ORIGINAL PAPER

Resident perspectives on tornado-induced tree canopy loss and a decade of regrowth in Springfield, Massachusetts

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Abstract

Urban residents have strong connections with the trees that provide beauty, character, structure, familiarity, and myriad ecosystem services to their landscapes. When tree canopy declines, the associated benefits and landscape impacts decline as well. In the context of gradual tree canopy decline, this reduction in tree-related benefits and the changes to residents' experiences of their landscapes may not be immediately noticeable. However, dramatic and instantaneous canopy loss as a result of severe weather events is significantly more noticeable, even for residents who may not normally pay close attention to trees. This research investigates resident experiences of an EF-3 (Enhanced Fujita scale) tornado in Springfield, Massachusetts to understand their feelings about canopy change from pre-disaster through three stages of disaster aftermath. We employed semi-structured interviews to learn: how tree loss associated with the tornado altered residents' feelings about/relationship with their urban forest; how they felt about and interacted differently with their treeless landscape; how they made decisions about and experienced the tree replanting process in the mid-term aftermath, and with tree stewardship in the long-term aftermath; and how they felt about their landscape after more than a decade of canopy regrowth. We found that residents: had strong emotional responses to tree loss; missed the benefits that the trees provided (even if they did not enjoy the specific trees that were around their home prior to the tornado); felt disoriented in the treeless landscape; and were pleased with their decision to replant, despite minor frustrations with their new trees.

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1 Introduction

Severe weather is becoming increasingly frequent and its impact on communities has intensified (Huber and Gulledge 2011; Massachusetts Bureau of Climate and Environmental Health 2022; McBean 2004). When these severe weather events (SWE) hit densely populated cities, recovery resources can be in high demand and thinly spread. In the period following a SWE, these recovery resources are generally first deployed to address pressing needs (like securing necessities for those in the most dire circumstances and addressing hazardous conditions) before communities begin to gradually reconstruct essential infrastructure in order of importance (Chester et al. 2021; Kates and Pijawka 1977; Lizarralde et al. 2009; Smith and Birkland 2012). What these multi-phase response initiatives often do not include—neither in the immediate nor longer-term recovery process—are programs that address the natural landscape disturbances caused by SWEs that can disrupt the "human perception of place" (Hunter 2011) and place attachment that is so intertwined with one's familiar natural landscape (Cox and Perry 2011; Hunter 2011; Lizarralde et al. 2009; Zetter and Boano 2009). Indeed, post-disaster recovery efforts generally focus on providing housing and essential supplies and services (Lizarralde et al. 2009), resulting in collective feelings of displacement within a suddenly unfamiliar landscape, which "fragments the relationship between people and their familiar habitual environments" (Lizarralde et al. 2009; Zetter and Boano 2009). As one consequence of the relative infrequency of disaster recovery initiatives that engage with urban natural landscape reconstruction (as opposed to built landscape reconstruction), there are fewer studies to help practitioners understand what community members need from these sorts of programs (and why they need them), how they make natural landscape decisions following a SWE, as well as how they feel about the stewardship and regeneration process in the immediate, mid-, and long-term disaster aftermath (Butler et al. 2019; Eisenman et al. 2015; Rumbach et al. 2016).

1.1 How do we understand "aftermath"?

Aftermath is defined as the period following a disaster or destructive event—the duration of that period is influenced by the effects of that disaster (Cambridge Dictionary 2024) and inherently, the resolution of those effects. With this definition, the temporal bounds around disaster recovery can be quite fuzzy (for instance, one may argue that the United States is still experiencing the aftermath of 9/11, depending on which of its aftereffects are examined). For the purpose of this study, we define "aftermath" as the period of time before an individual, community, or system recovers from a disaster and arrives at a state that feels like (psychological recovery) or resembles (practical recovery) pre-disaster normalcy or familiarity.

In understanding disaster response, it is important to consider the ways in which the recovery process is intertwined with this concept of aftermath—in part because it means something different in relation to each individual and system impacted by a disaster. For example, on the individual level, the aftermath period of a person who experienced a few broken windows may be substantially shorter than the aftermath period of someone whose home needed to be entirely reconstructed; aftermath might be further extended if the individual is coping with enduring trauma as a result of the SWE (Bryant 2006; Carroll et al. 2009; Reissman et al. 2009).

Similarly varied recovery timelines are present in the context of urban systems. Some systems are quicker to recover, particularly if they are deemed essential and require the reconstruction of gray infrastructure (FEMA 2023). Transportation systems, for instance, may be prioritized and recover relatively quickly following a SWE (Chester et al. 2021; Jordan and Javernick-Will 2013; Rouhanizadeh and Kermanshachi 2020; Smith and Birkland 2012). Conversely, environmental systems, and the urban forest specifically, may experience a more prolonged aftermath period. Woody vegetation regenerates at differing—and often slower—rates with limited options for accelerating that regeneration. Additionally, though the importance of a thriving urban forest is increasingly recognized, it is still common for decision-makers to minimize its value (Hartel 2019). Because of slower and less malleable regeneration, as well as reduced valuation and dedication of fewer recovery resources, the aftermath period for the urban forest (and for the individuals that care for and about it) may be decades longer than other urban systems' aftermath periods. This is especially true in the instance of the loss of a mature urban forest, where restoration of a pre-disaster landscape could take many decades. Accordingly, disaster research that focuses on urban forest regeneration following SWEs ought to reflect this extended timeline and explore relationships with trees and the urban forest at multiple stages: (a) pre-disaster, (b) immediate aftermath, (c) mid-term aftermath, and (d) long-term aftermath. These stages, which will be utilized in framing the findings of this study, are influenced by foundational works in place attachment theory (Altman and Low 1992; Brown and Perkins 1992) and disaster recovery theory (Kates and Pijawka 1977). These recovery phase theories, described below, were combined and modified to assist in understanding how connected the subjects of this research felt to their urban trees as features of their familiar landscapes, and how that connection compelled them to take action in restoring those features in the aftermath of a tornado.

While many disaster recovery researchers agree that disaster aftermath broadly includes phases of "relief, restoration, and recovery" (Sobhaninia and Buckman 2022), Kates and Pijawka (1977) established a unique four-phase model of disaster aftermath and recovery, which consists of: (a) emergency, (b) restoration, (c) reconstruction I, and (d) reconstruction II—longer term reconstruction—acknowledging that different aspects of recovery and reconstruction necessarily take place along different timelines. Relatedly, in the final chapter of Altman and Low's *Place Attachment* (1992), Brown and Perkins describe how a disruptive event, like a SWE, causes a "loss of normal attachments [which] creates a stressful period of disruption followed by a postdisruption phase of coping with lost attachments and creating new ones." They outline the three distinct phases of this model as: (a) predisruption, (b) disruption, and (c) postdisruption.

In order to engage with *both* pre-disaster connections with the urban forest (as a component of place attachment) and long-term disaster recovery, the above models were combined and modified to encompass the initial place attachment ("predisruption", à la Brown and Perkins 1992) all the way through the reestablishment of a secure place attachment following a disruption through long-term restoration ("reconstruction I and II", à la Kates and Pijawka 1977). Hence, the stages employed throughout this research are (a) pre-disaster (as a baseline for understanding a research subject), (b) immediate aftermath, (c) mid-term aftermath, and (d) long-term aftermath.

1.2 Sense of place, disruptions of place attachment, and urban tree canopy (UTC) loss

The experiences that individuals and communities have within a disaster and throughout its aftermath are shaped by the characteristics of the relationship between the impacted individuals or communities and the impacted landscape. Because of this, it's necessary to situate urban trees as a component of residents' sense of place (Jones and Cloke 2002), and understand how their attachment to place (and the trees that help to define it) is disrupted when SWEs cause abrupt urban canopy loss. In the context of this research, it is important to distinguish "sense of place" from "place attachment"—although the concepts are related. Sense of place can be understood as "an experiential process created by the setting, combined with what a person brings to it" (Steele 1981), whereas place attachment is understood as "the bonding of people to places" (Altman and Low 1992). In part, this research seeks to understand how urban trees contributed to residents' *sense of place* prior to a SWE, what sorts of pre-SWE behaviors contributed to *attachment to place* through attachment to trees, and how they experienced and responded to an abrupt disruption.

Human relationships with trees have been understood as an important component of place identity in urban environments (Jones and Cloke 2002). While the urbanized, built environment creates psychological distance between residents and local ecosystems (Andersson et al. 2014), trees help to create a sense of place (Jones and Cloke 2002; Tuan 1990) and connection with nature, which is essential for fostering community and individual identity (Judice et al. 2021; Warsini et al. 2014). Research suggests that city-dwellers develop psychological connections with the trees around them (Dwyer et al. 1991; Ryan 2006; Tidball 2014). Trees contribute greatly to the aesthetic quality of a streetscape, represent a large proportion of the urban greenery that residents are able to observe from their windows (Hunter 2011) and may be the main ecological features that they experience in their daily lives (Coleman et al. 2021). Understanding this baseline of human-tree relationships in urban environments suggests that when SWEs cause dramatic tree canopy loss and natural landscape alteration, the reverberating impacts to urban residents' experiences of their homes and neighborhoods can be significant (Adie 2020; Bonaiuto et al. 2016; Greer et al. 2020; Lizarralde et al. 2009; Novais et al. 2022).

This research purposefully explores these reverberations, centering the concepts of normalcy, familiarity, disruption, and the impulse to make decisions that return a home or neighborhood to a pre-disaster state. The term "solastalgia," coined by philosopher Glenn Albrecht, describes the emotional distress and loss of identity associated with environmental degradation and landscape change, and an innate desire to reconstruct or return to a familiar landscape (Albrecht 2005; Warsini et al. 2014). This strong impulse to recreate a familiar landscape is evident in post-Katrina New Orleans, where many residents chose to rebuild their homes and did not favor property-level nor neighborhood-scale modifications that might reduce future vulnerability (Lizarralde et al. 2009). This research seeks to understand how urban residents describe and respond to a "solastalgic" impulse to replace trees that were lost as a result of a SWE, even when they experienced the harmful effects of tree failure.

1.3 Severe weather and the urban forest

For the purpose of this research, it is useful to situate SWE impacts on the urban forest within two realms: (a) alteration of the environment, and (b) alteration to the sense of place. Alteration of the environment can be understood as the changes to the functions of habitats and ecosystems impacted by trees and tree loss (i.e., changes to microclimates or changes in tree-associated food and material presence). In cities, trees provide many of these environmental and climatic functions—they moderate temperature and wind, clean the air and water, reduce stormwater impacts, and provide wildlife habitat (Domke et al. 2021; Nowak and Dwyer 2007; Nowak and Greenfield 2018; Tyrväinen et al. 2005). Post-disaster reduction of UTC can dramatically reduce the availability of those benefits. Alterations to the sense of place, on the other hand, concern the new and potentially startling way that urban residents perceive, sense, and interpret their home landscape when it shifts from tree-filled to treeless (and gradually, back to tree-filled). The results of this research at times demonstrate that these realms overlap where the environmental alteration itself causes the shift in place perception (e.g., loss of bird habitat impacts the ability to engage in birdwatching).

Due to this multifaceted impact of alteration to resident experiences of their natural landscapes caused by dramatic UTC loss, as well as the associated consequences of disruption to sense of place, it is sometimes concluded that urban replanting efforts following a SWE should be implemented as a component of long-term disaster response. Indeed, numerous governmental reports following SWEs that significantly impacted the urban forest suggest reforestation as an important intervention (Alabama Forestry Commission 2004; Florida Forest Service 2022; Matteson 2017; Texas Tree Foundation 2021). However, implementing these planting recommendations—particularly on private property—may present challenges.

1.4 Challenges associated with yard tree planting

The majority of plantable space in U.S. cities exists on private property (O'Neil-Dunne 2009, 2011, 2012); thus, post-disaster urban reforestation should include a plan to plant trees on private properties as well as in public spaces. However, a multitude of barriers create challenges in engaging urban residents in tree planting efforts, particularly when it comes to yard tree planting (Dawes et al. 2018; Pearsall et al. 2024; Riedman et al. 2022; Saldarriaga et al. 2020). For instance, caring for trees on one's own property can be time consuming and costly, and residents may have fears about the potential for trees to become hazardous when planted close to their homes or cars (Dawes et al. 2018; Pearsall et al. 2024; Riedman et al. 2022; Saldarriaga et al. 2020). In the absence of access to free trees, plant purchase itself can be the prohibitive factor (Conway 2016). Thus, even the most pro-tree urban residents may find themselves with complex relationships with yard trees and mixed feelings about the prospect of tree planting on their property. In the context of post-disaster yard tree replanting, where experiences of tree loss and tree-related property damage and trauma may further complicate residents' relationships with residential trees, it is necessary to explore these experiences when planning for successful post-disaster planting initiatives.

A number of cities have engaged in replanting efforts in the aftermath of SWEs (Kurosawa 2021; Lavy and Zavar 2023; Morgan and Ries 2022; Tidball and Aktipis 2018; Tidball and Krasny 2013). However there is a dearth of research on those types of interventions

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and substantial knowledge gaps remain regarding how residents feel about and interact with them throughout the aftermath period. Thus, through interviews with residents of Springfield, Massachusetts who experienced dramatic tree loss associated with a tornado in 2011, and opted into a yard tree replanting program, this research seeks to understand:

(a) How tree loss associated with this SWE altered residents' feelings about/relationship with their urban forest and with specific trees in the vicinity of their home;
(b) How they felt about and interacted differently with their treeless landscape;
(c) How they made decisions about and experienced the tree replanting process in the mid-term aftermath, and with tree stewardship in the long-term aftermath; and.
(d) How they felt about their reconstructed landscape more than a decade after trees were replanted.

This research intentionally exists at the intersection of the psychological and the practical in the context of post-disaster urban forest recovery, as we posit that this work necessarily involves both. Understanding the psychological experience of loss and recovery is crucial for creating practical solutions (e.g., tree planting programs), informed by residents' experiences of alterations to their environments and to their sense of place. The ways in which those practical solutions are received (positively, negatively) by impacted communities may impact their psychological landscape anew.

2 Methods

2.1 Study area

Located in the western region of the state, Springfield, Massachusetts is the fourth most populous city in New England (pop. 155,929; US Census Bureau 2020). On June 1, 2011 an EF-3 tornado tore a 31.52 mile path through Western Massachusetts from Westfield to Holland, which included seven of Springfield's neighborhoods: Metro-Center, South End, Six Corners, Upper Hill, Old Hill, East Forest Park, and Sixteen Acres. As a result, thousands of trees were damaged or uprooted—including 7500 mature trees in the City of Springfield (National Oceanic and Atmospheric Administration 2011). The following year, residents in these neighborhoods were notified of the availability of free yard trees as part of a post-tornado planting program via direct mail flyers (Fig. 1), a commercial marketing campaign, and other in-person community outreach methods. Four hundred and fifty-three property

Fig. 1 Post-tornado tree planting promotional flyer. The front and back sides of the flyer that was mailed to approximately 5000 properties within the seven Springfield neighborhoods impacted by the tornado

owners opted into this program, the majority of whom were residents of East Forest Park and Sixteen Acres (Davey Resource Group 2012), which are further from the urban core, have lower percentages of residents of color, higher median income (although still largely working class), and a higher percentage of urban tree canopy cover (UTCC) than the other neighborhoods within the city's tornado-affected landscape (American Forests 2022). City-wide, Springfield has 30.75% UTCC, whereas the lowest canopy tornado-affected neighborhood (Metro Center) has 8% UTCC and the highest canopy tornado-affected neighborhood (Sixteen Acres) features approximately 50% UTCC (American Forests 2022; US Forest Service 2022).

In the absence of a case-specific study to uncover why more residents in East Forest Park and Sixteen Acres opted into the program than in any other tornado-affected neighborhood, findings from studies about other tree planting or tree giveaway programs could be considered. A number of studies (Donovan and Mills 2014; Greene et al. 2011; Locke et al. 2015; Locke and Grove 2016; Nguyen et al. 2017; Riedman et al. 2022) have demonstrated that increased participation in tree planting programs may be associated with higher income, whiter communities with higher homeownership rates. In addition to the aforementioned racial and socioeconomic features of East Forest Park and Sixteen Acres, the two neighborhoods each contain more owner-occupied housing units than the other 5 affected neighborhoods combined (Springfield Planning and Economic Development 2019). Furthermore, *Homes.com* reports larger median lot sizes within these neighborhoods (10,890 and 7405 square feet in Sixteen Acres and East Forest Park, respectively, as opposed to the other 5 neighborhoods, which range from 3267 to 6098 square feet). It could be suggested that larger residential lot sizes may provide more potential tree planting space.

2.2 Subject eligibility and outreach

Residents that might be eligible and willing to participate in a research interview were purposively solicited from a list of records of 453 properties that had received a free tree (or multiple trees) through the replanting program. From this list, eligible interview subjects included individuals who lived in their home during the tornado, made the decision to plant a free tree or trees, and who lived there long enough to witness regrowth and/or participate in tree-related landscape stewardship. This minimum amount of time living at the same property at which the tree was planted was set at two years, as this is generally the minimum number of years that residents (or tree maintenance contractors) are expected to perform new tree maintenance (Breger et al. 2019; Riedman et al. 2022; Roman et al. 2015). We determined this eligibility (and this two-year minimum residency following the 2012 plantings) through an initial property search on the city's Tax Assessor database of each address that opted into the program and then through an outreach phone call. If the home that received trees was owner-occupied at the time of planting, the name on the planting record matched the 2012 ownership of the property, as listed on the Tax Assessor database. In this case, it was possible to see if and when the property was sold. Per the eligibility protocol, only those who were listed as owning that same property until at least 2014 were contacted. In the cases where the property owner in 2012 did not match the name on the planting record, the tree recipient was contacted regardless of changes in property ownership, as listed on the Tax Assessor database, for they could have been renters and the researchers could only determine the duration of residency through an outreach phone call.

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Outreach was conducted utilizing an Institutional Review Board (IRB)-approved script and residents received one initial phone call, with subsequent communications taking place only upon a positive response from the resident. Participants were informed that research interviews would last between 35 and 40 min, with the option to extend the interview duration at the participant's discretion. Once a resident agreed to participate, an in-person interview was scheduled at a time and location of their choosing (options provided were their home, place of work, or a local coffee shop).

Of the 453 yard tree recipients, 180 were determined to be eligible for the first round of outreach (through the Tax Assessor database search and elimination of residents with disconnected phone numbers or without preserved contact information). From those eligible residents, 25 interviews were conducted with 29 participants (4 of the interviews were conducted with 2 participants each—three of which were couples, and one of which was a mother and daughter-in-law pair).

2.3 Interview process and analysis

Utilizing a case study approach, we elected to use semi-structured interviews to uncover the experiences of these residents, as this method uniquely provides the opportunity to gain a deeper and clearer understanding of an individual's values, experiences and perspectives in ways that other human-subject methods may fall short (Bailey 2007; Elmendorf and Luloff 2006; Leets et al. 2022; Luloff 1999; McCracken 1988; Powning et al. 2024; Rubin and Rubin 2005). Furthermore, a number of studies suggest that open-ended, interview-based research is optimal for investigating the complex relationships between people and place, particularly in the context of disrupted place attachment (Anthony 1984; Brown and Perkins 1992; Cochrane 1987; Oliver-Smith 1986). Despite this, a review of the literature on place attachments in the wake of disasters shows that interviews have been used significantly less frequently than survey methods (Carone et al. 2025).

The semi-structured interview guide (Appendix A) was organized into four categories, asking participants to describe: (1) their feelings about and relationship with the trees and nature around them before the tornado; (2) their experience of the tornado itself, immediate aftermath, and the damage they experienced; (3) their experience and impressions of the replanting program itself; and (4) their perception of the regrowth process over the previous decade plus.

All interviews were conducted between mid-2023 and early 2024. Each participant was invited to choose the interview location and all but 4 of the interviews were conducted at the homes of the participants (naturalistic interviews). During outreach and scheduling phone calls, participants often cited the ability to show researchers their trees as the reason for selecting a home interview (though this was never prompted). Of the 4 interviews not conducted at participants' homes, 3 were conducted at a coffee shop and 1 was held at the participant's workplace. In all of the naturalistic interviews, subjects interacted with the domestic space in the process of responding to questions—pointing out the locations where their home was damaged, showing the sites of trees that were present prior to the tornado, explaining how the path of the tornado moved through their neighborhood, and showing off their new trees and/or pointing out features that they liked or disliked about those new trees. All but 1 of the interviews were conducted on weekdays during business hours, with only 1

taking place on a Saturday, speaking to the fact that the majority of participants had somewhat flexible schedules. Interview duration ranged from 21 to 73 min, averaging 42 min.

Audio recordings of each interview were generated, with the exception of three interviews where field notes were taken because the participants opted out of being recorded. The interview recordings were transcribed and smoothed utilizing Otter.ai (Otter.ai 2024) and uploaded into the computer-assisted qualitative data analysis software (CAQDAS) NVivo 13 (QSR International 2022) for coding. Field notes were also digitized and uploaded into the software. During transcription, notes were taken regarding emergent themes, which were then converted into a node structure (see Appendix B). The first author developed a node structure and systematic coding protocol using the emergent themes, which were then edited by, and corroborated with, the second author (RH). Authors engaged in ongoing discussions throughout the interview, transcription, and coding phases (and participated in one joint coding session) to ensure consistency and reliability in the methods of node structure creation, data coding, and analysis.

The number of subjects ($n=29$) was determined to be sufficient to obtain data saturation—the point at which no new insights were availed or "forthcoming" (Ritchie and Lewis 2003). In addition to the observation from the research group that the data coming through during the later-stage interviews was becoming repetitive (i.e., no new insights), the list of potential subjects (outlined in Sect. 2.2) limited researchers' ability to broaden the subject group. All eligible tree-recipients were contacted during the outreach phase, and all but 29 individuals either declined to participate or were non-responsive. The limitations of this study with regard to selection bias and non-response bias are discussed in Sect. 5.2.

'N' values described in the results of this study depict the value out of 29 total participants in order to demonstrate the prevalence of each theme.

2.4 Subject demographics

All but one of the interviews were conducted with the owners of the home at which the trees were planted. Only one participant had rented the home at which they planted their tree, but no longer lived there (though they lived in that home long enough to care for the young tree, had grown up in that neighborhood, and still lived nearby at the time of the interview). Seventeen interviewees brought up their length of residency in Springfield, with over half of them ($n=9$) identifying as being lifelong residents of the city. Two others were from nearby towns in Western Massachusetts, but lived in Springfield for their entire adult lives. Nine subjects shared the length of time that they had lived in their home, with the average number of years of residency prior to the tornado's occurrence in 2011 being 26 years.

Participants were overwhelmingly female, white, and retired: 21 of the participants were women and 8 were men; 27 of the participants were white and 2 were Black; 22 of the participants were retired or of retirement age while 7 were pre-retirement adults. Of the 29 research participants, almost all ($n=25$) resided in East Forest Park with remaining individuals residing in the South End ($n=1$), Sixteen Acres ($n=2$) and a suburb of Springfield ($n=1$). This participant from outside of the city was not included in outreach but was brought to the interview by a family member who was included in the outreach and met the eligibility criteria.

At the time of the planting, in 2012, tree recipient demographics were not collected, so it is not possible to evaluate how representative this sample is of the full group of original tree

recipients. When looking at the demographics of the primary neighborhoods that received free trees after the tornado (East Forest Park and Sixteen Acres), they each have resident populations that are predominantly white (American Forests 2022; Springfield Planning and Economic Development 2019) and older than any other neighborhood in the city and the city average (11.6%)—with 17% of their residents being over the age of 65 (Springfield Planning and Economic Development 2019). While this study's subject demographics certainly are not representative of the residents of these two neighborhoods, the demographic features of the neighborhoods contribute some context to the demographics of the study participants, along with evidence that white and middle-to-older aged individuals may be more likely to participate in voluntary environmental activities like this study (Merenlender et al. 2016; Pateman et al. 2021).

3 Results

3.1 Participant relationship with trees and nature in their community

In order to gather context regarding how individuals related to their landscape, interview participants were initially asked to speak generally about their relationship with nature—whether that be the nature in their yard, in their neighborhood, or outside of Springfield. All but 1 of the participants ($n=28$) had positive experiences and awareness of nature, with responses being classified into two general categories:

(a) Passive interactions/activities in natural settings ($n=18$), including walking, running, hiking, biking, birdwatching, and visiting parks.

   "I run, so I like to be outside. I like to go to Forest Park, our local park. I do like to hike and bike. I like to be outdoors." (17 g).

   "Can you imagine the variety of birds? I could go out anytime I wanted to…to this sink and look outside and they would all come in at different times… having those birds there perked me up…" (16f).

(b) Nature stewardship activities ($n=21$), including gardening, growing vegetables and landscape maintenance/beautification.

   "I've always been a gardener at heart. I've always loved it since I was a child… And I always loved going in and weeding, weeding, you know, things that other people think is weird. 'Why do you want to do that?' But just enjoying the process of freeing up the plants in the garden." (20j).

   "My father always grew tomatoes, so that's the main thing I grow." (24n).

Participants were asked about these interactions with nature in the immediate vicinity of their home, as well as with the nature in the broader community (their neighborhood or

Springfield as a whole). The passive activities generally existed in settings outside of the domestic landscape (with the exception of birdwatching, which was generally performed in residents' own yards), whereas nature stewardship activities were concentrated on their own property or in the immediate vicinity (publicly owned nature in front of their home, like street trees and sidewalk lawn strips).

3.2 Pre-tornado relationship with trees and the urban forest

Most of the participants had positive feelings about trees in general, with 22 expressing some variation of the general sentiment around loving trees or needing trees. However, when prompted to comment on specific trees or categories of trees, their remarks became more complex (and somewhat less positive). When discussing their pre-tornado feelings about the urban forest, 15 participants expressed that they thought Springfield had a lot of nice trees and that the city did a good job of maintaining them, while 3 felt that Springfield did not have enough trees (some participants expressed both of these sentiments). Seven individuals believed the city did not adequately care for the trees, regardless of how densely treed they felt the city was. However, the opinions held about Springfield's urban forest were generally not as strong as the opinions held about residents' own yard trees. One participant expressed this difference in the following way:

"They're in my yard and I'm interested in what they do and how they gonna accommodate what I need. But as far as anything else in surrounding areas, I won't say that I ignored it but it's part of nature…" (13c).

In regard to city-owned trees in the immediate vicinity of their home, very few residents reported that prior to the tornado, they had contacted the city about pruning or assessing a street tree ($n=1$), removing a street tree or clearing weed trees on city property ($n=2$), or requesting the planting of a street tree ($n=1$). Eight residents expressed concerns or issues that they had with certain street trees but did not contact the city to resolve those issues—some even performed the work themselves. Many residents explained that they did not contact the city because of their lack of awareness of the Springfield Forestry Division—the municipal department dedicated to the stewardship of public trees in the city.

Though participants typically had less to say when asked about the trees in their community, the topic did re-emerge, unprompted, when describing how they felt about their neighborhood prior to the tornado. Some participants chose their home or liked their neighborhood specifically because of the trees in their yard or their densely canopied street ($n=15$). Throughout the interviews, those residents reminisced about the appearance of their neighborhood prior to the tornado, citing the streets lined with large mature trees as one of its major draws. Three of the participants who originated from cities larger than Springfield (two of whom were a married couple) were particularly enthusiastic about the pre-tornado presence of trees in their neighborhood, as it differed significantly from their previous landscapes. They described their experience of their pre-tornado neighborhood in the following ways:

"I grew up in the projects in Boston [Massachusetts], so we didn't have a lot of, you know, nature. We really didn't. It was just buildings and hardly any trees. There was

just nothing, and the water was behind us. Lots of factories. But when we moved here, you see, 20 years ago, it was kind of neat. You know, I got to see blue jays and all the birds and the squirrels… The trees are awesome. I really enjoyed seeing… 'Ooh, there really are trees.'" (28r).

"Compared to Queens [New York], Springfield was the country… If you hadn't seen the neighborhood before, you'd think it looks nice. But if you knew it before, you'd know how beautiful it was with the big big oaks." (32v).

One lifelong Springfield resident expressed a similar feeling about Springfield's pre-tornado tree canopy, while suggesting that they could not imagine living in a place without trees:

"I think that's very much a part of… the charm of Springfield, that natural decoration for lack of a better word, you know? … You see these new developments and there's like no trees, it's like, 'Oh God, who would want to live there?' You know, it just wouldn't tempt me." (22L).

With regard to privately-owned trees, all study participants, except the sole renter, had trees on their property prior to the tornado ($n=28$) and expressed mixed feelings about those trees (Fig. 2). Many participants ($n=10$) expressed *both* positive and negative feelings about their pre-tornado yard trees. Eleven participants exclusively expressed positive sentiments, and 7 exclusively expressed negative sentiments. It is worth noting that all but one of the residents who exclusively expressed negative sentiments about their pre-tornado yard trees mentioned at other points in the interview that they missed those trees, implying that there were elements of their presence that they valued. For example, all of the residents that felt they had too much shade prior to the tornado either mourned the loss of shade once the trees were gone or reveled in the shade they received from the trees planted after the tornado.

What residents liked about their trees:	Number of residents:	What residents disliked about their trees:	Number of residents:
Blocked unfavorable views	n=5	Created litter (leaves, needles, cones, acorns, sap, twigs/branches)	n=11
Provided beauty	n=11	Provided too much shade	n=5
Provided shade	n=20	Felt the trees were ugly	n=3
Created privacy between neighbors	n=4	Created maintenance costs	n=4
Provided materials for heating/starting a fire	n=2	Took up too much space in the yard	n=4
		Created the potential of tree failure / fear of damage to the home	n=3

Fig. 2 Participant likes and dislikes about pre-tornado yard trees. Quantities of participants who expressed the following pros and cons about the trees they had in their yards prior to the tornado

"I'm glad that one fell because it was starting to shade my garden." (24n)

"So I put that one [tree] there. Which is amazing. I just can't believe how that tree grew. It's beautiful. It shades…it actually shades the house." (24n).

Participants were also asked about the types of pre-tornado tree stewardship activities they participated in on their own property—13 stated that they engaged in some level of tree stewardship, which included:

(a) Pruning (performed by the resident themself or a family member)-$n=5$.
(b) Pruning (performed by an arborist)-$n=4$.
(c) Pruning (performed by a general landscaper)-$n=1$.
(d) Planting a tree-$n=5$.
(e) Removing a tree-$n=9$.

Recurring reasons for lack of engagement with tree stewardship activities were: minimal knowledge about how to care for trees, lack of financial resources to hire an arborist, the belief that the "woodsy" nature of their yard eliminated the requirement for the level of maintenance that a landscaped area would receive, or the general feeling that their trees were "too big" or "too old" to need care. Four participants mentioned that there were trees that they had considered removing prior to the tornado but could not afford to do so. One of these individuals even mentioned that they spoke to their home insurance company to request financial assistance to remove potentially hazardous yard trees, but their request was denied:

"My husband and I went back and forth about cutting them down because they did look dangerous, to be honest. And ended up being so. And there were like four specifically that my husband called homeowners [insurance]… and he said, I can't afford to cut down these trees. They look dangerous to me… Would you pay for the trees to be cut down? And he said it would only be like $4000, but it's $4000 I don't have. I have a young baby… He had already told them, warned them, said, I can't afford to do it but they looked dangerous to me. And it was funny just because they [the insurance company] ended up having to pay a lot more than $4000." (27q).

3.3 Immediate aftermath

3.3.1 Intertwinement of disaster memory and tree loss

Following a discussion of their relationship with the pre-tornado natural landscape, participants were asked to recount their experience of the tornado. Although the purpose of this research was not to understand general disaster experiences, it was helpful—before beginning to ask questions about the changed landscape—to bring participants' minds back to June 1, 2011 and the days and weeks that followed. This context elucidated the ways in which tree loss and landscape change associated with tree loss were woven into their disaster experience. There were three distinct ways in which this was apparent:

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(a) Alteration of a familiar landscape to the point that it felt foreign.
(b) Spatial disorientation and landmark loss.
(c) Damage to property and infrastructure.

The two main perspectives from which participants "saw" the impact of the tornado were through the observation of impact to their own property and a post-tornado walk or drive around their neighborhood. There was no consistent order in which residents had those two types of observational experiences, rather the order depended on where they were located during the brief moments of the tornado. Those who were at home during the tornado initially observed the impact to their property, and then deliberately toured the neighborhood afterward to understand the level of damage, check on the wellbeing of friends, family, and neighbors, and offer clean-up assistance as needed. Those who were not at home (i.e., at work) during the tornado had to navigate the debris-filled streets to return home—thus observing the damage in their community before learning the fate of their own property.

(a) Alteration of a familiar landscape to the point that it felt foreign

In describing their experience of community-level tree loss and landscape change, participants generally expressed an initial shock associated with such an immediate and drastic change to their familiar landscape, and there were some clear recurrences in the ways that they explained what this newfound unfamiliarity felt like. Four participants likened the image of trees and debris strewn everywhere to a warzone. Following the removal of debris, participants felt that their neighborhood's barrenness resembled geographic locations with dissimilar natural landscapes—like Florida, Texas, the desert, "a different landscape" (30t), or "a completely different city" (35y); others described unfamiliar, fictional locations like Oz, "a movie" (15e) or an "alien place" (20j).

(b) Spatial disorientation and landmark loss

Since many participants had lived in Springfield for a large portion of their lives, they were intimately familiar with the layout of their neighborhoods. A substantial number ($n=18$) also described a tactile knowledge of the landscape as they recounted frequent walks and runs through their neighborhood. Even so, a large majority ($n=21$) of participants articulated that even after the debris from the tornado had been cleared, they found it challenging to navigate, often missing turns that they had been taking to arrive at their home for decades. It is clear that this spatial disorientation was caused by the loss of trees as landmarks and wayfinders—even residents who lived in areas without substantial damage to homes indicated that the disorientation was associated with the loss of trees specifically:

> Partner A: "Very disorienting, really disorienting…for the longest time when I'd be driving back home… 'Okay, so what street is mine?' Like you just, you lose the landmarks."

> Partner B: "Yes, the landmarks are gone."

Partner A: "…And even now I'm like, 'Oh, that's right. Look for the brick house, that's [name of the street they live on].' Like, which is just bizarre. Right? Because they had a big tree before that was always my landmark. Yeah, so it was, it was disorienting." (25o).

"But I actually learned after the tornado that they [trees] become like a fixture in your mind. When like you're going to someone's house or something familiar to you. You've always driven there, 100 million times, until like… my parents neighborhood was also affected. And so a lot of their trees were gone. And I remember driving down their street the first time after, and I drove right past their house, because your mind kind of puts you in places based on, I think it's the trees. I don't know, or big structures, but the trees, you can drive right past a place you've driven to. If a tree is gone, just because your mind is like, 'where was that?'" (27q).

Relatedly, another participant alluded to this same concept by noting that they used one remaining damaged tree as a landmark:

"And you know, but the half a pine tree, for a long time, was how I could tell when it was coming up for the turn into my street… 'Oh, that's where I gotta turn.'" (33w).

(c) Damage to property and infrastructure

Twenty-six out of the 29 interview participants not only experienced landscape change in their community, but also dealt with damage to their property. As previously articulated by subject 13c, private property may be the component of one's landscape that an individual pays the most attention to—and in the context of natural disasters, that is the component of the landscape that a resident is responsible for restoring. Private property damage that participants experienced was classified as damage to yard trees and damage to non-tree property (i.e., damage to the home, porches, outbuildings, fences). Participants' non-tree damage was further sub-divided into three categories (Fig. 3).

(1) No significant damage to the dwelling, but damage to other property.

"But that one tree… Actually, I don't think it came down. But the part that broke off came this way. That's what landed on my car." (24n).

(2) Damage to the dwelling but the original structure remained.

"I lost half the roof on this house, and was lucky to find someone to rebuild it in the next few days… The structure wasn't so damaged, but the violence of the experience loosened the sheet rock tape, which 10 years later is now starting to come loose." (11a).

(3) Home demolished and rebuilt

Level of damage:	Number of residents:
(1) Damage to non-dwelling property only	n=6
(2) Damage to dwelling but original structure remained	n=15
(3) Home demolished and rebuilt	n=4

Fig. 3 Categories of damage to participants' non-tree property. The level of damage experienced by 25 participants whose built (non-tree) personal property was impacted by the tornado. Each participant is counted only once and placed in the category that represents their highest level of damage (i.e., a participant who had their fence broken and their windows smashed would be placed in category 2)

> "Seven of them [trees] fell on the house. There was a tree in the kitchen, there was a tree in my daughter's bedroom. We were in the basement. Twenty-two broken roof rafters. Thankfully, the main beam wasn't broken. So we kept our foundation." (27q).

> "We had a large one in the front on the tree belt, which actually came down and split the house in half… And our whole house was replaced. So everything, everything in it, everything outside of it, everything." (15e).

It is worth noting that for all of the participants that experienced damage, some if not the majority of the damage was caused by trees—either their own tree, a neighbor's tree, or a city-owned tree. A significant majority of interview participants ($n=26$) lost at least one yard tree as a result of the tornado.

3.3.2 Emotional response to tree loss and landscape change

Thirteen participants described having a strong emotional response to viewing their treeless landscape—both immediately following the tornado (in their initial viewing of the changed landscape) and during the subsequent months. The loss of trees in the vicinity of their home brought some to tears ($n=9$); others were forced to seek alternate walking, running, or driving routes in order to avoid repeatedly witnessing the most dramatically altered parts of their neighborhood. As one participant stated, "It was not only an environmental loss, but an emotional loss." (16f)

> "I would go out to the South Branch Parkway and actually cry on my run because it was just unrecognizable. There were no trees… Our backyard neighbors there hardly had any damage. So I would come home from work that way. Because if I came the other way, it would be… I just didn't want to see it." (17g).

"My backyard looked so bad after that day… It looked so bad, that I actually sat and cried… And my husband said, 'What are you crying about?' I said, 'I can't believe all my trees are gone.' And he was a little bit upset about it too. But there was nothing we could do about it." (35y).

Other participants situated their emotions at the time as being in a state of shock or disbelief (n=5). Relatedly, something that was mentioned by many of the participants (n=13) was the feeling that tornadoes do not normally occur in Springfield, or that New England does not experience extreme weather in general—and that this tornado was a fluke event that could not be predicted or planned for.

"It's not supposed to be here… We just don't think about tornadoes here. And we don't think about hurricanes." (14d).

"I think also it was unheard of… like, tornadoes don't happen around here. So I think it was probably not even on anyone's plan that they would have to kind of navigate something like that. (25o)

3.4 Mid-term aftermath

3.4.1 Acclimation to a new, treeless landscape

After the initial shock of the tornado wore off, residents had to acclimate to their new landscape, and as they settled into this acclimation phase, they noticed the ways that the trees had impacted their experience of their environment—and many of them were not aware of how much the trees had impacted their experience of their environment until they were gone. They spoke of what one might call the 'don't know what you've got 'til it's gone' phenomenon.

"You take for granted or you don't notice things until they're gone." (12b).

"You know, you don't realize what you miss [shade] until it's gone." (28r).

Some negative changes that participants described experiencing in and around their homes were: increased wind (n=2); more sun/heat in the their homes—or the need to run their air conditioner more (n=13); the ability to see unsightly landscape elements that they had not previously been able to see such as buildings, power lines, and traffic lights (n=5); lowered ability to utilize/enjoy/spend time in their yard (n=3); reduced presence of birds and other wildlife (n=8); soil loss/erosion and associated challenges with plant regrowth (n=2); and gardening challenges caused by excessive sun exposure (n=4).

"The old growth oak trees screened our environment from the overhead power lines. They were there, but you didn't really notice. Now they're the ugliest thing of the neighborhood." (11a).

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"And since the tornado… I have a fence around my yard and the wind pattern that comes through there… I have to tie my doors shut and I keep something in front of them because they would just blow open. It's amazing the amount of wind that comes through there now." (12b).

"It was much hotter. Because that's the heat of the day. And the sun with no shade? The sun is just heating up the house. And so really, I know I had to run my air conditioner more during the time that we didn't have the trees there. And now that's why I got three trees to go back there." (13c).

While nearly all residents reported negative changes to their property as a result of tree loss, fewer residents (n=14) additionally noted some positive changes and new opportunities that occurred as a result of the tree loss in the immediate vicinity of their homes: reduced/eliminated fear of trees falling on their home (n=4); reduced/eliminated litter and tree maintenance activities (n=9); increased sun/warmth in the wintertime (n=7); ability to utilize rooftop solar (n=1); ability to move exterior structures or build new ones (n=2); ability to grow sun-loving plants (n=4); and 'free' removal of disliked trees (n=9). A number of participants expressed general sentiments that indicated they were pleased with the loss of certain trees (no one was pleased with the loss of all of the trees that came down, but rather with the loss of a specific unpleasant or bothersome subset of the trees in their yard).

"I missed the trees. But I don't miss the trees. With all the work that comes along with having them. So like I say, it's a catch-22." (12b).

"As far as that tree specifically being gone, because it provided so much shade, that was almost… too much, you know? So I was at peace that that tree was gone. And all the others I was bummed about. This one, I was like, 'It's okay.'" (25o).

"I feel so safe. If there's a tornado warning, I want to be home now. Because the trees have fallen. There's no other tree that can fall on me." (27q).

At the neighborhood/community level, residents exclusively brought up the negative associations with tree loss (as opposed to at the home level, where residents connected both positive and negative impacts to their experience of tree loss). The most commonly-cited impacts of canopy loss in their neighborhood were: barrenness or emptiness (*n*=15); increased brightness—with a negative connotation because there was no respite from the sun (*n*=7); and loss of the neighborhood's characteristic beauty (*n*=3).

3.4.2 Post-tornado tree fear and resident inconsistencies around description of tree fears

Although the vast majority (n=26) of participants stated that they had no fear of trees as a consequence of the tornado, a number of those same individuals (n=9) did mention concerns in relation to their new trees (or trees in general) at other points in the interview that suggested that they retained complex feelings about trees post-disaster. Participants were quick to express that the experience of the tornado did not cause them to have a fear of trees,

but later followed that sentiment with statements on their increase in consideration and awareness for trees, given that when they are large and in the proximity of personal property, they can be a source of concern when the weather turns. Some stated that they might have requested to plant a different species had they known the size potential of the species that was planted; others would have placed the tree farther away from their home.

> "I have to say no. But… I have to laugh, because these trees aren't big enough, obviously, to do that much damage. But I do have to laugh. Because now when, you know, a windstorm or something kicks up that's like, wow… I guess we have nothing to worry about because we don't have any trees that could fall on the house… we don't have any trees left to come down." (15e).

In the interview guide, the question that participants were asked in this regard was general—whether or not they had changed feelings about trees or more fear of trees (Appendix A). Participants were not asked specifically if their comfort level with trees planted around their home had changed. Perhaps this is the distinction that participants were unconsciously responding to—in that their feelings about trees in general remained unaffected (i.e., they still liked trees and didn't feel fearful around them), but felt that they ought to have been more cautious about the placement of trees in their yard and more careful about future planting choices. For example, one participant, when asked if their experience of the tornado made them more nervous around trees or fearful of trees, stated:

> "No, not at all. No." (19i).

Later, that same participant mentioned that the trees were growing "too well." When prompted to elaborate, they realized that their previous statement could be further elucidated:

> "Well, I mean, getting back to what you asked me, I do have a little, you know… if God forbid, if we ever got another bad storm, I don't think this, the tree out here, would hit the house. Maybe. But I don't know." (19i).

3.4.3 Interaction with yard tree planting program and receptivity to replanting

Participants were asked why they opted into the post-tornado yard tree planting program—and their reasons were generally in line with their feelings about their home and community without trees (i.e., if they mourned the absence of shade, natural beauty, or bird habitat, those were some of the same motivators for participation in the program). When asked if they had any hesitations about planting new trees, given that they had either experienced or witnessed tree-related damage, the vast majority (n = 28) immediately stated that they had no hesitations and were very quick to sign up once they learned about the opportunity. Only one resident hesitated to sign up because they worried that the new tree would be extremely small or that the city would have some long-term control over management decisions for that tree. Of the residents who expressed no hesitations around participation at the time they made the decision to replant, 25 opted to replant because they felt strongly that they needed trees and were very excited about the prospect of replanting. Still without hesitation, three other residents were slightly more tepid about replanting, but were unable to afford

the decision deep thought due to their overwhelmed mental state during the mid-term aftermath. Notably, these three participants that expressed not thinking through the decision as carefully as they would have liked, had lost their entire homes during the tornado and were in the process of rebuilding (or just barely completing it) when they learned of the planting program.

"I really didn't overthink it at all. I didn't think about it at all." (15e).

"We were still in shock… Designing and building the house, we had a few ideas of what we wanted [re: landscaping], but we didn't realize how much detail you had to make decisions about, so when somebody said they were giving you something for free, and they were trees, and we had trees before, so we'll be happy to take whatever you got." (34x).

A small number of participants ($n=5$) additionally cited the fact that the trees were free as a factor in their decision-making.

"Actually it was a no-brainer. I mean, they were giving them away free. So why anybody wouldn't take advantage of that…" (12b).

Although less than half of participants ($n=13$) had engaged in tree care activities prior to the tornado, the majority of participants ($n=26$) engaged in tree care activities relative to their new trees—likely in part because they were provided instructions for young tree care and free supplies (watering bags) through the program. All 26 of them kept their new trees watered, 4 emphasized that point by stating that they watered "religiously" or diligently in order to keep their new trees alive. Twenty-one residents had engaged in other types of tree stewardship in relation to the new trees, such as fertilizing ($n=3$) and pruning ($n=19$). For 9 of the 19 residents who pruned their new trees, this was the first time they engaged with this type of tree care (i.e., they did not prune the trees in their yard prior to the tornado). One participant (28r) alluded to the fact that they have learned more about tree care since the tornado and the replanting program, and feel regret that they did not perform any maintenance on their pre-tornado yard trees.

Almost all of the trees that participants received are still alive and relatively healthy – only a few ($n=5$) mentioned tree health concerns or structural issues, like a split double leader ($n=2$), cracks in the bark ($n=1$), and vague comments about the tree looking sick ($n=2$). A few residents ($n=8$) have since removed one of their newly planted yard trees, either because it had died or because they wanted to do something different in their yard where the tree had been planted. Two participants (neither of whom removed their trees) expressed differing feelings about tree removal:

"I had no hesitation [about participating in the program] because if it goes bad, you just take it out." (26p).

"Some of them [the trees] were supposed to be dwarf and it wasn't dwarf, but what are you gonna do? Come back and take it out? I wouldn't do that." (28r).

That leads into another concept that came up somewhat frequently: expressions of frustration or regret associated with their new trees or with the decisions they had made about planting, particularly with regard to species (n=6), size (n=5), and location (n=6). Only 2 residents (a couple) acted on those feelings of regret regarding the tree's location by removing their new tree. The remaining 12 decided to live with the elements of the tree that frustrated them because of the benefits they were receiving from that tree and/or utilized pruning as a method to deal with concerns related to tree size. When asked about resources or information they wished they had around the time of planting, residents stated that they would have liked more information about the species they were getting (n=3), more species options (n=3), more time to decide about tree location (n=3), and long-term tree care assistance—either financial assistance or access to a tree care professional from whom they could seek advice (n=4).

> "The only thing, and I really don't have any complaints, is I wish that I had known more about the trees I was planting… I like that one in there now, but at first I didn't like it. But now I've grown to like it, you know, once it kind of filled in and got bigger, I do like it. But I didn't know anything about any of the trees that were planted… But that's my only… not even a complaint. But I wish… maybe I should have been more inquisitive. But I think I was just so happy to get free trees. I wasn't fussy." (17 g).

> "I somewhat regret the oak tree, it's too big for being out there. But it's there." (33w).

3.5 Long-term aftermath

3.5.1 Resident feelings about regrowth

In addition to discussing the landscape changes that resulted from tree loss, participants were also asked to reflect on their experience of the regrowth stage of the long-term aftermath period (during the decade following tree planting). Participants spoke about the changes they have experienced at the home level and at the neighborhood level. As was the case with pre-tornado trees, the feelings that participants had about the new trees on their property were more mixed than their feelings about the trees that had been planted around the neighborhood. Residents' feelings about their new yard trees were overwhelmingly positive, with participants citing increased shade and beauty (and consequently, increased use of their outdoor space) as the main ways that the new trees have improved their home and yardscape (Fig. 4). However, they also expressed significant frustrations—particularly around the size of their new trees, as mentioned above. Some participants expressed that, while they felt positively about the impacts of regrowth in their yards, they were frustrated with the large size/rapid growth (*n*=6), undesirable species-specific traits (*n*=4), issues with roots (*n*=2), and the return of leaf litter and tree-associated maintenance responsibilities (*n*=3). At the neighborhood level, participants only spoke positively about the regrowth of trees, citing the return of shade, beauty, and birds to their community as the major positive impacts of regrowth, along with the sensation of existing in a landscape that is "more normal" (14d).

Fig. 4 Interview participants' yard trees. The yards of two study participants, including the maturing trees from the post-tornado planting program, depict more than a decade of tree growth

3.5.2 Are Springfield residents who were impacted by the tornado still in an aftermath state?

While all residents felt generally positive about the regrowth, some residents expressed a terminal perspective regarding the state of regrowth (e.g., the trees are "back again" (14d)). These residents acknowledged that the urban forest looks different than before the tornado, but with a certain amount of completeness to their statements, suggesting that the urban forest had been in a period of transition, but by the time of their interview more than a decade later, that transition had largely concluded:

> "Yeah, I feel better… now that there are substantial trees, because in the beginning, it's like, even though there are trees, they're these scrawny little things that… so yeah, now it's nice that there's trees back… I mean, it's different, but we're used to it." (17 g).

> "When they're first put in your like, 'Okay, where's my big tree that, you know, I recognize?' and then just give it a few years, and then it becomes, you know, a more prominent landmark once again." (20j).

Other residents, however, expressed a more indefinite/transitional positivity—sharing that while it was nice to see the trees start to grow back, they felt that the landscape was still in an earlier state of regeneration that did not yet resemble how the urban forest was before.

> "People have different kinds of flowering trees on their belts. And I'm not fond of them, because they never get bigger. They don't provide shade… Again, these were very beautiful, mature, tree lined streets. I mean, the canopy is gone. (23m)

Fig. 5 Tree "graveyard". One study participant held onto remnant wood from trees lost during the tornado for over a decade as a way to hold onto the memory of those trees

> "And it's getting to a point where they're not brand new anymore. They're getting to the point where they're feeling like full grown trees… They were vulnerable. That is a much better word… Like it had potential to become canopy, but it wasn't really canopy yet. And it was like, okay, yeah. So we have to work to make this happen [regrow the tree canopy]." (21k).

This suggests that some Springfield residents might still exist in a long-term aftermath state, due to their relationship with and memory of the urban forest (Fig. 5), and the reality that the city's pre-tornado urban forest would take longer than a decade to fully recover.

4 Discussion

4.1 Place attachment, length of residency, and sense of control

As discussed in the Methods (Sect. 2.4), the majority of subjects owned the home at which trees were planted and many lived in that home for a substantial amount of time prior to the tornado. A smaller, but still significant, portion of the interview subjects lived in Springfield for most of their lives—some even continuously residing on the same street (or in the same home) where they grew up. A number of foundational place attachment studies have lifted

the connection between the strength of an individual's attachment to a place and the length of time spent in that place. Manzo (2003) and Taylor (1996) discuss how a sense of "root-edness" in one's neighborhood is correlated with the amount of time lived there. Similarly, Anton and Lawrence (2016) note that increased psychological investment in a place is associated with time spent there.

The predominance of homeowners within the participant group may have also contributed to the strength of place attachment, distress upon experiencing a disturbance to that attachment, and conviction in the decision to replant trees despite experiencing first-hand the risks associated with tree ownership. Brown (1987) explained that feeling a sense of control over one's home and the surrounding landscape (e.g., home ownership) is crucial for developing a strong place attachment. The results of this study illustrate this concept well—residents wielded their control over their home landscape by choosing to replant, while demonstrating their place attachment through their reasons for replanting (the desire to restore the pre-disaster conditions of their home environment). Conversely, the minimal number of residents from Springfield's lower owner-occupied neighborhoods that chose to replant trees might point to the connection between those who have less control over their home landscape and a reduced ability to demonstrate place attachment through tree planting (Pearsall et al. 2024; Riedman et al. 2022). Control over one's landscape as a component of place attachment is particularly pertinent in the context of SWEs. The progression of aftermath phases themselves (Brown and Perkins 1992; Kates and Pijawka 1977) may be linked to a progressive regaining of control following a moment (SWE) when individuals and communities are stripped of their control. It might be suggested that insofar as a sense of control is linked to place attachment, and SWEs inherently disrupt that sense of control, that landscape reconstruction in service of restoring place attachment can be a way for communities to take back control.

4.2 Disorientation and difficulties in wayfinding

The psychological conditions that arise from feeling out of control may contribute to the distress and disorientation experienced by survivors, which was expressed strongly by interview participants (Sect. 3.3.2). Disorientation and challenges with wayfinding came up in this study as clear examples of disconnection from one's home landscape and disrupted place attachment. One feature of living in the same landscape for many years is the familiarity with navigating through that place. Indeed, one of the ways familiarity with a place can be measured is through ease of navigation (Epstein et al. 2017; Spiers and Maguire 2008). How might one feel attached to a place that feels unfamiliar – like Florida, Texas, the desert, "a different landscape", Oz, "a movie" or an "alien place" (Sect. 3.3.1)? Place attachment necessarily forms out of long-term familiarity with the features and landmarks of a place, and may be restored through replacement of the destroyed features and/or readjustment (i.e., re-familiarization) to the changed features of the place. It stands to reason that readjustment might be accelerated if some features of the place are recreated as they were prior to the disturbance, through activities such as tree planting.

There is very little existing research on challenges with wayfinding in the aftermath of SWEs. Most studies in this area address the challenges with wayfinding during the immediate aftermath phase of a disaster, particularly regarding the work of responders when communication lines are down and roads are blocked (Azimi et al. 2017; Heitor 2017; Plonski

et al. 2025). This study, however, demonstrates that the challenges with wayfinding are not only associated with the chaos of the SWE itself, but with the absence of landscape features that establish familiarity and ease of navigation.

4.3 Solastalgia and inclination to reconstruct tree-filled landscapes

While residents evidenced a heightened degree of awareness of tree risk post-tornado, their initial impulse was one of receptivity to replant, as the vast majority of them were pleased and grateful to receive a free tree. A number of the participants were not necessarily tree lovers—while all had some amount of appreciation for nature, many were not particularly enthusiastic about interacting with trees as a personal hobby, and disliked a number of factors about the trees around them prior to the tornado. So simply loving trees was not necessarily the catalyst for choosing to replant. For the self-proclaimed tree lovers in the participant pool, it may seem understandable that they would seek to replant without hesitation. However, why did the non-tree lovers, all of whom had some negative feelings about their pre-tornado trees and experienced damage to their property as a result of a fallen tree, still choose to replant? Anton and Lawrence (2016) suggest that those with stronger place attachment have a more negative experience of place change—so although some participants had negative feelings about their pre-tornado trees, the change in their environment may have felt even more negative than the inconvenience of raking leaves in the fall.

This negative association with change suggests that residents had more positive associations with what feels 'normal'. Seventeen residents expressed some version of this idea—that their street or their yard was suddenly abnormal or "empty" (i.e., there was something missing that they understood to belong in the landscape). Participants' decision-making and behavior appears to be in line with the concept of "solastalgia" and largely corroborate findings from research on the re-creation of familiar landscapes following a SWE (Albrecht 2005; Lizarralde et al. 2009; Warsini et al. 2014). One couple who very much disliked their pre-tornado yard trees, mentioned the fact that they "had trees before" (34x) as one of their reasons for opting into the replanting program. This is evidence of "solastalgic" impulse to replant: when residents who are not tree-huggers, who disliked many aspects of their pre-tornado trees, *and* who experienced property damage caused by trees—still chose to restore their pre-disaster, tree-filled landscapes.

Insofar as residents—particularly long-time residents—feel connected to the landscape that they are accustomed to, it might be concluded that while the same phenomenon (an attachment to a *treeless* landscape or yard) that might make a resident opt *out* of a yard tree planting program outside of a SWE/tree loss experience, could make it easier to convince a resident to opt into a yard tree planting program once they have endured a SWE or tree loss experience (realizing an attachment to a *tree-filled* landscape—that they no longer have). When individuals lose something of value in the landscape, even if it had some undesirable features, they become more aware of those values and uncomfortable with the new ways that they experience their landscape.

Although interview participants had complicated feelings about their trees both before the tornado and throughout the aftermath phases, they made it abundantly clear that they felt worse-off with yards and streets that were devoid of trees, and that their landscape felt abnormal and physically, visually, and auditorily uncomfortable. While the aftermath period might not have fully come to a close—with many participants recognizing that their

neighborhood's trees were not, and might never be, as they once were—all participants acknowledged that the green appearance of their community has been distinctly returning. Environmental disturbances (at varying levels of visibility and severity) and their impacts on urban trees are inevitable and somewhat constant, so perhaps periods of landscape disturbance and recovery are overlapping and interwoven, rendering it especially difficult to define aftermath endpoints in the urban forest.

The tornado aftermath period provided a unique opportunity for urban forestry practitioners to utilize residents' sense of landscape alteration and tree loss to engage them in private property planting—which they might not have been inclined to do under normal circumstances. A SWE opened up new space in their yards, and they suddenly had landscape decision-making opportunities that they did not have prior to the tornado. The SWE also created a uniquely sensitive climate for tree replanting, as residents made replanting decisions at the same time that they were rebuilding other aspects of their lives, which highlighted a need for tailored outreach, communication and planting strategies—lessons that have widespread application in relation to community rebuilding, post SWE.

5 Conclusion

Utilizing semi-structured research interviews, we were able to explore the perspectives of 29 residents of Springfield, Massachusetts with regard to their perceptions of the impacts of the June 1, 2011 tornado that swept through the city, their choice to replant trees that were lost, and their experience of more than a decade of UTC regeneration. During these interviews, residents discussed: how tree loss associated with the tornado altered their feelings about/relationship with their urban forest; how they felt about and interacted differently with their treeless landscape; how they made decisions about and experienced the tree replanting process in the mid-term aftermath, and with tree stewardship in the long-term aftermath; and how they felt about their reconstructed landscape more than a decade after trees were replanted.

As was shown in this study, urban residents' feelings toward the trees around them may only partially have to do with the measurable services (e.g., temperature reduction) and disservices (e.g., burdens/expenses of stewardship, potential hazards) commonly associated with urban trees. Rather, they largely identify with a more feelings-driven valuation of the trees around them (i.e., the way that the trees around them make them feel, or the sorts of experiences that a tree-filled environment provides). In many cases, these feelings associated with their familiar, tree-filled landscape were accentuated or revealed during disaster aftermath. This heightened awareness of an underlying but deeply held attachment, which was discussed in Sect. 3.4.1, is also highlighted in the literature on theories of place in disaster contexts. Brown and Perkins (1992) explain how survivors of disasters often observe that "they had taken the provisions of places for granted" and that "disasters may reveal that humans never articulated all of the benefits of a place, that taken-for-granted benefits are appreciated only in retrospect." Similarly, one research subject in a study by Silver and Grek-Martin (2015) expressed that he took the trees for granted and truly became "aware of how important trees are to the topography" in the post-disaster period.

For the Springfield residents included in this study, loss brought about the opportunity to engage with underlying feelings about trees and about their landscape, as well as with

tangible acts of landscape stewardship in service of urban forest regeneration. As a result of the damage to the landscape and loss of urban tree canopy cover, residents became more aware of the importance of trees in their community. They found themselves disoriented in and unfamiliar with their home landscape following tree loss; they opted to plant trees to recover their landscapes and restore the benefits associated with UTC while simultaneously navigating their unique post-tornado crises; they became more dedicated to tree stewardship in order to ensure the success of their new trees; and they felt generally fulfilled with the ways that the new trees in their yards and around their neighborhoods were helping to recreate a landscape that had been lost. Residents were able to uncover *and* recover what they valued about their landscapes and play an active role in their own personal recovery as well. This research demonstrates the ways in which the psychological experience of tree loss and recovery informed individuals' interactions with practical landscape interventions like this post-tornado yard tree planting program in Springfield, and how the program impacted their ongoing aftermath experiences.

5.1 Policy implications

While a number of cities have engaged in post-SWE replanting efforts similar to the one explored in this case study in Springfield, none have formally investigated the long-term impacts on residents' connection to and relationship with their landscape. This research attempts to uncover the characteristics of prolonged and evolving human-tree relationships from the pre-disaster period through three stages of disaster aftermath to contribute to the urban forestry community's knowledge of how urban residents feel—and what they need from practitioners—after a disaster. As SWEs increase in frequency and severity, and new tree pests and diseases emerge (Judice et al. 2021; Tidball 2014; Young 2013), there will be continued need for post-disruption urban greening programs (Brown 2017; Eisenman et al. 2021; Freilicher 2011) in order to recreate familiar landscapes (Lizarralde et al. 2009), reestablish a community's sense of place (Hunter 2011), foster connection with nature (Brown 2017; Mei et al. 2021), and assuage fears related to trees/nature that SWE's may amplify (Judice et al. 2021). This study addresses critical knowledge gaps and provides urban forest managers and community tree organizations with new perspectives on community needs and desires throughout the experience of UTC loss and regeneration.

City dwellers have the potential to feel strongly about the trees around them (Dwyer et al. 1991; Jones and Cloke 2002; Ryan 2006; Tidball 2014; Tuan 1990) and urban foresters frequently come into contact with and respond to these strong community sentiments, and increasingly endeavor to incorporate them into management decisions alongside industry best practices (Ordóñez et al. 2019, 2020). Elucidating the ways that urban residents relate to trees and the extent to which experiences of UTC loss and stewardship alter these relationships is crucial for creating community-informed urban forest reconstruction policies that incorporate effective communication and support for residents when trees in their community are destroyed or removed at a large scale. Overcoming these sorts of landscape disruptions should involve preparation that incorporates place-based identities (Agyeman et al. 2009; Clarke et al. 2018; Fresque-Baxter and Armitage 2012) and the significant psychological and relational impacts of tree loss that are highlighted in this study. The results of this investigation may be utilized by urban forest advocates and policy-makers to emphasize the need to allocate resources for urban forest recovery within disaster-response plans.

5.2 Study limitations

As mentioned in the Methods section of this study, there were some key limitations that contributed to the research outcomes, which must be acknowledged in order to properly contextualize the results of this study and the potential applications of its findings.

(a) Outreach to potential interview subjects was performed in English and over the telephone. Residents who spoke limited or no English may have not responded to outreach voicemails due to expectations of a language barrier between themselves and the interviewer.

(b) As is the case in many interview-based studies, most participants were individuals who had flexible enough schedules to meet during the workday (even though the interviewer expressed willingness to conduct interviews outside of the workday or at participants' place of work). Additionally, no stipend was offered to participants. These factors likely played a role in skewing the participant group toward retirees and those with more time and resources. Furthermore, a mixed methods approach that included an electronic survey might have allowed for increased participation and a more diverse group of subjects by lowering the barrier to participation and reducing the non-response bias.

(c) The tree planting records from 2012 did not include the names or addresses of those who opted-out of planting trees in their yard after the tornado. This is because, as mentioned in Sect. 2.1, direct mail was the main way that residents received information about this yard tree replanting program. Springfield residents who did not respond to the mailing could have (a) hated trees, (b) accidentally thrown the flyer out before reading it, or (c) anything in between—so it was concluded by the research team that this group would not have had similar enough experiences to draw conclusions about their instincts in regard to tree planting. Seeking out these individuals may have been helpful in uncovering the benefits and drawbacks of utilizing direct mail flyers as a tree giveaway outreach tactic, but this was not an objective of this research. Additionally, there was no record of contact information for these households. Because of this, it was not feasible to include interviews with individuals who chose not to participate in replanting following the tornado. The perspectives of those who choose not to plant trees (Carmichael and McDonough 2019) would be helpful in showing a fuller picture of how Springfield residents felt about and responded to the abrupt canopy loss and landscape change.

(d) The majority of residents who received trees through this program (and who elected to participate in this research) were homeowners. This research was only able to explore the perspectives of one individual who rented their home at the time of the tornado. Renters potentially had a different experience of tree loss and the replanting process in their communities—particularly in neighborhoods with lower owner-occupancy rates that received fewer trees through the program.

5.3 Opportunities for future research

The limitations encountered during this study present a number of opportunities for future research in the area of place attachment disruption as it relates to abrupt tree canopy loss. Research methods that reduced the barriers to participation (use of an electronic survey,

monetary stipends for participants, multilingual outreach and interview conduction, and alternative outreach modes) could allow for greater diversity of participants and perspectives of tree loss and interactions with tree replanting. Furthermore, this research pointed to (in Sect. 2.1) the uneven distribution in tree planting across the seven neighborhoods within the tornado's path. Future studies might explore opportunities and methods for equitable urban forest reconstruction in the aftermath of SWEs that support post-disaster tree planting and stewardship in areas with lower rates of owner-occupancy, lower incomes, greater racial diversity, and minimal private property growing spaces. Finally, as noted above, it would be worthwhile to explore the perspectives of those who experienced the tree loss and associated property damage and landscape change, but who were not interested in replanting trees in their yards.

Appendix A: Interview Guide

1 Participant's pre-tornado impression of/relationship with nature and Springfield's urban forest

- As a resident of Springfield, could you share your thoughts on (or impressions of) the greenery/nature in your community?

  - Follow-up questions:

    - For instance, yards, parks, trees, "wild" spaces….

      - Is there enough? Is it well cared-for?

    - How do you interact with the natural landscape in your community?

      - Probe for active interaction: Do you cut the grass? Do you garden?
      - Probe for passive interaction: Do you use parks? Observe/appreciate the nature in your community?

- Did you have any trees at your home prior to the tornado?

  - Follow-up questions:

    - Is it (are they) still there?
    - Tell me about that tree (those trees). How did (do) you feel about it (them)?
    - Probes about the tree(s):

      - Species/size?
      - What sorts of things did you do to care for the tree(s)? (If anything?)

- If there was no tree at their home before the tornado: What (if any) was your experience interacting with or caring for trees prior to the tornado?

  - These could be trees in your yard or in your community….
  - Examples: planting, watering, picking fruit, observing, sitting in the shade.

- How would you describe your feelings about the trees in your neighborhood prior to the tornado? (These could be any trees—in your yard, park, sidewalk trees, etc.)

  - Follow up questions:

    - Do you recall thinking about or paying attention to the trees in your yard or neighborhood? If so, what did you think about them or notice?
    - How important did you feel trees in your neighborhood or yard were?
    - What benefits and/or drawbacks of trees come to mind when you think about their impact on your experience of living in Springfield?

- Can you describe your interaction with Springfield's urban forestry program or personnel before the tornado?

  - Follow-up questions:

    - Did you even contact the Forestry Division? If so, for what reason?
    - Were you familiar with any Forestry personnel?
    - Were you familiar with any community tree-related events/activities?

2 Participant's immediate-post-tornado feelings about the urban forest/trees in general

- Tell me about your experience of the tornado.

  - Follow-up question:

    - What were you thinking and feeling in the days/weeks that followed?

- What do you remember about the tornado's impact on trees?

  - Follow-up questions:

    - How did that make you feel?
    - Depending on whether they lost a tree in your yard, follow up about:

      - Trees in their yard, neighborhood, city.

- Has the experience of the tornado changed your feelings about the drawbacks/benefits of trees that you mentioned before? [remind them of what they said in Sect. 2]

- Follow up question:

    - Could you give an example of how your feelings changed?

3 Participant's tree(s)—condition, species, the care it has needed

- How are your trees doing?

    - Follow-up questions:

        - If tree(s) are doing well: What do you think factored into its (their) success? What tree care/tree health issues have you experienced, if any?
        - If tree(s) are struggling: What have you observed that makes you concerned about the tree(s)? What tree care/tree health issues have you experienced?
        - If tree(s) have died/been removed: Do you have any theory as to why the tree(s) did not survive? -or- What factors were involved in your decision to remove the tree(s)?

            - When did the tree die/when was the tree removed?

- What kind(s) of care have you performed on the tree(s)?

    - Follow-up questions:

        - What sort of care did you perform initially (in the first few years)?
        - What sort of ongoing care have you provided over the past 10 years, if any?

            - Pruning, weeding, understory planting, pest/disease control, tree removal?

        - How did you know how to care for your tree(s)?

            - What information/resources did you use for guidance?

4 Connection between tree loss, tree stewardship, and tree regrowth

- Could you describe your reasons for participating in the 'Energy Saving Tree Planting Initiative', when presented with the opportunity to replant in 2012?

    - Follow-up questions:

        - Prompt them to also describe any possible hesitations.
        - Did you speak to anyone in your community (neighbors, friends, etc.) about your decision regarding the program, or their decision? (Prompt them to elaborate on their response.)
        - Before you learned about this program, were you already thinking about planting new trees? Why/why not?

- Tell me about what it was like to see the trees begin to get replanted.
- Have the new trees impacted your experience of your home/neighborhood?

    - Follow-up questions:

        - If yes/no: why do you think that is?
        - If yes: We spoke a little about caring for your tree(s) at the start of this interview. Can you tell me a little bit about the experience of participating in this tree care work that contributed to the tree regrowth in your community?

- What resources or support might have been helpful for you following the tornado (re: this planting program, or about trees in general)?

    - Follow-up question:

        - Offer examples of resource types: Tools, handbooks, information/outreach, hands-on instruction, money, damage clean-up assistance.

- How would you now describe your interaction with or knowledge of Springfield's Forestry program & personnel?

    - Follow-up questions:

        - Since the tornado, have you contacted them for information or assistance? (If so, what was/were the reason/s and outcome/s of that/those interaction/s?)
        - Would you be interested in providing input regarding the management and care of Springfield's trees?

- How would you describe your interaction with or knowledge of ReGreen Springfield (the nonprofit that stemmed from this 2012 planting program)?

    - Potential follow-up question:

        - Have you participated in any of their programs/activities since the tree planting program we're discussing here, or have you volunteered with them? If yes, please describe.
        - Are there programs you think Springfield's city urban forestry program or ReGreen Springfield should offer?

Appendix B: codebook

1 Pre-tornado

1) Nature relationship

a) Passive outdoor activities.
b) Nature stewardship activities.
c) Positive feelings.
d) Negative feelings.
e) Childhood memories.
f) Experiences with children or grandchildren.

2) Trees on participant's property

a) Positive feelings.
b) Negative feelings.
c) Care performed.
d) Planting activity.
e) Tree removals.
f) Description of trees.

3) Residential, right-of-way (public) trees

a) Positive feelings.
b) Negative feelings.
c) Care performed.
d) Planting or removal requests.
e) Description of trees.

4) Springfield's urban forest

a) Positive feelings.
b) Negative feelings.
c) Feels that there are many trees.
d) Feels that there are few trees.
e) Likes their neighborhood/street specifically because of the trees/canopy.
f) Feels that Springfield is known for its trees/canopy.

2 Immediate aftermath

5) Tornado memory

a) Descriptive language of landscape appearance.
b) Emotional response.
c) Feels that this region does not get tornadoes.
d) Experiences of spectatorship.
e) Experiences with neighbors and community.

6) Impact on property

a) Tree loss.

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   b) Non-tree property damage.

       i)   No damage.
       ii) No damage to the dwelling, but damage to other built elements of the property.
       iii) Damage to the dwelling, but original structure remained.
       iv) Home demolished and rebuilt.

   c) Insurance contribution.
   d) Description of debris.

7) Feelings about tree loss

   a) At the home level.
   b) At the neighborhood level.

       i)   Inability to recognize neighborhood, landmark loss.

   c) Resources needed.

3 Mid-term aftermath

8) Planting program

   a) Decision-making around planting.
   b) Hesitations and concerns.
   c) Communication with neighbors.
   d) Planting a tree in the same location as a pre-tornado tree.

9) Planting additional trees on their own.

4 Long-term aftermath

10) Tree stewardship.

   a) Care performed.
   b) Tree removal.
   c) Tree health/structural issues.
   d) Frustrations and regrets.

11) Feelings about trees and tree loss.

   a) Positive associations with tree loss.
   b) Negative associations with tree loss.
   c) Tree fears/changed feelings about trees.
   d) Impressions of regrowth.

       i)   At home level.
       ii) At neighborhood/community level.

e) Tornado legacy in the landscape.

5 Miscellaneous

12) Length of time living in Springfield and/or their home.
13) Subject age.
14) Interest in an Urban Forest Master Plan process.
15) Interactions with Springfield Forest Division.
16) Awareness of ReGreen Springfield.
17) References to large, old oaks.
18) Interaction with physical setting during interview.

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Declarations

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