pilot program. (A) shows the initial protocol, in which crews were asked to identify and recover, if possible, marketable logs from all parts of the tree. Numbers indicate acceptable lengths and diameters (inside bark diameter; dib) for marketable logs. (B) indicates the modified protocol, based on initial tree crew feedback, which called for crews to focus on recovering only the butt log of the tree.

Past research suggests that possible challenges in wood recovery include lack of necessary equipment and local processors (Endahl 2015), need for educational seminars for operators who had not previously engaged in wood utilization (Endahl 2015), ability to access trees around obstacles (MacFarlane 2007), safety concerns due to proximity to hazards (MacFarlane 2007), and perceived low wood quality due to suboptimal growing conditions and potential presence of contaminants in the wood (e.g., nails, concrete; MacFarlane 2007). We hypothesized that similar concerns would arise in this study. Additionally, we expected that the utility vegetation management context would pose challenges, including proximity to electrical hazards and physical obstacles (i.e., utility poles and wires, fencing, driveways, roads), which might preclude the crews' abilities to remove longer lengths of wood. Therefore, we hypothesized that tree crew members would express concerns about such obstacles and challenges in relation to participating in a wood product recovery program from utility tree removals.

MATERIALS AND METHODS

To assess potential opportunities or barriers associated with the pilot program, we conducted semistructured qualitative interviews with tree crews (Neuman 2006). In this context, the advantages of qualitative data collection are threefold. First, qualitative methods can supplement data collected through quantitative methods, deepening and enriching understanding of relationships between the urban forest and its stakeholders (Elmendorf and Luloff 2001; McLean et al. 2007; Gundersen and Frivold 2008; Ostoic and van den Bosch 2015). Second, qualitative data collection has the potential to reduce conflict and promote collaboration between stakeholders by gathering rich and localized information to consider for program development and implementation (Elmendorf and Luloff 2001; Brody et al. 2003; Elmendorf and Luloff 2006). Finally, open-ended (qualitative) questions have been shown to provide different data than close-ended (quantitative) questions about values related to forests (Bengston et al. 2011). Limitations of qualitative interviewing include a lack of precise, quantitative measurements for distinct variables and lack of statistics to test hypotheses (Neuman 2006). However, for our purposes, we determined that qualitative interviews were appropriate for assessing tree crew perceptions of wood recovery despite these limitations. Topics addressed in the interviews for this study included work areas and procedures, current destination of wood from tree pruning and removals, interaction with homeowners or other community members, perceptions of or experience with wood recovery, and anticipated or actual barriers and challenges to wood recovery (see Appendix A for specific interview questions).

We worked with two utility companies for recruiting tree crews to interview: Eversource Energy (Eversource) and The United Illuminating Company (UI). The study included two types of interviews to investigate tree crew perceptions and experiences with wood recovery. The first type, pre-implementation interviews, was conducted with crews who had not been involved in the pilot program. The goal of pre-implementation interviews was to assess crews' current workflow and their perceptions of wood recovery in the utility context. Both Eversource- and UI-contracted crews were included in pre-implementation interviews. The second type, post-implementation interviews, was conducted in two phases with UI-contracted tree crews who had been involved in the North Haven pilot program. The first phase was completed shortly after pilot program implementation (September and October 2015); the second phase was conducted a year later (September 2016). Post-implementation interviews addressed the same goals as the pre-implementation interviews and, in addition, assessed the actual challenges and opportunities that tree crews experienced in implementing the pilot program.

The initial protocol for the pilot program called for tree crews to identify potentially valuable logs from all parts of the tree, including the butt log (i.e., bottom log closest to the ground), the trunk, and branches of sufficient diameter (Figure 1A). However, initial feedback from the first round of post-implementation interviews indicated that this protocol was prohibitively complex and posed potential safety hazards when trying to recover logs from above the power lines. Therefore, the protocol was modified to focus on preserving the butt log of the tree when feasible (Figure 1B), rather than all parts of the tree. Pre-implementation interviews and the second round of post-implementation interviews solicited feedback on this modified protocol.

For pre-implementation interviews with Eversource-contracted crews, we interviewed crew members from three tree crews in each of the seven

Table 1. Summary of interviews conducted with tree crews in relation to a wood recovery program for utility tree removals.

	Timeline interviewed	Number of individuals to pilot program?	Prior exposure
Eversource pre-implementation	July–August 2016	42	No
UI pre-implementation	April 2017	16	No
UI post-implementation 1	September–October 2015	13	Yes
UI post-implementation 2	September 2016	11	Yes

geographic work areas defined by Eversource. Tree crews typically included two or three individuals but sometimes included up to six individuals when multiple trucks were working together. A comprehensive list of the work locations for crews in each region was sent to the interviewer on the scheduled morning of interviews. The three crews to be interviewed within each work area were randomly selected. If one of the selected crews could not be located, a replacement crew was randomly selected. For interviews with UI-contracted crews (both pre- and post-implementation), a comprehensive list of all applicable crews and work locations was supplied to the interviewer on the day of interviews. The interviewer randomly selected crews from that list. Interviews were concluded once researchers determined that information saturation had been reached at each phase. Information saturation occurs when the range of ideas relevant to the research questions has been addressed in the interviews and no new information is gained through additional interviews (Krueger and Casey 2009).

When the interviewer arrived at a work location, the crew ceased operations. Crew members were provided with an information sheet describing the interview process and given the opportunity to ask questions and determine whether they wanted to participate. Because a translator was not available, only individuals who were comfortable completing the interview in English were included in the study. Interviews were completed on-site and conducted out of earshot of other crew members to ensure privacy. The human subjects research protocol was approved by the University of Connecticut Institutional Review Board (#H15-175 and #H16-007). Interviews were transcribed for analysis, and open coding was used to identify recurring themes in the data (Neuman 2006).

RESULTS

We conducted 58 pre-implementation interviews and 24 post-implementation interviews. Pre-implementation interviews exceeded post-implementation because we aimed to include tree crews from both utility companies and crews working in different parts of the state. Post-implementation interviews could only be completed with crews working in the town where the pilot program existed. Four individuals participated in both 2015 (post-implementation 1) and 2016 (post-implementation 2) interviews, for a total of 82 interviews with 78 participants (Table 1). As follows, values of *n* indicate the number of participants who provided each response. These *n* values are only included in instances when 10 or more participants gave the same response, in order to focus on responses that were most prevalent.

Workflow (Pre-Implementation Interviews)

Work Settings

Most participants ($n = 52$) indicated that they worked in a variety of settings ranging from urban to rural. The remaining participants indicated that they worked only on back roads, or primarily in rural, suburban, or urban areas.

Tree Removal Process

Many participants indicated that they removed 1 to 3 trees per day ($n = 33$). Several participants stated that the number of trees pruned per day was 20 to 30, but responses ranged from 5 trees to 7 spans (i.e., areas between utility poles). Participants indicated that variation in the number of trees pruned or removed was most often due to the size or diameter of the trees ($n = 21$) because larger trees took more time.

Safety was a prominent concern for participants. Seventeen participants discussed safety procedures as an important component of the tree removal process. Participants emphasized that each job site presents a different set of conditions that may affect their workflow:

> "...[W]hen we pull up to a job site, we'll do what's called a pre-job. We assess the surroundings, you know, are we working on the hillside or is it sloped down? Are there guardrails? . . . Is it a busy street or a nice quiet street? You take all these things into consideration."

Participants described two means of removing a tree. Most participants (n = 39) explained the process of removing a tree as follows: start at the bottom of the tree removing branches, work up to the top of the tree to clear out all of the branches, and then "chunk" the tree down. The process referred to as "chunking" involves cutting the trunk into smaller lengths of wood, which are either dropped or lowered with ropes ("rigged") to the ground. The branches are removed from bottom to top for safety reasons. Removal of obstacles around the bottom of the tree reduces the risk of branches cut from the top becoming caught or bouncing off of other branches while falling. Once all of the branches are removed and the height of the tree trunk is below the height of the utility lines, the butt log (i.e., the bottom log of a tree; below the branches and above the roots or stump) is felled whole if possible. Alternatively, some participants described a tree removal process in which the tree is felled whole, but this description of tree removal was rare among those interviewed.

Participants were asked about the length of the wood removed when "chunking" a tree down. Lengths discussed ranged from several inches to 20 feet (6 m), with most in the range of 3 to 6 feet (0.9 to 1.8 m). Participants expressed that lengths vary based on tree diameter (n = 13), proximity to utility wires, whether the crew was dropping or rigging the logs to the ground, and the preferences of the crew foreman.

Participants also gave a range of responses for the diameter of material that could be chipped. The most common responses were 4 to 6 inches (10 to 15 cm) (n = 19) and 8 to 12 inches (20 to 30 cm)(n = 22). Participants indicated that newer chippers were able to handle larger diameters. If homeowners requested small-diameter wood for firewood, that wood was not chipped.

Interactions with Homeowners and Other Members of the Public

Most participants (n = 53) stated that they have interacted with homeowners in the course of their work:

> "[S]ome people want to stick around and watch every part of it . . . then some people just, they sign off the work and that's it, they don't want to know about it again."

Many tree crew members had been asked what they were doing by homeowners (n = 26). Several participants stated that homeowners have expressed concerns about potential disturbance to other trees or their property (e.g., asked the crews to stay out of gardens or be cautious around fences)(n = 11). Some participants indicated that homeowners have asked them either to not conduct the pruning or removal, or to prune less than planned (n = 10). Participants also indicated that homeowners have asked them questions about the wood from tree removals: what would happen with the resulting wood, whether homeowners could keep the wood, and when the wood would be removed from the property by the company's log truck.

Participants stated that they interact with the general public primarily through managing vehicular and pedestrian traffic around the worksite. Other interactions include questions about what the crews were doing and why, inquiries about taking the wood or wood chips, and complaints about tree removals.

Destination of Wood from Utility Tree Removals

Participants (n = 27) expressed that they delivered the wood chips to a town-owned property or a general dumpsite, but they did not know where the chips went after delivery to these locations. Wood chips were sometimes taken to customers who sought the chips for use in yards and gardens (n = 25). Alternatively, chips were recycled at mulch producers or landscaping facilities (n = 18). Participants commented that it was more difficult to find a location to deposit wood chips when working in urban areas.

Many participants (n = 25) stated that a log truck picked up the logs, but they were unsure where the logs were delivered. Some participants (n = 17) stated that the wood stayed on the property where the tree

was felled, and the homeowner had to request removal if he or she did not want to keep the wood. Other destinations for removed wood that were mentioned by participants included wood processing plants, recycling centers, private houses, and woodlots. In the UI territory, many participants expressed that the logs were taken to a processing plant to be ground into mulch ($n = 11$).

Participants were asked how often homeowners kept the wood generated by utility tree removals and how often people looking for firewood took the wood when homeowners chose not to keep it. Crew members found it difficult to provide specific estimates of frequency since homeowners' desires for wood included several factors. For example, homeowners were more likely to keep hardwood than softwood because hardwood was more desirable for firewood:

> "You want like a hardwood for . . . firewood, like hickory, oak, things of that nature."

Homeowners in rural areas were more likely than those in urban areas to keep the wood or give the wood to neighbors, friends, or family. In response to being asked about how often homeowners chose to keep the wood from utility removals, one participant responded:

> "A lot, if it's out of the urban—like the city area—then most, pretty much all the time. But if we're in like a downtown area, or in a more like suburban area or whatever . . . we'll take the wood. But people in the woods want the wood."

In addition, homeowners were more likely to keep the wood as winter approaches than during the summer. However, homeowners were less likely to keep larger pieces of wood that may be too difficult to manage with available tools:

> "You'll have customers come out and say, 'Can you leave the small pieces?' . . . they usually don't want the big pieces."

According to participants, homeowners in wealthier areas were less likely to keep the wood than those in less wealthy areas. Additionally, the wood was less likely to be picked up by other people in wealthier areas, according to participants.

Program Perceptions (Pre-Implementation)

Positive Impressions of a Wood Recovery Program

The participants who were not involved in the pilot program were asked about their general impressions of a potential wood recovery program (Figure 1B). Many of the participants expressed that they had no concerns about wood recovery taking more time than their usual workflow ($n = 22$), or no safety concerns ($n = 24$). Several participants believed that the new process might be faster and easier than their current removal process, as it would require fewer chainsaw cuts to remove a tree:

> "It might even make it easier because we normally cut that in half, four feet."
>
> "Yeah, I can't see why leaving it in ten foot lengths is any different, once it's down to here, versus cutting it into three or four, six foot lengths. I don't see the difference."

Many participants stated that they already tried to preserve the butt log at a longer length when possible, as this saved time and generated fewer pieces for the log truck to pick up ($n = 23$). Participants also expressed interest in the benefits of the program to society, particularly generating funds for the community and reducing wood waste going to landfills:

> "If it's a possibility for everybody to benefit from that process then I would be all for that."
>
> "That would be a really good idea, especially if it involves planting trees that we're taking out."
>
> "I'm all for recycling and everything, just trying to make the most of things, 'cause we just, you know, a lot of the stuff just goes to waste."

Concerns About the Program

Some participants expressed concerns that it may take them longer to remove longer logs. Measuring the correct length of the log and using more caution when felling logs were expected to take more time. Thirteen participants ($n = 13$) stated that the new protocol had the potential to cause safety issues because of proximity to electric and communication wires. Some expressed concern about the larger fall radius of a longer log or the need to rig down larger pieces of wood with the potential for injury:

> "That's a great idea and it depends though, the height of the wire and stuff, 'cause sometimes that's not practical to leave [the butt log] that tall . . . if it's up on a hill, if it's like in a dangerous spot."

Besides time and safety issues, there were two other main concerns expressed about potential implementation of a wood recovery program. First, some participants were concerned that homeowners would be unwilling to donate logs to the program. This was particularly a concern in more rural areas, where homeowners often kept the wood or gave it to a friend or neighbor:

> "Um, to be honest with you, around here it [a barrier to the program] would probably be more the homeowners than anything else because they may not want to give it [the wood] up. They may want to keep it."

The second main concern was about the low quality of the wood from utility tree removals. Some participants stated that sawmills would not be interested in logs from roadside tree removals because these logs might contain metal:

> "People nail up signs for yard sales, so that wood technically is junk. You can't do anything. No mill will put a saw into it."

Others stated that trees were often targeted for removal because they were dead or rotting, so the wood would not be marketable.

Other Comments on the Program

Participants provided other insights into how the program could be made more feasible or acceptable for the tree crews. Thorough instruction prior to implementation was considered important for program success, as tree crew members did not always have prior experience in the logging industry. The crew members also mentioned the need for additional equipment, such as larger chainsaws or wedges, to aid wood recovery.

Program Evaluation (Post-Implementation)

Participants working within the pilot program area in North Haven indicated a range of comprehension and communication about the program. Three of the thirteen participants in the first round of interviews (UI post-implementation 1) could not recall receiving any information about the program. Of those who had received information from either the utility company or their general foreman, four were aware that the revenue from the logs would go back to the town from which the trees were removed. When asked whether they would support or oppose continuing the wood recovery program at all of their tree removal sites (i.e., including outside of North Haven), seven supported continuing wood recovery, while others were unsure or indicated that it would depend on the specific site. None of the respondents indicated opposition to continuing the program. Concerns included personal safety ($n = 4$) and time ($n = 6$), with participants estimating that it took 15 to 30 minutes longer to remove a tree with the wood product recovery protocol:

> "Every scenario is different . . . if we have the space and we can just drop larger sections you know it actually saves us time because we're making less cuts and we can get it on the ground faster, but you know then there's other times when we have to really think about whether we can do it safely. So it's just all logistically, you know, it's just a tree by tree basis."

> "It is a little bit more of a safety issue because, of course, you know, we're doing our job, which is dangerous as it is and then we have to do extra work on top of that, so that kind of makes, you know, added time pressure, which leads to more accidents."

In the second round of interviews (UI post-implementation 2), 7 of the 11 tree crew members interviewed indicated that they had worked on the pilot program in North Haven. The remainder had either not worked in North Haven or had recently started working on the crew. Of the 7 who had worked on the program, 3 indicated that they had not encountered any issues with implementing the new tree removal process, but 4 indicated that the new process took more time. Six of the interviewees supported continuing the wood recovery program at tree removal sites outside of North Haven; another indicated that their support would depend on the specific location.

DISCUSSION

The objective of this study was to assess the perceptions and experiences of utility-contracted tree crews

with regard to a wood recovery program. At the time of writing, the pilot program in North Haven, Connecticut, had generated about $5,800 in revenue for the town (E. McConnell, personal communication); there had been no estimate of utility implementation costs. For a similar concurrent pilot program in Haddam, Connecticut, utility costs were estimated to be $12,000, with $6,000 in revenue for the town (S. Stotts, personal communication); the utility company identified opportunities for improving efficiencies and reducing costs in the future. To guide our discussion, we focus on three findings from our analysis: (1) the generally positive attitudes of tree crews toward a wood product recovery program in the utility context; (2) the potential barriers to such a program identified by tree crews; and (3) the utility of qualitative interviews with practitioners in assessing urban forestry and arboricultural programs.

First, contrary to our hypothesis, we found that participants were generally supportive of wood recovery from utility vegetation management. Through the interviews, we learned that participants were particularly motivated by the opportunity to reduce wood waste and to provide benefits to the communities in which they worked. Many participants also expressed that the modified protocol (Figure 1B) was very similar to their current workflow, making the program relatively simple to implement. This enthusiasm is consistent with findings from Endahl (2015), who found that a majority of respondents (municipalities and arborists in Virginia, US) considered urban forest waste utilization a major issue for the urban forestry industry currently and in the future.

Participants were able to provide insight into where such a program might be most successful. Since homeowners in urban areas are less likely to keep the wood from removals for personal use than homeowners in rural areas, a wood recovery program might be more successful in urban areas. Participants indicated that urban areas generally pose a challenge in finding places to dispose of the wood. Therefore, in urban settings, a wood recovery program might save time if crews are provided a consistent location for log and chip drop-off. Previous research has highlighted urban environments for potential wood recovery due to the high density of tree removals and close proximity of potential end users (MacFarlane 2007). Endahl (2015) found that private arborists often cited the need for local facilities available to receive and stockpile urban forest waste. In the pilot program for our study, the town provided property at which wood could be dropped off, sorted, and stored until pickup by the end user.

Second, the potential challenges that participants perceived for implementing a wood recovery program were consistent with those hypothesized. These included: (1) increased time required to remove a tree according to the new protocol; (2) safety concerns for removing larger logs; (3) physical obstacles to removing logs (i.e., mailboxes and stone walls); (4) homeowners who want to keep the wood; and (5) low-quality wood (i.e., containing rot or metal). In modifying the protocol for the program (adjustment from Figure 1A to Figure 1B), we were able to take into account the feedback provided during the first round of post-implementation interviews. The new protocol aligned more closely with the current workflow of tree crews and addressed some of the time and safety concerns that were expressed. By focusing on the butt log of the tree for recovery, rather than assessing the entire tree for potential wood products (Figure 1), the modified protocol ensured that crews worked below the height of the power lines when recovering logs. This modification was intended to reduce the risk of contact with the power lines and minimize disruption to workflow. However, participant feedback indicated that even the modified protocol could pose challenges at some worksites. Therefore, program success might be enhanced if supervisors are aware of such challenges and emphasize the importance of only recovering logs when it is safe and practical to do so.

To address concerns about the time required, asking homeowners whether they plan to keep the wood concurrently with obtaining permission for tree pruning or removal would allow crews to focus the wood recovery program on properties willing to donate their trees. Additionally, a protocol for wood recovery might emphasize recovering only logs that are not obviously damaged or decaying. While low-quality logs may be an issue in some cases, the revenue generated thus far by the program in our study area indicates that high-quality logs are available from utility removals. Despite identifying low-quality wood as a potential barrier for urban wood utilization, a previous study found that quality of urban-grown hardwoods was comparable to that of nearby forest-grown

hardwoods in southeastern Michigan (MacFarlane 2007). As observed by the authors, collaboration among the municipality, utility company, and a local wood products company in the pilot program in our study implies willingness of some sawmills to engage with urban wood waste recovery.

Finally, we found that qualitative interviews with practitioners (in this case, tree crews) provided valuable insight into the potential opportunities and challenges in implementing a wood recovery program. Elmendorf and Luloff (2001, 2006) suggested that qualitative data collection methods, particularly key informant interviews, facilitate stakeholder collaboration in urban forestry programs because participants can provide localized and in-depth information that can be considered for program development. In this study, interviews provided tree crew members with the opportunity to have a conversation about their work process. Tree crew perspectives and experiences made a tangible difference in the program by giving feedback that resulted in a modified protocol (i.e., the transition in protocol from Figure 1A to 1B), supporting previous research suggesting that key informant interviews can improve planning processes (Brody et al. 2003). Another benefit of the qualitative methods used in this study was that participants were able to provide additional context for quantitative data. For example, participants were able to not only state the diameter of material chipped, but also explain their response, including the range of possible diameters chipped, why larger diameters might not be chipped, and how different equipment impacted chipping. In-field interviews also allowed for reference to specific equipment, trees, settings, and conditions (Lowery and Morse 2013; Conway 2016). During our interviews, participants referred to specific trees and equipment at the worksite to facilitate their description of tree removals, as well as potential obstacles that might pose a problem around power lines.

The results of this study indicate potential for developing wood recovery programs for utility vegetation management, particularly in urban areas. Our study focused on one of the stakeholders most directly involved with implementation: the tree crews. Future research may include other key informants, including municipal officials, homeowners, utility work planners and arborists, and wood product buyers.

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ACKNOWLEDGMENTS

This project was supported by Agriculture and Food Research Initiative Competitive Grant no. 2014-38420-21802 from the USDA National Institute of Food and Agriculture and the Eversource Energy Center. The authors express their gratitude to the tree crew members who participated in interviews and made this research possible, as well as to Doug Pistawka and Sean Redding of Eversource Energy and David Goodson and Eric McConnell of United Illuminating.

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Conflicts of Interest:
The authors reported no conflicts of interest.

Résumé. La gestion de la végétation sous les réseaux publics génère de grandes quantités de bois dont il faut disposer. Afin d'examiner les opportunités de réduction des résidus ligneux et promouvoir la récupération du bois, nous avons évalué les perceptions et les expériences des équipes de travailleurs forestiers embauchées par les services publics concernant un programme de récupération du bois. Des entrevues furent effectuées avec des travailleurs forestiers, certains concernés (n = 24) et d'autres non concernés (n = 58) par le programme pilote. Les questions d'entrevue mettaient l'accent sur le flux de travail, les interactions avec les propriétaires et le public, ainsi que la perception des travailleurs quant aux opportunités pour l'implantation d'un programme de récupération du bois. Les participants ont généralement montré une attitude positive envers un tel programme, souhaitant générer des bénéfices pour les communautés grâce aux recettes provenant de la vente des billots et ainsi réduire le gaspillage des résidus ligneux. Les défis potentiels associés à un tel programme incluaient: (1) l'augmentation du temps requis pour l'abattage des arbres; (2) les préoccupations de sécurité lors de la manutention de billots plus gros; (3) les obstacles physiques dont les boîtes aux lettres et les murs de pierre; (4) les propriétaires souhaitant conserver le bois et finalement (5) la faible qualité du bois (contenant par exemple, de la carie ou des morceaux de métal). Le protocole fut modifié afin de prendre en compte de telles inquiétudes. Avec l'apport des travailleurs forestiers, nos constatations suggèrent qu'un programme de récupération du bois a le potentiel de réussir à réduire le gaspillage des résidus ligneux originant de l'entretien de la végétation croissant sous les réseaux publics et de générer des avantages pour les communautés, particulièrement en milieu urbain.

Zusammenfassung. Das Management von Utility Vegetation (UVM) generiert große Mengen von Holz, welches entsorgt werden muss. Um die Möglichkeiten zur Reduzierung von Holzabfällen und Förderung von Bestandserholung heraus zu finden, haben wir die Wahrnehmungen und Erfahrungen von Baumpflegefirmen, die vertraglich mit UVM beauftragt sind, bezüglich eines Bestandserholungsprogramms bewertet. Wir haben Interviews mit Mitarbeitern dieser Firmen durchgeführt, die beide involviert (n = 24) und nicht involviert (n = 58) waren mit dem Pilotprogramm. Die Fragen in dem Interview fokussierten auf Arbeitsfluss, Interaktionen mit Hauseigentümern und der Öffentlichkeit und sich bietenden Gelegenheiten zur Implementierung von von Gehölzregenerationsprogrammen aus der Perspektive der der Mitarbeiter. DieTeilnehmer hatten generell eine positive Einstellung zu Gehölzregenerationsprogrammen und wollten Vorteile für die Kommune schaffen durch den Rückfluss von Holzverkauferlösen und die Reduzierung von Holzabfällen. Potentielle Herausforderungen in Verbindung mit solchen Programmen schließen ein: (1) ansteigender zeitaufwand für die Baumentsorgung; (2) Sicherheitsbedenken bei der Entsorgung größerer Stämme; (3) physikalische Hindernisse wie Briefkästen und Steinmauern; (4) Hauseigentümer, die das Holz behalten wollen; (5) schlechte Holzqualität (z.B. mit Fäule oder Metall). Das Protokoll wurde modifiziert, um solche Bedenken zu berücksichtigen. Mit dem Input der Mitarbeiter kommen wir mit unseren Ergebnissen zu dem schluss, daß ein Gehölzregenerationsprogramm das Potential hätte, den anfallenden Holzabfall aus dem UVM zu reduzieren und Vorteile für die Kommunen, insbesondere in urbanen Umfeldern zu generieren.

Resumen. La gestión de la vegetación en líneas aéreas genera gran cantidad de madera que requiere su ubicación. Con el fin de explorar oportunidades para reducir los residuos de madera y promover su recuperación, evaluamos las percepciones y experiencias de los equipos de arboristas contratados por servicios públicos con respecto a un programa de recuperación de madera. Realizamos entrevistas con los miembros del equipo involucrados (n = 24) como no involucrados (n = 58) con el programa piloto. Las preguntas de la entrevista se centraron en el flujo de trabajo, las interacciones con los propietarios y el público y las oportunidades para la implementación de un programa de recuperación de la madera desde la perspectiva de los miembros del equipo. Los participantes generalmente tuvieron actitudes positivas hacia un programa de recuperación de la madera, proporcionando beneficios para las comunidades a través de los ingresos de las ventas de troncos y reducir los desechos de madera. Los desafíos potenciales asociados con un programa de este tipo incluyeron: (1) el aumento del tiempo necesario para la remoción de árboles; (2) problemas de seguridad para eliminar troncos más grandes; (3) obstáculos físicos tales como buzones y muros de piedra; (4) propietarios que deseen conservar la madera; y (5) madera de baja calidad (es decir, que contiene podredumbre o metal). El protocolo se modificó para abordar esas preocupaciones. Con la aportación de los miembros del equipo de los árboles, nuestros hallazgos sugieren que un programa de recuperación de madera tiene el potencial de tener éxito en la reducción de los residuos de madera de la gestión de la vegetación de líneas públicas y la generación de beneficios para las comunidades, particularmente en entornos urbanos.

Appendix A. Interview Questions.

Pre-Implementation Interview Questions

Prior to Interview (UI only): Have you been interviewed by researchers from UConn in the past year? Have you been trained to remove trees in a way that produces logs that can be sold?

Initial Questions:

(1) Do you work primarily in urban, suburban, or rural areas, or do you work in all of these settings?

(2) About how many trees do you remove or trim in a typical day?

(3) Can you walk me through how you go about removing the tree?
- (a) In what order are parts of the tree removed?
- (b) What parts are chipped or cut up? *Prompt:* Approximately what diameter material is chipped?
- (c) How large are pieces cut for those parts of the tree that are not chipped?

(4) Where does the wood from tree removals and trimming go after you leave the site for the day?
- (a) In your experience, where do the chips go?
- (b) Where does the rest of the wood go?
- (c) How often do homeowners ask to keep the wood? *Prompt:* About what percentage of the time would you estimate that this happens?
- (d) When they ask to keep the wood, do you cut it differently?
- (e) If homeowners do not keep the wood, how often is it picked up by other people in your experience? *Prompt:* About what percentage of the time would you estimate that this happens?
- (f) How often does it need to be picked up by your company for disposal? *Prompt:* About what percentage of the time would you estimate that this happens?

(5) When you're removing trees, do you have any interaction with the homeowners?
- (a) If yes, what does that usually involve?
- (b) Do you have any interaction with other people passing by?

Program Explanation:

[UI/Eversource] is considering a new process for removing trees that will result in logs that can be sold. The revenue from these logs would be given to the town from which the trees were removed to fund tree-planting programs. This process would involve cutting branches closer to the truck, identifying logs that are of high enough quality for sale, and cutting the butt log of the tree to a length of 8'8" or more whenever it is safe and practical to do so. [Participants were shown a diagram similar to Figure 1 to clarify the explanation.] We are interested in your opinions about this new program.

(1) Does this explanation make sense to you or do you have any questions about the process?

(2) Do you have any experience working with this process?

(3) If you were asked to implement this new process, what barriers or challenges might you anticipate? Do you have any concerns about the new process? *Prompts:* Concerns about time, safety, costs?

UI Post-Implementation Interviews (1)

(1) Have you recently received direction from UI to make some changes in how the wood is cut during tree removals?
- (a) If yes, proceed to Question 2.
- (b) If no, *prompt:* Have you been asked by your foreman or anyone from UI to cut longer logs when removing trees?
  - (c) If yes, proceed to Question 2.
  - (d) If no, proceed to Question 4.

(2) Who did you receive the directions from? (e.g., foreman, directly from UI)

(3) Did UI provide information about why these changes were made?
- (a) If yes, proceed to Question 5.
- (b) If no, proceed to Question 4.

(4) Have you heard of the biomass recovery program initiated by UI?
- (a) If yes, proceed to Question 5.
- (b) If no, *prompt:* UI is requesting that the logs be left long (greater than 8 feet) whenever possible so that they can be collected and sold to log buyers. The money from these sales will be given to the town of North Haven (or other towns as appropriate) for a tree planting program. Does this sound familiar?
  - (c) If yes, proceed to Question 6.
  - (d) If no, proceed to Question 9.

(5) What information did you receive about why the changes were made?

(6) Can you briefly explain the protocol you are following for the biomass recovery protocol?

(7) Have you encountered any issues in the process? (e.g., clarity of communication with the process, personal safety issues, etc.)

(8) Have you had any interaction with a UI representative to receive feedback about the harvesting process? If so, what did that feedback include? Have you received any feedback from your foreman or another supervisor?

(9) Do you have any interaction with homeowners when you are removing trees? If so, what does that interaction usually involve?

(10) Have you encountered individuals who have asked you about removing downed wood after it has been cut?

(11) Would you support or oppose continuing wood recovery at all of your tree removal sites? Why or why not?

(12) Do you think that wood recovery adds to the time required to remove a tree?
   (a) If yes, how much more time does it add? What is more time consuming?
   (b) If no, does this system reduce the time to remove a tree or does the time required remain the same? Why?

(13) Is there anything else you would like to add?

UI Post-Implementation Interviews (2)

Initial Questions:
[See Initial Questions from UI/Eversource Pre-Implementation Interviews.]

Biomass Recovery Program Questions:
(1) Have you been asked to remove trees in a way that produces logs that can be sold?
   (a) If yes, proceed to Question 3.
   (b) If no, proceed to Question 2.

(2) Have you been asked by your foreman or anyone from UI to cut longer logs when removing trees?
   (a) If yes, proceed to Question 3.
   (b) If no, end of interview.

(3) Were you interviewed last year about this program?

(4) Who did you receive the directions from?

(5) Did UI provide information about why you are asked to remove trees this way?

(6) What information was provided about the program?

(7) Can you briefly explain the protocol you are following for the biomass recovery program?

(8) Have you encountered any issues in the process? (e.g., clarity of communication about the process, personal safety issues, etc.)

(9) Have you had any interaction with a UI representative to receive feedback about the harvesting process? Is so, what did that feedback include? Have you received any feedback from your foreman or another supervisor?

(10) Do you have any interaction with the homeowners when you are removing trees? If so, what does that interaction usually involve?

(11) Have you encountered individuals who have asked you about removing downed wood after it has been cut?

(12) Would you support or oppose continuing wood recovery at all of your tree removal sites? Why or why not?

(13) Do you think wood recovery adds to the time required to remove a tree?