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Weighing values and risks of beloved invasive species: The case of the survivor tree and conflict management in urban green infrastructure☆

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ABSTRACT

A critical aspect of urban green infrastructure management hinges on the treatment of native and invasive species. Invasive species are widely seen as a major threat, yet the context-specific values people have for some of these species pose challenges for their management. Here, we offer a case study of the 9/11 survivor tree, a Callery pear (*Pyrus calleryana* Decne.) that survived the terrorist attack on September 11, 2001 at the World Trade Center in New York City and has since become a symbol of resilience. That individual tree and its progeny are beloved and they are also characterized as invasive. As part of the longitudinal research of the US Forest Service Living Memorials Project, we report findings from semi-structured interviews conducted with eight stewards from six living memorial sites that have survivor trees and with five individuals who have expert knowledge of the survivor tree, its propagation and dissemination. We find that some people see the tree primarily as a heroic symbol of hope and resilience, others see it primarily a threat to personal property, safety, and to biodiversity, which overshadow its social value. We conclude that Callery pears are associated with multiple, conflicting values, having the power to both unite and divide around issues of recovery and resilience in social and ecological spheres. Whereas managers and policy makers tend to have absolute views of invasive species as negative, living memorial stewards and others affected by tragedies have personal relationships that significantly influence their attitudes and practices toward a line of Callery pears. We conclude that urban green infrastructure management might best be seen as a highly contingent and value-driven practice, and that understanding these social meanings may lead to better stewardship of the whole social-ecological system.

1. Introduction

While it is human nature to appreciate nature, there is no consensus on what we value most. What is beloved to some can be disregarded by others, and what is desirable can change over time, space, and context, even for the same person (Gobster et al., 2007; Flint et al., 2013; Cocks and Wiersum, 2014; Buizer et al., 2016). Whether a function of an ecosystem or an element of nature is seen as valuable or as undesirable depends on societal values and priorities that vary among and within cultural groups (Gómez-Baggethun et al., 2013) as well as among researchers, managers, and the public (Elands et al., 2015). Competing interests can pose challenges for urban green-infrastructure planning (hereafter 'UGI'), "a strategic planning approach that aims to develop networks of green and blue spaces in urban areas, designed and managed to deliver a wide range of ecosystem service and other benefits at all spatial scales" (Hansen et al., 2017:iv). The complexity of these competing interests is further amplified when considering the need to manage for both our present and future environments. Conflicting values can pose challenges as well and perhaps especially in urban areas, where green space is limited and increasingly dense populations of people rely on nearby nature for a range of needs from filtering air and water, to mitigating heat and erosion, to providing wildlife habitat, to supporting social-emotional well-being (Dwyer et al., 1992; Svendsen et al., 2016).

1.1. Objective

In the interest of more inclusive, responsive UGI management that promotes sustainability and well-being of urban social-ecological systems, in this paper we hope to deepen and broaden the conversation

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about environmental values and the negotiation of multiple priorities, including invasive species management, in UGI planning. We begin by describing our setting of New York City; reviewing concepts of invasive, native, and non-native species; and providing brief histories of the Callery pear (*Pyrus calleryana* Decne.) — a species considered to be invasive — and the survivor tree phenomenon. Next, our results provide empirical evidence from a case study of a particular line of highly valued Callery pears that descends from a specimen in New York City known as the "9/11 survivor tree." We conclude by suggesting that UGI management might best be seen as a highly contingent, heterogeneous, and value-driven practice, and that understanding these social meanings may lead to better stewardship and more effective management of the whole social-ecological system.

1.2. Setting

In New York City (NYC), the urban forest is a critical component of UGI as well as a critical contributor to the health and well-being of the city's 8.5 million residents (Svendsen et al., 2016; Campbell, 2017). NYC greenspace is valued for its ecological diversity, with over 40% of New York State's rare and endangered plant species, more than the surrounding semi-urban/rural areas (Gómez-Baggethun et al., 2013). This diversity exists largely in "natural areas" including 51 "Forever Wild" nature preserves representing over 3,521 ha of the most ecologically valuable forests, wetlands, and meadows throughout the five boroughs of NYC (New York City Parks Department, 2016), but crucial ecosystem benefits are also provided by the approximately half million street trees in the public right of way and an approximated 2,104 ha of landscaped parkland. One of the biggest threat to native habitats is invasive species and New York State invests heavily in their management, including 40 million dollars annually just for efforts to eradicate Asian Long-horned Beetle from NYC and Long Island (New York State Invasive Species Task Force, 2005).

1.3. Conceptualizing invasive, non-native, and native species

A critical aspect of UGI in NYC and beyond, hinges on the treatment of native, non-native, and invasive species. At the heart of our case study are the tensions that result from the fluidity of these concepts (described below). While we recognize the challenges associated with these categories, for the purposes of our discussion we refer to authoritative definitions from the U.S. "Executive Order – Safeguarding the Nation from the Impacts of Invasive Species" (Exec. Order No. 13112, 2016). Executive orders are issued by U.S. Presidents and directed towards U.S. Federal Government officers and agencies. Executive orders have the full force of law. In Exec. Order No. 13112 (2016), non-native species are defined with respect to a particular ecosystem as "an organism, including its seeds, eggs, spores, or other biological material capable of propagating that species, that occurs outside its natural range." Although not defined in the order, it follows that native species are understood, with respect to a particular ecosystem, as those that occur within their natural range. Invasive species are defined with regard to a particular ecosystem as "a non-native organisms whose introduction causes or is likely to cause economic or environmental harm, or harm to human, animal, or plant health" (Exec. Order No. 13112, 2016). While native species can be locally weedy, their damage is "miniscule in comparison with those caused by alien [non-native] species" (Richardson et al., 2008). Importantly, most non-native species do not become invasive.

Invasive species are a major threat across the urban to rural continuum, with corresponding ecosystem management and biodiversity conservation practices designed to foster native species and reduce or eliminate invasive species. However, the beliefs that native species are categorically more valuable than non-native species and that all invasive species should necessarily be eradicated are not held by all, especially in highly anthropogenic, socially diverse, urban contexts (del Tredici, 2014; Gaertner et al., 2016). The sustainability of cities depends upon addressing the complements and conflicts among diverse sets of human needs because of the limited capacities of ecosystems to meet those needs (Daniel et al., 2012). It is important to understand how different groups perceive and value urban ecosystems from the species level to the landscape level and how sociocultural interactions with biodiversity modify urban landscapes (Cocks and Wiersum, 2014). As part of UGI management, the treatment of invasive species should also consider their positive and negative impacts on ecosystems (Dickie et al., 2014) and social systems (Estévez et al., 2015; Gaertner et al., 2016; Head, 2017). Essentially, we are faced with the questions: *Do the benefits of valuable, but non-native and potentially invasive species ever outweigh their risks? Are there cases that call for exceptions to policies regarding the management of invasive species in highly anthropogenic, urbanized environments where the risk of spread is minimal and managed?*

Worldwide, invasive species have irreversibly transformed ecosystems (IUCN, 2000) and caused losses in forestry, agriculture, fisheries, conservation, tourism, and transportation (Pimentel et al., 2005). Invasive species threaten native biodiversity, sometimes to extinction (Sax et al., 2007). In the U.S. "more than 400 of the over 1300 species currently protected under the Endangered Species Act, and more than 180 candidate species for listing are considered to be at risk at least partly due to displacement by, competition with, and predation by invasive species" (U.S. Fish and Wildlife Service, 2012). The cost of invasive, introduced species in the U.S. is estimated at US $120 billion annually (Pimentel et al., 2005).

Despite their negative impacts, invasive species management can be a contentious issue. This is partly because of the fluidity of native, non-native, and invasive classifications, which reflect shifting boundaries of nature, culture, agency, and time (Helmreich, 2005; Warren, 2007). As such, defining nativity and identifying invasiveness becomes an entangled endeavor (Head, 2017). We can question whether planting species where they were once native in what have become urban anthropogenic landscapes with altered soils, temperatures, built structures, and pollutants even makes sense. Given the warming temperatures and the northward migration of species, the native—non-native distinction is expected to become even more uncertain (Head, 2017). The reality of changing global climates and environments and shifts in species distribution has influenced calls to accept and even embrace these novel communities (del Tredici, 2014), as invasive species are also recognized for providing ecosystem benefits (Gaertner et al., 2016). At the same time, counterarguments about invasive species' ability to provide ecosystem services continue to enliven the literature (e.g., Pimentel et al., 2005; Pyšek et al., 2012).

Another challenge to the native-introduced concept is that it can be influenced by subjective values and ethics, rather than relegated by 'objective' science (Warren, 2007; Head, 2017). Although strong views defend the distinctness, utility, and objectivity of the native-introduced categories (Richardson et al., 2008, 2016), they continue to be called into question. Reviews by Woods and Moriarty (2001) and Warren (2007) concluded that empirical criteria are elusive and definitions of native and introduced are ambiguous, subjective, used inconsistently, and are "tainted with troubling associations" (Warren, 2008:300). The cultural loadings and value-driven aspects of the discourse around non-native and invasive species are revealed through a politicized lexicon that has been compared to that of immigration control officers (O'Brien, 2006), evoking issues of power and xenophobia through the terms: alien, invaded, colonization, immigrant, indigeneity, identity (see also Pauly, 1996). Policies designed to respond to invasive species are said to "frequently adopt the militaristic language of counter-insurgency campaigns" (Warren, 2007:429; see also Larson, 2005). While these highly-charged terms may be falling out of favor in scientific literature, their influence on the minds of the populace may remain for some time.

Adopting alternative language can be a powerful strategy to more fully engage in democratic, collaborative management of what are otherwise called non-native and invasive species. Larson (2005:449)

asks whether the combative militaristic language used for invasive species can be counterproductive to achieving conservation objectives, suggesting that analogies related to invasive species and health or invasive species "living together'" with people rather than "invaded" by them would be more effective. Colautti and MacIsaac (2004) use neutral terms such as "residing," "travelling," "introduced," "localized," "rare," "widespread," and "dominant," which can be applied to both native and non-native species while also accounting for variation across geographies. Poe et al. (2014) suggest that urban landscapes and plants be managed for a wider set of intentional purposes—such as their contributions to health, wellness, connection and belonging—rather than their status as native or non-native.

Conflicts surrounding invasive species are based primarily on differences in value systems and risk perceptions (Estévez et al., 2015). Culture, livelihoods, education, and socio-economic status influence how invasive species are perceived (Warren, 2007; Pfeiffer and Voeks, 2008; Bhattacharyya and Larson, 2014). Bhattacharyya and Larson (2014) provide a thorough literature review on the problematic nature of invasive species identification, costs and benefits, and the power relationships reflected in their management. Thought they may be targeted for removal, some species categorized as invasive have aesthetic, utilitarian, sociocultural, or spiritual value. They are intentionally propagated and disseminated for their ornamental characteristics, their hardiness, or the fruit they bear. Indeed, Reichard and White (2001) note that most invasive plants were introduced for their horticultural value. In some cases, invasive species also contribute to a sense of place (Warren, 2007; Lien and Davison, 2010; Schlaepfer et al., 2011; Dickie et al., 2014) and carry associations of identity, home, and belonging. Certain species have become so thoroughly incorporated into local systems they are considered native and culturally iconic. Some invasive species even achieve symbolic status as state flowers and birds such as Maryland's black-eyed Susan and South Dakota's ring-necked pheasant (Pfeiffer and Voeks, 2008). Culturally iconic examples of invasive species for indigenous people include wild horses in western North America and feral pigs in Hawai'i. Native, non-native, invasive species concepts themselves are products of colonialism and therefore do not necessarily fit with indigenous worldviews (Head, 2017).

Reconciling differences in perceptions of invasive species is important because community support is often vital to meeting management goals. In some cases, opposition to invasive species management can delay the process, increase the expense, or even prevent the management altogether (Mackenzie and Larson, 2010; Dickie et al., 2014; Gaertner et al., 2016). Plans to eradicate invasive species that are locally valued have been met with consternation by those who want to maintain an economic resource, their cultural heritage, or an aesthetic landscape. For example, in Hawai'i feral European-Polynesian pigs, *Sus scrofa*, have been dubbed by conservationists as the "roto-tillers of the forests, destroyers of native plants, and vectors for diseases" while many community members, especially local pig hunters "value pigs, regard hunting as a traditional activity, and feel it is their right to maintain populations" (Gollin et al., 2004), and so some hunters also promote wild pig populations. In the process of invasive species eradication, the relationships between managers and communities can suffer, further weakening the potential for productive collaborations and the realization of a broad suite of ecosystem services (Mackenzie and Larson, 2010) from biodiversity to heritage values. Sometimes community stakeholders' perspectives align with those of managers and policy makers, as when urban park visitors' well-being was positively correlated with species richness and habitat diversity (Fuller et al., 2007). Sometimes they do not, as when ecologically healthy landscapes, such as wetlands, are seen as unattractive and undesirable by community members (Gobster et al., 2007). The site-type and context plays an important role in species' desirability and acceptability. What managers may consider appropriate for planting in an urban woodland being managed for restoring native biodiversity is different than what they may consider to appropriate for planting as a street tree in a high-traffic area.

A number of frameworks and models created to reduce conflict around natural resource management can be applied here. Estévez et al. (2015) offer a tiered framework where risk perceptions and values influence attitudes, and attitudes determine behavior. Kenter (2016) describes the deliberative values formation model as a way to bridge the divide between complex and contested values, emphasizing the need to clearly understand and conceptualize how value formation processes occur. Gaertner et al. (2016) propose a framework for evaluating invasive species that positions invasive species along two axes: benefits and negative impacts. We draw from these frameworks and models in our discussion of the perceptions, values, and negotiations of the management of the Callery pear survivor tree and we consider what it means for UGI management.

1.4. The callery pear, an invasive survivor

In 1916, the U.S. Department of Agriculture brought the Callery pear from China to the U.S. to crossbreed it with orchard pears and produce a strain immune to fireblight (Culley, 2017), an early demonstration that it was valued as resilient. Through this program, the 'Bradford' cultivar was produced. By the mid-1960s it became one of the most widely planted boulevard trees in urban areas of the U.S. Because it is resistant to disease and herbivory, and tolerant of moisture, soil compaction, salt run off, and pollution, it became seen an ideal street tree (Culley and Hardiman, 2007). In NYC, the Callery pear is the 3rd most common street tree (New York City Parks Department, 2017). Beyond its hardiness, the tree is also noted for its abundant white flowers in the spring, brilliant orange-red color leaves in the fall, in addition to serving as a food source for birds in later winter.

Despite these benefits, the Callery pear's desirability has changed over time. Like many other tree species that were introduced for ornamental purposes or to enhance ecosystem services, once they naturalize and become invasive, they disrupt ecosystem services, causing conflict over their removal, particularly in urban areas (Dickie et al., 2014). The invasive populations form from seeds produced by crossing between genetically different cultivars (since this is a self-incompatible species). Today, the 'Bradford' cultivar, the same cultivar as the 9/11 survivor tree, is listed as invasive in Alabama, Georgia, North Carolina, Maryland, New Jersey, Pennsylvania, Ohio and is on watch lists in Tennessee, South Carolina, Oklahoma, and New York (Culley and Hardiman, 2007). The tree poses risks because it is perceived as a hazard to people and property with "narrow crotch angles" that cause branches to split under their own weight after 15–20 years (Culley and Hardiman, 2007) or earlier when strained by wind, ice, or snow (Barnard, 2002). Some urbanites consider the tree's prolific fruit litter to be a nuisance (Culley and Hardiman, 2007) and the odor of its blossoms to be offensive, variously described as semen, rotting flesh, or chlorine (Lapidos, 2013). When and where the tree is given the space and opportunity, it establishes dense thorny thickets that compete with native species and make it impenetrable to people who want to remove it (Culley, 2017). Because of its invasive nature, NYC's Department of Parks and Recreation stopped planting the Callery pear; however, the events following September 11th changed people's attitudes and behavior toward the tree, at least for some individuals of that species.

1.5. Survivor trees

Survivor trees are those that have witnessed and withstood extreme disturbances and become compelling symbols for communities seeking to respond, recover, and reconnect following a tragedy (McMillen et al., 2017a, 2017b). They are found on battlefields in Europe and Africa (Gough, 1996), atomic bomb sites in Japan (Tsuchida and del Tredici, 1993; Conti and Petersen, 2008), areas affected by natural disasters in Asia (Malam, 2013; Matsuda, 2011) and terrorist attacks in the U.S. (Veil et al., 2011; McMillen et al., 2017a, 2017b). Our case study

Fig. 1. Callery pear Survivor tree at the National September 11 Memorial & Museum.

focuses on a tree that survived the attacks on September 11, 2001, when two planes crashed into the World Trade Center, creating an explosion that destroyed the towers and adjacent structures and grounds in lower Manhattan, reducing them to rubble, and killing thousands. Today, this 9/11 survivor tree, a Bradford Callery pear, grows at that same site, which is now the 9/11 Memorial Plaza (Fig. 1).

Our case study of the 9/11 survivor tree emerges from a longitudinal study of the U.S. Forest Service Living Memorials Project that began in 2002 (Svendsen and Campbell, 2010) following the events of 9/11 and continues as an ongoing research initiative to understand changes in the use and stewardship of UGI (McMillen et al., 2017a, b). We describe how this line of Callery pear trees, originating from the 9/11 survivor tree, has attained luminary status and become a symbol of resilience, strength, and unity (McMillen et al., 2017b) and we examine the conflict surrounding the tree. Saplings grown from its seeds are highly desired by those who wish to commemorate recovery from the events of 9/11 or another traumatic event; however, because the Callery pear is considered invasive, conflicts have arisen over propagating and distributing its offspring.

2. Methods

This case study of the survivor trees is part of the ongoing research of the Living Memorials Project (Svendsen and Campbell, 2010). Case studies are an appropriate methodology when detailed and holistic investigation of phenomena is used to build upon existing theory, extrapolating from the "micro from the macro" (Burawoy, 1998:5). Through our follow-up research with previously documented Living Memorial Project sites (n = 34) in the NYC region (McMillen et al., 2017b), our attention was drawn to the phenomenon of the 9/11 survivor tree. We identified five living memorials to 9/11 that had obtained survivor tree saplings. The "Garden of Healing" in the Staten Island Botanical Garden (NYC, NY) received and planted one of the first offspring from the survivor tree, although in a twist of irony, it did not survive its first winter. Other survivor tree saplings are planted at: "An American Remembrance in the Manalapan Arboretum" (Manalapan, New Jersey); the "9/11 Family Group Memorial" in Coney Island, Brooklyn (NYC, NY); Eisenhower Park's "American Patriot Garden" in (Nassau County, NY); and the memorial at the Fire Department of New York's Fire Academy and Life Safety Campus in Bayside, Queens (NYC, NY). We also followed up with a sixth site, the "Living Memorial Grove," that features survivor trees that were relocated from the crash site (not grown from the 9/11 survivor tree as were the others in this case study).

This case study is based on semi-structured interviews we conducted with the stewards (n = 8) of those six 9/11 living memorials that feature survivor trees (at two sites two stewards participated in the interview). As with the larger follow up study with stewards of Living Memorial Project sites, stewards were invited to participate in interviews based on their in-depth and long-term relationships with the researchers (for authors ES and LC this is 14 years in most cases) and stewards participated based on their availability (See McMillen et al., 2017b).

Interviews with site stewards ranged from 30 min to one hour and focused on changes to the site and its stewardship, the flora present and the stewards' reasons for choosing them, how their survivor trees were obtained, the values, risks, and benefits associated with the survivor trees, and achievements, and challenges of the sites. (Four sites had on-site interviews, one site had an off-site interview due to its limited access, and one site had a telephone interview with a separate site visit). To deepen our understanding of the diverse values and perceptions of the 9/11 survivor tree, we also conducted semi-structured interviews with five individuals who have expert knowledge of the tree: two who were integral to its rescue, care, and "repatriation" (one of these individuals was also included in the previously mentioned group of stewards), and three people who are key to the propagation and dissemination of the 9/11 survivor tree's progeny. These five interviews, (four conducted by telephone and one conducted in person) ranging from 20 min to one hour, explored the history, recovery, and care for the original 9/11 survivor tree; the programming concerning the survivor tree propagation and dissemination; and the multiple meanings, values, and risks associated with those trees. Although this is a small number of interviewees (n = 12), it includes the key respondents for this phenomenon. (As will be described later, a broad distribution of 9/11 survivor trees has not occurred.) To provide further context, we also include two USFS foresters' reflections on the halted multi-agency program to distribute survivor tree seedlings. We offer this case as an entry point for identifying core themes related to the planning and management of invasive species in UGI.

3. Case study results

Here we share findings from our interviews that represent the values associated with the 9/11 survivor tree, a Callery pear specimen, and the contradictory risk perceptions of the Callery pear as a species. We begin with the days immediately following 9/11, when a NYC Parks Department supervisor did a reconnaissance of the trees and recalled:

> "The first thing I noticed is that there were six trees on the northeast end of the plaza which was the least damaged part of the plaza.

Fig. 2. Callery pear with damaged branches recovered from Ground Zero and prepared to be transported to the nursery, photograph courtesy of Bram Gunther.

> Three little-leaf lindens and three Callery pears that had survived and, like the other trees, they were covered with dust but that was about it. Although the City was already moving away from planting Callery pears as part of their street tree plantings, there was no doubt about whether or not to save those trees. It was not even on people's minds, there was no question about not planting it because it's a Callery pear. We always felt that those trees needed to be together and that they were siblings that survived a tragedy and you couldn't separate them….We all knew then at that point that sort of spiritually, aboriculturally that these trees needed to be nearby. We already understood that, so I sort of assessed some areas. I saw an open space right across from City Hall…and we just, in one day we dug the holes, transported the trees and put them all in that spot and just started spontaneously calling it a memorial grove…"

That grove, nestled against the on-ramp to the Brooklyn Bridge, became one of the earliest memorials to 9/11, officially called the "Living Memorial Grove" and it still exists today. Although they survived 9/11, none of these trees gained celebrity as "the survivor tree." Soon after these six trees were transplanted, the tree that came to be known as *the* survivor tree was spotted (Fig. 2).

A Parks Department supervisor recalls how some of the Parks Department landscape architects found the tree.

> "[It was] decapitated and maimed and mangled and they said, 'you need to get this tree out of there and save it!' and my first reaction was 'there's no saving that tree.' We've already saved six trees why do we need to do this one? But it was very important to the people that were spending 24/7 down there so at one point they convinced me that if they could get it out, I would take it up to our city-wide nursery [where]… horticulturists would do their best to resuscitate the tree… and they gave it everything they had, and that tree just flourished and…we just assumed that the tree was going to spend the rest of its life with us at the nursery…"

While the tree was meaningful for those who rescued it, it had a profound impact on the man who had just began working at the NYC Parks Citywide Nursery where it was delivered.

> "…the tree symbolizes, for me, the beginning of my career here. I was also wounded. [Prior to working at the nursery] I was a corrections officer, I got shot in the line of duty and I was able to bounce back, like the tree. If you look at it from far away, you could never tell that anything is wrong with it. …. I'm the same way, wounded and I recovered just like the tree."

Its life in the nursery was relatively quiet. Staff cared for the tree and propagated it through cuttings. The tree's celebrity was initially not broadcast by the nursery, but it did attract visitors who communed with it as a fellow survivor. The director shared his observations of the tree

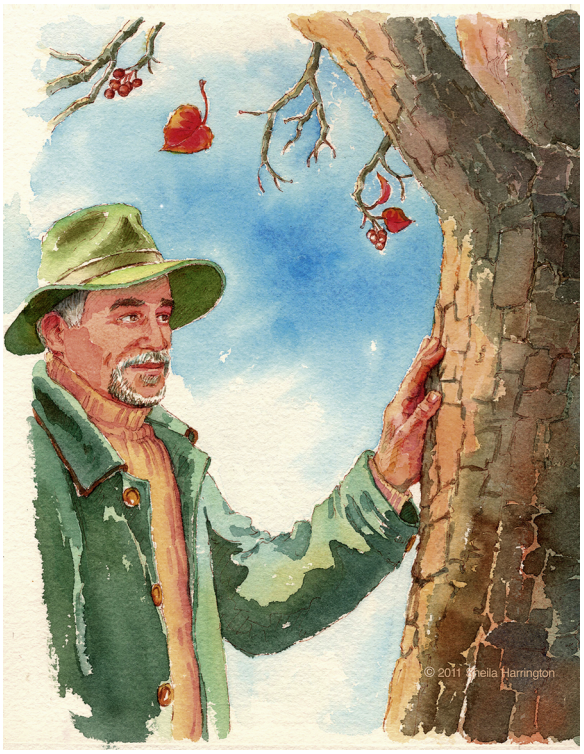

Fig. 3. The Citywide Nursery Director says goodbye to the survivor tree the day before it is transported back to the 9/11 Memorial Plaza. Reproduction of the painting is provided courtesy of Sheila Harrington from the book The Survivor Tree: Inspired by a True Story, written by Cheryl Somers Aubin.

at the nursery:

> "…one policeman and one fireman on two separate occasions came …because they heard about the tree from Ground Zero. And we would see the police or fireman just go and stare at it and we would see that reaction, real reaction, not brought out by media or memorial museum."

The nursery cared for the tree for years before it was rediscovered by the 9/11 Memorial Director of Design and Construction. He led what he called the "repatriation" of the tree to the 9/11 Memorial plaza at the World Trade Center. The nursery director reflected on the departure of the tree from the nursery, "…tears came to my eyes…I felt so connected to it, almost like you would feel when you were giving away your daughter at a wedding" (Fig. 3).

The 9/11 Director of Design and Construction recalled when it was delivered to the World Trade Center (December 2010); a landscape architect objected to the tree because it disturbed the uniform design of the memorial grove's 400 swamp white oaks. Others objected because Callery pears had been removed from the list of trees planted by the City. The nursery director recounted his response to those who objected:

> "I said – it's not the species, it's what the tree represents and how they connect to it. It's what the tree represents! About three weeks later [after the survivor tree was planted] they called us back. All of the white oaks had crashed, insect infestation, and looked horrible, and the one tree that he didn't want [Callery pear] was the one he was the most grateful for!"

The compelling story of the survivor tree as a resilient, inspiring, patriot has become widespread. Today, the survivor tree is not marked, as the Memorial's policy is that signage is only used for the names of those who were killed, but its singularity amidst the 400 swamp white oaks is noticeable to and sought out by visitors to the site (Fig. 4).

Fig. 4. Though unlabeled, the survivor tree at the National September 11 Memorial & Museum is sought out and recognized by visitors who touch and photograph it.

For many, it symbolizes the recovery of the city from 9/11, the promise of new life ahead, and also a connection to the losses resulting from 9/11. A representative from the 9/11 Memorial and Museum interviewed for this case study explained that when lower Manhattan went underwater with Hurricane Sandy in 2012, many people sent emails asking about the condition of the survivor tree; the living source on the plaza was a primary concern amidst all the destruction from flooding. At the 9/11 Memorial and Museum, we observed how the value of the survivor tree continues to be represented by the material items and practices of those visitors who leave offerings or commemorabilia at the tree—flowers, teddy bears, flags, coins, and other personal items. We also observed people creating their own personal keepsakes of the tree by picking leaves and having their picture taken with the tree.

Based on observations of how much people value the 9/11 survivor tree and because they expected that disseminating its progeny would inspire and unite people, the 9/11 Memorial and Museum contracted Bartlett Tree Experts (hereafter Bartlett) to care for it, along with the other memorial grove trees. Bartlett propagated survivor trees from seeds of the 9/11 survivor tree. Of the 500 that were attempted, 421 survived (421 Trees Grow in Queens by 590 Films). Since then, John Bowne Agricultural High School in Queens, NYC, has taken on the responsibility of caring for those saplings. With support from Bartlett, students at John Bowne Agricultural High School have the facilities, supplies, and training needed to care for the trees. Their propagation has become an integrated lesson in history, tolerance, and horticulture. The faculty member at the school who runs the program described the impact on students.

> "[They] were emotionally attached [to the trees]…for a lot of reasons…it really helped them through difficult times having caretaker roles, and then through us, they were taught about 9/11 and then became the teachers for other kids about 9/11… even if they didn't live at that time."

Due to the dedicated efforts at the high school and the high seedling survival rate, hundreds of seedlings became available for distribution. In 2014, there was momentum in developing a multi-agency program to distribute survivor tree seedlings to 9/11 living memorial sites (there are over 600 in the U.S., Svendsen and Campbell, 2010) and to family members; however this did not materialize. Because Callery pears are characterized as invasive in many states (Culley and Hardiman, 2007), and are no longer planted by the City of New York, local and federal agencies did not partner in the propagation and distribution program, although agency staff readily recognize the survivor tree as an important and valuable symbol. One Urban and Community Forestry Specialist commented, "The tree is a survivor because of its resilience and reproduction in all types of climate and terrain – the educational and spiritual value of this survivor tree are not disputed – but the poor structural quality and invasive nature of the tree species also was undisputed – the head won over the heart for USDA on this project" (personal communication 21 April 2017). Another U.S. Forest Service administrator referred to the Forest Service's decision not to participate in the program to distribute Callery pear survivor trees as a case of "making a decision to act on one set of values opposed to another" (personal communication 21 April 2017). Although a multi-agency program did not materialize, the 9/11 Memorial & Museum, in collaboration with Bartlett and John Bowne Agricultural High School, initiated a program in 2013 to gift survivor tree saplings to sites that have overcome a range of tragedies from natural disasters to massacres. (See Supplemental Information, Table 1).

Through our research we found that local 9/11 memorial sites have obtained survivor trees through less publicized routes. Both at "An American Remembrance in the Manalapan Arboretum" (Manalapan, New Jersey) and at the "9/11 Family Group Memorial" (Coney Island, Brooklyn, NYC) (Fig. 5), the memorial stewards described their dedicated efforts to obtain survivor tree saplings and how proud of and rewarded they are of their survivor trees. They described how saplings connect them both to the site of the tragedy as well as to the broader community of survivors; the tree helps tell their story of resilience and tenacity. One of the site stewards in Manalapan proudly explained how she nursed the survivor tree sapling at her home until she felt it was big enough to thrive in the memorial and then commented, "I love it that it's here. I mean I know it's not… like the most respected species…a pear tree. But hey, it's…We know where it comes from." She recognized the problematic reputation of the tree while also acknowledging that it has a special status because of its origins. One of the site stewards in Coney Island spoke of his connections to their survivor tree: "It brings some comfort to see because it's almost like bringing the past and the future together."

Through the common experiences shared by people who visit the survivor trees at their sites and through propagating and disseminating offspring from the parent survivor tree, they inspire and connect networks of people and trees in recovery from trauma. Yet, their distribution has been a challenge. Hundreds of saplings remain available at John Bowne high school's nursery. Due to restrictions on their dissemination (as invasive species) and due to the care taken to ensure they are planted where they will be taken good care of (to avoid the negative implications conveyed if a highly symbolic survivor tree was not cared for or died), they are not given out at the rate that is desired by the high school, by Bartlett, or by those communities that wish to receive a tree. In the meantime, the saplings continue to outgrow their pots and nursery.

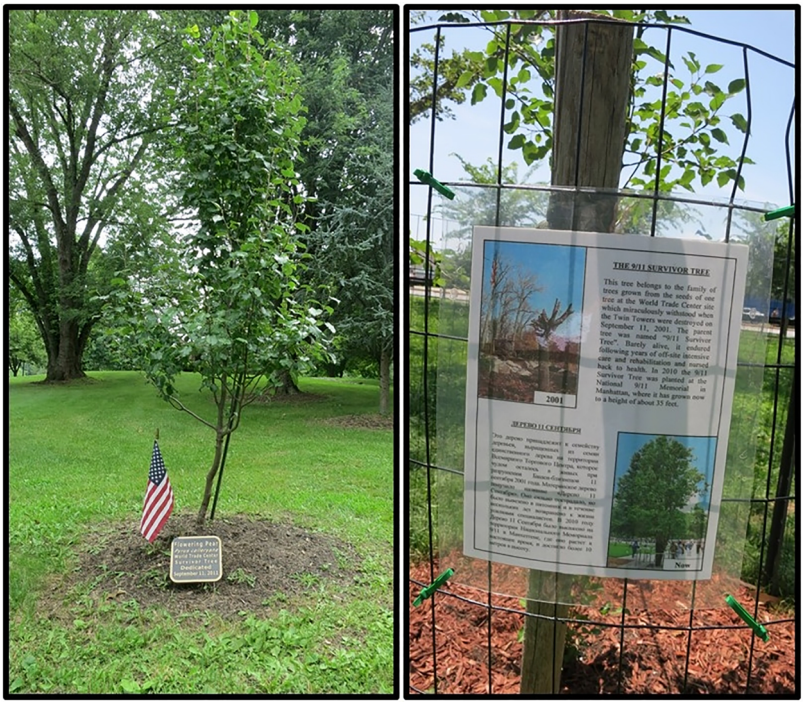

Fig. 5. Two 9/11 survivor tree saplings planted at living memorials: "An American Remembrance at the Manalapan Arboretum" in Manalapan, NJ (Left, pictured with an American flag) and "September 11 Family Group" in a Russian neighborhood of Coney Island, NYC (Right, with English and Russian description of the tree).

When asked if the tree's invasive labeling was an issue, one interviewee involved in its dissemination admitted that "some states don't want the seedlings 'til they hear the story." Another said, "We met a lot of resistance from Federal and State, because they [Callery pears] are listed as invasive, so they go on private properties…There's two outside of Camp David [the country retreat of the U.S. President, in Catoctin Mountain Park, Maryland] They've gone to DC, outside [the] Pentagon." Clearly, this tree changes attitudes and behavior related to the species, even if it is reserved for the progeny of one celebrity Callery pear, not all Callery pears. One person involved in the dissemination of survivor trees described:

> "When you see the faces of the people who get them, you realize what they meant to them…This [treatment of the tree as an invasive species] is the nonsense of politics….If you could witness the effect these trees have on people…How much of a 'risk' is it really? The damage that is occurring in massive amounts [due to other environmental problems] compared to trees being planted….you wouldn't believe about the desire to get these trees."

While some interviewed agreed that unattended Callery pears pose risks due to breakage, they insisted that proper pruning eliminates risk. "They are brittle, need pruning. The survivor tree has proven how sturdy it can be. If you prune properly early on, it's not a problem." Yet, high maintenance requirements can be an issue and a liability for parks with limited budgets and staffing. One interviewee involved in the distribution program for the survivor tree saplings spoke of their complex and conflicted nature:

> "People I've talked to that are smart enough to recognize it is an invasive species [also] realize the importance of the tree itself and what it denotes. They move beyond the designation of it being invasive and want it because of what it represents, and that I've found to be true of everybody I've talked to."

Having a Callery pear as a memorial tree was also described as risky, not from an ecological perspective, but from an emotional perspective. Two people interviewed who have been involved in the care for the original 9/11 survivor tree referenced how the inevitable death of the tree may bring disappointment for those attached to it and what it symbolizes. Callery pears typically have a relatively short lifespan of about 20 years, which is close to the age of the 9/11 survivor tree now. In anticipation of this event, Bartlett has propagated two buds from bud wood from the original tree and the NYC Parks Citywide Nursery has propagated and kept three clones grown from cuttings of the original survivor tree. These individual trees are being kept as potential replacements for the tree at the 9/11 plaza when the day comes. The trees are seen as special because they are replications of the 9/11 survivor tree, whereas the saplings grown from its seeds are F1 hybrids that also have genetic material from other trees.

4. Discussion

Our case of the Callery pear survivor trees represents the "emotional and embodied entanglements" (Head, 2017:4) invasive species can have. A challenge that many urban natural resource managers face is getting people to care about and be invested in nature and UGI. Here, we have a case where people strongly desire to plant and care for a tree in living memorial site or garden, yet their ability to do so limited. All those we spoke with recognize the social benefits of the Callery pear survivor trees, yet perceptions about their potential to generate significant negative impacts range from high to none, depending on the person, suggesting it should be actively managed (cf Gaertner et al., 2016). As Callery pears are ubiquitous in NYC, people who want to commemorate 9/11 and plant survivor tree saplings see little risk and wonder what harm might come from planting one more tree.

Beyond the personal resonance the tree has for many individuals affected by 9/11, it has also become a symbol of and a platform for conveying resilience and recovery from trauma for a broadening community of survivors in diaspora. When the UN is in session and dignitaries visit NYC, it is common for a collection of international wreaths to be laid at the tree out of respect. Following various attacks around the world, the tree is often adorned with expressions of support. For example, following the terrorist attacks in Istanbul (January 2017) the tree was adorned with flowers and Turkey's flag. National September 11 Memorial and Museum-Instagram posted a photograph of the tree

with a message saying "Our thoughts and prayers are with the city of #Instanbul and the families of the victims" (January 2, 2017). In July 2016 an Instagrammer (peopleofpanynj) posted a photograph of the survivor tree adorned with flowers and French flags in solidarity with Nice in honor of those affected by the terrorist attack; following the terrorist attacks in Paris (November 2015) the 9/11 Memorial and Museum hosted a tribute to the victims of Paris, where the French consulate spoke and others gathered as a community at the survivor tree. People brought flowers, flags, and notes to adorn the tree. In July 2016 another photograph of the tree was posted on Instagram (donnaaceto, July 3 2017), this time tied with ribbons in all the colors of the rainbow in support of gay pride and in solidarity with those affected by the shootings at Pulse nightclub in Orlando. Beyond the symbolism the tree has at the memorial, the propagation and gifting of the survivor tree across sites of tragedy represents mutual support and unity and magnifies the value of the tree.

Those who advocate distributing the survivor tree believe that its social value far outweighs its ecological risks, which they believe can be mitigated through management. Potential management methods include spraying the Callery Pear trees' flowers with the chemical ethephon, which has shown to be highly effective in preventing fruit set (Culley, 2017); or removing fruits to contain the risk of spread. Still, official policies from local to federal levels mean that, even if individual employees see the value and meaning of the tree, they cannot support programs that intentionally disseminate an invasive species.

The management of invasive species can be enhanced through group valuation and collaborative decision making processes (Estévez et al., 2015; Head et al., 2015; Kenter, 2016) which can be transformative and democratically address conflicts between complex and contested environmental and other concerns (Kenter, 2016). With regard to invasive tree removal, Dickie et al. (2014:715) note that compared to other ecosystem services, differences in cultural values "often lead to more intense conflicts." In some cases, opposition to invasive species management can delay the removal process, increase the expense or even prevent them altogether (Mackenzie and Larson, 2010; Dickie et al., 2014; Gaertner et al., 2016), underscoring the value of engaging in such processes. Gaertner et al. (2016: 4) assert that "It is thus clearly prudent to anticipate and plan for such possibilities, and to accept that, in some cases, traditional goals need to be replaced with partial or complete tolerance of invasive species." In this case, partial tolerance for the survivor tree and its offspring, and continuing to prohibit planting other Callery pears, is one potential option. Essentially, this seems to be the current official management of the tree. While NYC Department of Parks and Recreation no longer plants the species, we observed that it did not prevent the planting of a Callery pear survivor tree in Coney Island on NYC Parks land.

Our case study describes how multiple stakeholders' value formation processes evolved and how they are influenced by shifting biological, political, and emotional factors. While such a collaborative decision process at the institutional level was not borne out, people at individual sites have negotiated this complex terrain resulting from the objection of a species and simultaneous appreciation of a specimen from that same species. Although policy decisions made at one moment in time implicitly assume that things will remain static (cf Edwards et al., 2016) or that one-size-fits-all, our case describes the dynamic, multiple, complex, intersubjective, and relational values associated with this tree. We agree with Estévez et al. (2015) who assert that it is critical to understand these complexities, and we suggest that collaborative processes are especially critical in urban areas where stakeholders are diverse and green space is at a premium. Balancing social and ecological values and outcomes in UGI management is critical. Gobster et al. (2007:970) suggest that ecological value alone may not be sufficient, asserting that "Appropriate design, planning, policy, and management can create aesthetically attractive landscapes, achieving ecologically beneficial landscapes that are also culturally sustainable." The key is to collaboratively manage for social-ecological resilience or, in the words of Gobster et al., (2007) an ecology of care.

5. Conclusions

Recognizing the complex nature of nature, the fluidity of desirable and undesirable species, and our various biases and preferences as scientists, managers, and community-based stewards is vital for UGI management. Our work highlights how a species can have multiple, conflicting values, having the power to both unite and divide around issues of recovery and resilience in social and ecological spheres. Whereas managers and policy makers tend to have absolute views of species in the native (good) and invasive (bad) categories, the personal relationships that community members have with the same species can significantly influence their attitudes and practices (cf Lien and Davison, 2010; Head, 2017). While many people simultaneously recognize the Callery pear survivor tree's social benefits and its ecological risk, some see it primarily as a heroic symbol of hope and resilience; others see it primarily as a threat to personal property, safety, and to biodiversity, which overshadow its social value. Calling forth the categories proposed by Pfeiffer and Voeks (2008), perhaps the Callery pear survivor trees could be described as both culturally enriching, through becoming a metonym for a piece of American history, and culturally facilitating, through connecting diasporic communities of survivors across the globe. Although this case may not be representative of invasive species management generally, it represents the potent values people can have for trees (including some invasive ones) and the trees' contributions to social resilience and social cohesion across space and time, begging the question: is there ever room for symbolic species, even if they are so resilient that they become "invasive," if they also support social resilience, inspire stewardship, and generate a range of ecosystem services more broadly?

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