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Stewardship, learning, and memory in disaster resilience

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In this contribution, we propose and explore the following hypothesis: civic ecology practices, including urban community forestry, community gardening, and other self-organized forms of stewardship of green spaces in cities, are manifestations of how memories of the role of greening in healing can be instrumentalized through social learning to foster social–ecological system (SES) resilience following crisis and disaster. Further, we propose that civic ecology communities of practice within and across cities help to leverage these memories into effective practices, and that these communities of practice serve as urban iterations of the collaborative and adaptive management practices that play a role in SES resilience in more rural settings. We present two urban examples to build support for this hypothesis: the Living Memorials Project in post-9/11 New York City, and community forestry in New Orleans following Hurricane Katrina. These cases demonstrate what we refer to as a memorialization mechanism that leads to feedbacks critical to SES resilience. The process begins immediately after a crisis, when a spontaneous and collective memorialization of lost ones through gardening and tree planting ensues, following which a community of practice emerges to act upon and apply these memories to social learning about greening practices. This in turn may lead to new kinds of learning, including about collective efficacy and ecosystem services production, through a kind of feedback between remembering, learning, and enhancing individual, social, and environmental well-being. This process, in the case of greening in cities, may confer SES resilience, through contributing to both psychological–social resistance and resilience and ecosystem benefits.

Keywords: resilience; communities of practice; civic ecology; urban; stewardship; memory; disaster; social learning

Introduction

In his 2006 book *Defiant gardens: Making gardens in wartime*, author Kenneth Helphand examines gardening as a response to some of the most hopeless wartime situations in history – gardening by soldiers inside trenches during World War I, gardening in the Warsaw ghetto among Jews knowing they would not survive the holocaust to see their harvest, and gardening by prisoners of war and Japanese-Americans interned in camps. Since publication of the book, hundreds of soldiers have come forth to share with Helphand their memories of how gardening helped them to

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be 'resistant and resilient' (Nucifora et al. 2007) in the midst of war. For example, a former helicopter pilot wrote about how the bananas, watermelons, and periwinkles he planted in Vietnam had:

> a calming effect on me … after a long day of flying missions in the I Corps area to see a little bit of green growing by my doorway … As small as it was, it was my oasis. I could almost block out the medevac choppers going out and the sound of the artillery in the distance. I have never forgotten much from that war and never my oasis … Thank you for reminding me that even one small little garden can create a sense of peace and hope in the midst of a war and a warrior's heart. (Helphand 2009)

Civilians also recounted their stories. For example, in Colombia, urban squatters and refugees fleeing from violence spoke about the importance of gardening, and posed the rhetorical question of why kidnappers in Colombia did not even allow their victims a garden, a charge that exemplified their cruelty. And newspapers in Iraq reported on the work of Baghdad parks supervisor Jaafar Hamid al Ali, whose 'principle is, for every drop of Iraqi blood, we must plant something green' (Helphand 2009).

Perhaps it is not surprising that interacting with nature through gardening offers a means of resistance and resilience for individual soldiers and civilians during war, given the large literature on the therapeutic benefits of plant–people interactions (Markee and Janick 1979; People Plant Council 1993; Relf 2005; Relf and Dorn 1995), and more specifically on the therapeutic qualities of gardening to ease trauma and to aid the process of recovery in individuals stunned by a crisis (Hewson 2001; Miavitz 1998). Beyond the therapeutic value of plants and gardening per se, Kaplan and Kaplan (1989) and Ulrich (1983) have researched the role of green places, or restorative environments (Kaplan and Kaplan 1978), in easing trauma or discomfort (Campbell and Wiesen 2009; Kaplan and Peterson 1993). Furthermore, studies have pointed to the symbolic value individuals place on trees, treescapes, and other aspects of nature immediately after a catastrophe (Anderson 2004; Jones and Cloke 2002; Miller 1997; Perlman 1994). For example, in a study of Charleston, South Carolina after Hurricane Hugo, Hull (1992, 100) concluded: 'the role of urban forests as symbols of cherished meanings and memories needs to be emphasized as a major benefit deriving from urban forestry … Trees symbolize spiritual values, personal memories, reminders of the past, preservation and endurance.' Thus, plants as well as interacting with plants (e.g., through gardening, tree planting) appear to aid in resistance and resilience not only through therapeutic effects linked to psychology, but also through eliciting memories.

Thus far, we have used the terms resistance and resilience as in the fields of human development, disaster medicine, public health, and preparedness (see, e.g., Nucifora et al. 2007; Patton and Johnston 2001; Powley 2009). So, *resistance* refers to the ability of an individual, group, organization, or entire population to *withstand* manifestations of clinical distress, impairment, or dysfunction, and *resilience* to the ability of an individual, group, organization, or entire population to *rebound* from psychological perturbations, both in the context of critical incidents, terrorism, and mass disasters (Nucifora et al. 2007). However, similarities between constructs that frame resilience theory and research at the psychological level, as described above, and at the level of the social–ecological system (SES), suggest that research addressing the overlap between these two distinct bodies of work might lead to new perspectives or discoveries (Masten and Obradovic 2008, cf. Lundholm and Plummer 2010). One

possibility, and that which we pursue in this paper, would be to explore whether tree planting and other greening activities known to foster psychological–social resistance and resilience might also be a source of SES resilience.

By SES resilience, we mean the potential of a system to remain in a particular configuration and to maintain its feedbacks and functions, involving the ability of the system to reorganize following disturbance-driven change (see also Plummer 2010; Walker et al. 2002). More specifically, our paper focuses on the idea of reestablishing SES resilience by community greening processes that contribute to system memory, processes involved in 'regeneration and renewal that connect that system's present to its past' (Gunderson et al. 2002, 264). Expanding on work on ecosystem resilience, Adger (2000) suggests that learning, trust, and engagement are key components of social resilience. Further, Gunderson et al. (2002) state that social learning is critical to SES resilience, and is facilitated by recognition of uncertainties, by monitoring, and by assessment of the results of management actions by stakeholders.

Fundamental to this paper is the argument put forward by Berkes and Folke (1998) that systems that demonstrate resilience appear to have learned to recognize feedback, and therefore possess '*mechanisms* by which information from the environment can be received, processed, and interpreted' (21, emphasis added). In this sense, these scholars go further than simply recognizing that people are part of ecological systems, but attempt to explore the means, or social mechanisms, that bring about the conditions needed for adaptation in the face of disturbance and other processes fundamental to SES resilience. One such social mechanism extensively documented by Berkes and colleagues is traditional ecological knowledge (Berkes 2004; Berkes, Colding, and Folke 2000; Berkes and Turner 2006; Davidson-Hunt and Berkes 2003; see also Shava et al. 2010). In this paper, we ask: What other social mechanisms might exist and how does one identify and describe these mechanisms in post-disaster scenarios?

We propose that the greening and civic ecology practices described in this contribution can be viewed as 'tangible evidence of *social* mechanisms behind social-ecological practices that deal with disturbance and maintain system resilience' (Berkes and Folke 1998, 21–2). We draw on Berkes and Folke's (2002) argument that some SES build resilience through the experience of disturbance, but in order for this to occur sufficient memory in the form of both ecological and social sources for reorganization must be present. In particular, we focus on one type of memory that people often gravitate to with a sense of urgency in post-conflict and post-disaster situations, i.e., *memories of how greening activities and stewardship lead to healing*. Such greening activities are one form of *memorialization*, which has been described as:

> the process of creating physical representations or commemorative activities that concern events in the past and are located in public spaces … designed to evoke a specific reaction or set of reactions, including public acknowledgment of the event or people represented; personal reflection or mourning; pride, anger, or sadness about something that has happened; or learning or curiosity about periods in the past. (Brett et al. 2007, 1)

In post-conflict situations, we often observe a phenomenon called spontaneous memorialization, or 'a rapid public response to publicized, unexpected, and violent deaths, typically involving the accumulation of individual mementos to create a shrine at the death site' (Roberts 2002, 569). Although community greening represents a more persistent memorialization, similar to spontaneously created shrines, it invites

participation by anyone who wishes to express not only mourning over the deceased, but also grieving over the social pathologies that might have contributed to the conflict, disaster, and resultant deaths (Haney, Leimer, and Lowery 1997).

Harkening back to the questions raised about social mechanisms of SES resilience in post-disaster settings, in this paper we ask whether this acting on and manifestation of memories of healing through greening might represent a social mechanism not previously addressed in the resilience literature. Because this mechanism is associated with the act of memorializing those lost during the disaster or conflict, we refer to it as a *memorialization mechanism*.

Thus, in this paper we describe how memories of trees and other living things that have died or been left behind, or that in symbolic terms represent place, hope, life, and rebirth, seem to play an important role in resilience at multiple levels following disaster. In so doing, we draw on two examples: the Living Memorials Project post-9/11, and community forestry in New Orleans following Hurricane Katrina. Through these examples, we explore a hypothesis that we hope will provoke further discussion and research: civic ecology practices, including urban community forestry, community gardening, and other self-organized forms of stewardship of green spaces in cities (Tidball and Krasny 2007), are manifestations of how social and ecological memories can be instrumentalized through social learning to foster SES resilience following crisis and disaster. Further we propose that civic ecology 'communities of practice' (Wenger 2003; Wenger, Mcdermott, and Snyder 2002) that emerge within and across cities help to leverage these memories into effective practices, and that such communities of practice serve as urban iterations of the collaborative and adaptive management practices that play a role in SES resilience in more rural communities (Berkes, Colding, and Folke 2003b; Davidson-Hunt and Berkes 2003).

Collective memory, social learning, and resilience

Collective memory, a term first coined in 1925 by Maurice Halbwachs (c1925/1980), refers to representations of important shared experiences by social groups, ranging from families to communities to nations. They often form when groups encounter significant threats and adverse events or victories over adversity that get imprinted on the collective consciousness of a group (Kahana and Kahana 2006). Stories that contribute to collective memory may contribute to social dialog by assisting in the creation of common values among citizens (Osiel 1999). Such collective memories have been described by Emile Durkheim (c1933/1964) as collective conscience because of their role in forming, maintaining, or reinforcing group identity. Shared values may emerge from collective memories and also shape how collective memories are represented (Sicher 2001).

Berkes' (2004) description of Cree hunters is consistent with notions of collective memories, and links such memories to SES resilience. In the early part of the last century, hunters, armed with newly available repeating rifles, slaughtered hundreds of caribou, following which the caribou herd disappeared from Cree hunting land. Seventy years later, the caribou reappeared, but were slaughtered again by younger members of the community who did not have memory of the disastrous events two generations earlier. The following winter, meetings were called at which elders retold the story of the 1910 disaster. The elders' retelling of unethical hunting practices and subsequent collapse of the caribou herd led to more sustainable practices among younger Cree hunters (Berkes 2004).

According to Berkes, Colding, and Folke (2000), such collective memories play a role in the ability of an SES to respond to crisis, and thus may be one source of SES resilience. Further, when shared through social learning processes, such memories are particularly important after a major perturbance or disaster 'flips' a system into a less desirable state, and the system is in the reorganization and rebuilding phase of Holling's (1973, 1986) adaptive cycle (Berkes and Folke 2002; see also Plummer 2010). In addition to social memories, ecological memories, such as seed banks and remnant populations that provide the biological materials needed for recolonization of ecosystems, are critical in the rebuilding phase of the adaptive cycle. In the case of the Cree, remnant caribou populations in neighboring territory represented a form of ecological memory, which served as a biological reservoir for recolonization following earlier overhunting (Berkes and Folke 2002). Similarly, Gadgil, Hemam, and Reddy (1998) and Gadgil et al. (2003) have described how communities in more densely populated regions set aside sacred forests as a source of ecological memory (e.g., seeds, animals, and other forms of genetic material for recolonization in the event of a crisis).

In the case of the Cree, collective memories were transmitted through a number of social learning processes, including storytelling by elders, rituals, and ceremonies, as well as apprenticeships in which novices learn alongside more experienced resource users (e.g., hunters, fishermen). Through such processes, learning at the individual level became distributed throughout the community, and thus was scaled up to the level of communities, organizations, and institutions (Berkes, Colding, and Folke 2000).

Scholars of social learning have variously used the term to refer to learning that occurs through imitation of role models and social interaction (Bandura 1977) and through iterative feedback between learners and their environment resulting in changes in both (Barab and Roth 2006; Chawla 2008; Greeno 1998; Pahl-Wostl 2006). In the context of resource management, Pahl-Wostl et al. (2007) suggest that movements from individual 'multiple cognitions' to interrelated 'distributed cognition,' and to understanding of group processes, are required to fully understand social learning. Learning concepts applied beyond solely individuals to whole social entities can be found in the field of organizational learning (Argyris and Schön 1996; Senge 1990; Wenger 1998a; see also Lundholm and Plummer 2010). As Pahl-Wostl et al. (2007) argue, such concepts emphasize the development of shared meanings and practices, often aimed at changing resource management policy (Blackmore, Ison, and Jiggins 2007). To these, we would add shared memories, which may form the bases for certain resource management practices, which in turn are shared and learned through a stewardship or civic ecology community of practice (Wenger, Mcdermott, and Snyder 2002).

In the context of natural resources management, Pahl-Wostl et al. (2007) further suggest that social learning results from an interplay among three elements: context formed by a given governance and physical system, process formed by the actual management practices, and a series of outcomes that feed back into the original context as changes in the institutional and environmental systems. Scholars of adaptive co-management (cf., Plummer 2009) emphasize these feedbacks or management outcomes in their definition of social learning as a collaborative process among multiple stakeholders aimed at addressing management issues in complex systems (Blackmore, Ison, and Jiggins 2007; Pahl-Wostl et al. 2007; Schusler, Decker, and Pfeffer 2003). Components of social learning that we find most relevant to the case

examples below include engagement in communities of practice and feedback to other parts of the SES through actions to address problems that are identified during the learning process.

Given the importance of cities to global sustainability, exploring resilience processes not only in rural indigenous communities like the Cree, but also in urban SES is important. We contend that civic ecology practices, or people joining together with neighbors to plant gardens and trees and otherwise restore small plots of land and watersheds in cities (Krasny and Tidball 2010; Tidball and Krasny 2007), can be a manifestation of linked social–ecological memory and when drawn on in times of crisis act as social mechanisms in SES resilience. Further, social learning that shares such memories may serve to foster adaptive capacity, which can be leveraged during the rebuilding phase post-disaster.

Greening examples from urban post-catastrophe settings

Though people do not have the ability to decide what is destroyed by a disaster, they do have the ability to decide what is reconstructed (Miller and Rivera 2007). Therefore, that which is reconstructed, like green spaces or an urban forest, symbolizes the cultural, social, and political ideals that the society values and wants to transmit (Baker 2003; Foote 1997), to which we add ecological ideals. We next present two examples of civic ecology practices post-catastrophe that exemplify the linkage between cultural, social, political, and ecological ideals, and provide evidence for our contentions about memory and learning. These examples draw on interviews conducted in confidentiality, and the names of interviewees are withheld by mutual agreement.

Living Memorials Project: greening responses to loss of life on September 11

The Living Memorials Project was created by the U.S. Forest Service at the request of Congress following the September 11, 2001, terrorist attacks in New York City (NYC). It was both a program to support the creation of landscape-based memorials as well as a research initiative to understand changes in the use and stewardship of trees and open space following the terrorist attacks. A total of 687 Living Memorial sites across the USA were mapped from 2001 to 2006, and interviews were conducted with memorial stewards in 113 projects to better understand open space and community involvement as a response to disaster (Svendsen and Campbell 2005).

Living Memorials varied greatly in form, from single trees to small forests, from underwater seamounts to bonsai trees, and involving the rededication of existing natural or open space and the creation of new open space. They were planted on the grounds of cemeteries, town greens, hospitals, libraries, churches, homes, sidewalks, and existing community gardens; and honored individual victims as well as more generally the nearly 3000 who perished in the 9/11 terrorist attacks. Spatially, the greatest density of memorials was in the NYC metropolitan area, with other clusters along the eastern sea coast and California. In states that did not contain crash sites, the state capital or largest city commonly served as a memorial site. Living memorials generally reflected the resources, attitudes, lifestyles, and cultures that were endogenous to a place. Overall, when stewards were asked about the purpose of their living memorial, 25% said that they wanted to promote stewardship and community

engagement, and 48% said they would hold events related to community stewardship and management at the site (Svendsen and Campbell 2005).

As the name Living Memorials implies, social and ecological memories were seen to blend in the act of memorializing loss. For example, the creator of the Sunflower Project in NYC related that:

> The official September 11 memorial in New York City will not be in place any time soon. We felt something should be in place – not just at Ground Zero, but everywhere. There is a power and healing that comes with digging in the dirt, planting new life and nurturing its growth. It also grows community. Sunflowers are easy to grow, and brighten up the most forgotten, neglected places. Like New Yorkers, sunflowers are tenacious, surviving and thriving in adverse conditions. Sunflowers improve the ground and air where they grow, attracting birds and butterflies. They make sense as one tall way to remember life and make it a bit better – it's hard not to look up in their presence.

Several mechanisms emerged to foster social learning within and across Living Memorials sites. For example, in the Bronx, NYC, residents held a Sustainable South Bronx Living Memorial Trail Community Design Meeting to plan their site. The Living Memorials website facilitated learning across sites by posting descriptions and photographs of all sites across the US, as well as by creating a toolbox to assist individuals in navigating the social, biological, and physical challenges of developing a Living Memorial.

Figure 1. Corporate and community volunteers organized by the New Jersey Tree Federation plant memorial trees at the New Jersey Grove of Remembrance in Liberty State Park in Jersey City, NJ. Photo reproduced courtesy of Living Memorials Project National Registry.

Figure 2. Neighborhood residents participate in a community forestry street tree planting coordinated by Groundwork Yonkers in Yonkers, NY. © Erika Svendsen.

Figure 3. Volunteers from Greening for Breathing create the Living Memorial Trail in the Hunts Point neighborhood, Bronx, NY. Photo reproduced courtesy of Living Memorials Project National Registry.

New Orleans: trees and rebirth after Hurricane Katrina

Hurricane Katrina made landfall in New Orleans on 29 August 2005. New Orleans endured weeks of inundation and devastation, and months of disorganized recovery efforts. Yet despite media reports portraying New Orleans as paralyzed and helpless, or even worse descending into chaos, ordinary citizens were observed planting and caring for trees in neighborhoods across the city. Within four years after the disaster, three local NGOs, Parkway Partners, Hike for KaTREEna, and Replant New Orleans, worked with community volunteers and government agencies to plant over 6000 trees in hard hit areas. Interviews conducted by the first author (Tidball) with volunteers in the devastated 9th Ward and other New Orleans neighborhoods, and with leaders of local NGOs, revealed how trees and replanting trees were critical in bolstering people's resolve to rebuild their lives, and how memories of the live oaks and other trees that had been symbolic of New Orleans as a place to live became a symbol of hope for re-growth of the city and of their lives.

Echoing the learning through memory experiences of the indigenous communities observed by Berkes, Colding, and Folke (2000), some neighborhoods described the importance of their post-Katrina tree planting in terms of memories of errors in natural resource management from previous generations and the community's desires to learn from those mistakes. This was especially true in the neighborhood called Treme, which was first developed in the early nineteenth century.

Claiborne Avenue runs through the Treme neighborhood. Historically, Claiborne Avenue boasted a wide 'neutral ground' lined with old and stately live oak trees, and the public green space is said to have been used as a community gathering place for the area's mostly African-American residents. The construction of an elevated highway through the Treme neighborhood above the oldest section of Claiborne Avenue

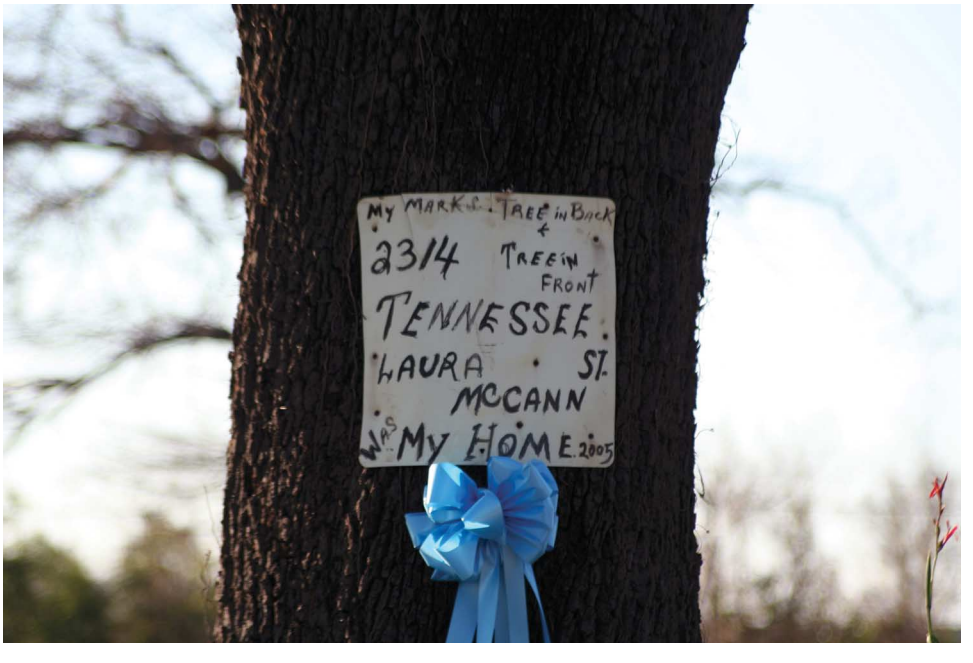

Figure 4. A tree marks the boundaries of home, all that remained after Hurricane Katrina destroyed most of the Lower 9th Ward in New Orleans. © Keith G. Tidball.

in the late 1960s is widely thought to be one of the most, if not the most, controversial development in the history of New Orleans, pitting residents of the French Quarter and preservationists against Treme residents. After construction, poorly lit cement parking lots under the freeway replaced the grassy neutral ground, and concrete supports for the highway replaced oak trees. Construction of the overpass contributed to the overall decline of the Treme neighborhood in the 1960s and 1970s (Rogers 2009). In 2002, as part of the 'Restore the Oaks' art installation, the outer freeway columns were painted by artists to memorialize the live oak trees that once stood on both sides of Claiborne Avenue.

After Katrina in 2005, residents of the Treme neighborhood urgently and vigorously began planting trees. During interviews with members of post-Katrina tree planting groups in Treme, it became clear that memories of the Claiborne Avenue highway development and subsequent loss of trees and neighborhood function were playing a large role in present day post-Katrina actions. A community elder recounted:

> I am going to go further back (than Katrina) … We lost something … we had these big majestic oaks that city planning and everyone else saw fit to uproot. Along with those oaks we had inherited businesses. So that's the legacy that's lost. So, these trees (we are planting) might be a reminder of what we lost, so that we don't ever forget it and don't let that happen to us again, as well as kind of light a fire under us to ensure that we won't have to worry about a legacy being lost (due to Katrina). (Treme community member and tree planter, January 19 2009)

Another community elder related:

> We remember, just about five short blocks from here, we have Claiborne Avenue, which was a beautiful corridor of oak trees that, it's unfortunate, but the government came through with the interstate, and they knocked all the trees down … it destroyed the neighborhood; by destroying two hundred or three hundred year old trees, they destroyed the neighborhood. We need to do the opposite of that. (Treme community leader and tree planter, January 19 2009)

Professional urban foresters corroborated these accounts of community members who seemed to invoke a kind of local knowledge in the planting of trees as a symbol of the broader rebuilding phase in New Orleans:

> I know that efforts to repair and reconstruct the urban forest canopy of the communities affected by hurricanes Katrina and Rita have been an important aspect of recovery for individuals in our area. The ability to help in these efforts by direct involvement, be it planting activities or whatever, has been important to give people the feeling that they have a contribution to give. But, I know this on an anecdotal level. There is no research that attempts to quantify or verify this important sense of stewardship that has arisen in our populace. Members of our community that direct these types of activities know this and have responded with vigor to afford people the opportunity to be involved. Disaster recovery officials however do not seem to have this on their radar. This is an important breakdown that, hopefully, can be addressed. (Professional Urban Forester, Louisiana)

Volunteers participating in the tree planting events were able to learn from each other and from more experienced tree planters. For example, the NGO Parkway Partners trained citizen 'Tree Troopers' to aid in the replanting and tree care efforts. Similar to what occurred in the Living Memorials Project, opportunities for cross-site learning were created, as when trained Tree Troopers were called upon to go to other

neighborhoods to train additional tree planters. Tree Troopers spoke of how sharing their skills contributed to the rebuilding of New Orleans:

> I have taken trees and so many other things for granted before the storm; I guess you don't appreciate what you have until it is gone. Planting trees now will give future generations an environment they can appreciate and makes me feel like a part of something way bigger than myself. (Parkway Partners 'Tree Trooper' volunteer, May 19 2009)

Memory in civic ecology practices post-disaster

Similar to memory and learning within the context of adaptive management in rural and indigenous communities (Berkes, Colding, and Folke 2000), in these urban post-disaster settings, community members acted on individual and collective memories of stewardship practices and their impacts, and shared their actions through processes of social learning. Further, similar to the remnant caribou populations of the Cree, the community gardens and other green spaces that were present prior to 9/11 and were converted into Living Memorials, as well as trees that survived the New Orleans hurricanes and served as a source of biological material for tree growth and replanting, constitute a kind of ecological memory. However, a number of important differences exist between the management practices, memory, and learning in the rural examples from the literature and these urban post-disaster scenarios.

Examples in the social–ecological resilience literature focus largely on communities that directly depend on natural resources for their livelihoods, whether they be hunting communities in northern Canada (Davidson-Hunt and Berkes 2003) or fishing communities in Southeast Asia (Armitage, Marschke, and Plummer 2008). In these settings, memories held by elders and knowledge held by experienced resources users play an important role in managing the wildlife or fisheries resources. In the urban settings, memories of specific planting practices may come from engaging in such practices prior to disaster, or from before urban residents moved to the city. (Many urban residents are migrants from rural areas of the USA or immigrants from developing countries to the USA (Dodson and Diouf, n.d.; New York City Department of City Planning 2004), and may hold memories of farming from their childhood.) Further, even though urban residents are not dependent on gardens or trees for their livelihoods, they still may have a positive psychological dependence on green spaces (Stedman and Tidball 2008) as would be suggested by research cited earlier on the role of greening in psychological resilience (Taylor et al. 1998; Taylor, Kuo, and Sullivan2001; Ulrich 1983).

However, in describing social mechanisms for feedback that is critical to SES resilience, we are not only interested in the memories of agricultural or resource management practices per se. Rather we are interested in the role of memorialization, evidenced in a kind of spontaneous or 'urgent' return to greening, as one component of a social feedback mechanism that also includes social learning (see below).

Drawing on the notion of biophilia put forward by E.O. Wilson (1984), Tidball and Krasny (forthcoming) has coined the term 'urgent biophilia' to suggest that greening as a post-disaster response may be in part attributable to human evolutionary memory, or a genetic and culturally learned affinity of humans for other living beings. While acknowledging the provocative nature of any claims about biophilia (Allen et al. 1975; Lewontin, Rose, and Kamin 1984; Segerstråle 2000), we find the notion that stewardship of green spaces might be in part an expression of evolutionary memory

in humans useful in explaining these spontaneous and self-organized stewardship behaviors post-trauma. The notion of urgent biophilia may play a role in resolving contradictions resilience scholars face in trying to integrate social and ecological processes related to memory at multiple scales (Gunderson, Holling, and Light 1995). Because humans are organisms, by focusing on human evolutionary memories, we may be able, at least heuristically, to blur the distinction between social and ecological memories; in other words, an urgent biophilic memory suggests an integration of human (social) and ecological/biological (genetic) processes.

Social learning in post-disaster civic ecology practices

According to Wenger (1998b), communities of practice are formed by people who engage in a process of collective learning in a shared domain of human endeavor. Such an endeavor may be subsistence hunting among indigenous communities or civic ecology practices in cities, both of which can be viewed as forms of adaptive and collaborative management. Put another way, communities of practice are groups of people who share practice and who learn how to improve and expand that practice as they interact regularly. A community of practice defines itself along three dimensions (Wenger 1998b): its *joint enterprise* as understood and continually renegotiated by its members (in our case, gardening and tree planting as response to disaster); *mutual engagement* that binds members together into a social entity; and *shared repertoire* of communal resources that members have developed over time (in our examples, the spaces and living things within the spaces, including live oak seedlings and trees, symbolism around these trees, experiences, ideas, stories, memories, tools, commitments, and ways of addressing recurring problems (Smith 2003, 2009; Wenger 1998a). Communities of practice can be seen as self-organizing systems and share many of the benefits and characteristics of associational life, such as the generation of social capital (Putnam 2000; Smith 2003, 2009). Learning can be the reason the community comes together and thus be intentional, or an incidental outcome of members' interactions. The Living Memorials and New Orleans post-disaster greening communities of practice are not intentionally designed around learning. Rather, they begin when people gravitate, often urgently and spontaneously, toward a greening response to disaster. Learning at first is unintentional, occurring largely through informal observations and social interactions. With time and more formal development of these post-disaster communities of practice, learning may become more formalized, as in the New Orleans example of volunteer Tree Troopers being trained and helping others to plant trees. Other types of learning may occur, for example, about the power of collective action to protect community gardens and trees in the face of subsequent commercial, highway, and other forms of economic development. This learning, as well as learning about the trees and the ecosystem services that they provide, has important implications for designing environmental education programs that are situated in stewardship practice (Krasny and Tidball 2009b; Krasny, Tidball, and Sriskandarajah 2009; see also Krasny and Roth 2010).

The Living Memorials and New Orleans tree planting communities of practice are important not only for the learning that occurs among participants in these communities, but also for the potential impact this learning has on the larger SES. The process starts with an urgent or spontaneous desire to plant gardens or trees, perhaps due to an individual or collective memory, initiated in some cases by a symbolic process in the

form of a memorial or a related social memorialization mechanism. Next, through the social learning processes of observing and sharing practice and reflection, members of the gardening or tree planting community of practice expand their shared repertoire from planting to encompass advocacy and an understanding how they, as humans, can enhance local biological diversity and ecosystem services. In using this learning to inform their planting and broader environmental and civic engagement practices, it becomes a source of feedback to the larger Living Memorials or urban community forestry system, suggesting new ways in which NGOs, volunteers, and governments might adapt their management practices. Such feedback is a critical component of adaptive management (Berkes, Colding, and Folke 2003b) and a source of SES resilience (Walker and Salt 2006). Thus, through facilitating adaptive management process, as well as through the social connectedness that builds among the tree planters and other civic ecologists, these processes may confer resilience on the urban SES (Pahl-Wostl et al. 2007; Tidball and Krasny 2008). It is possible that some cases, the critical role of this greening memorialization mechanism and related civic ecology practices, not only in healing post-disaster but more broadly in fostering urban sustainability, are being recognized by NGOs and government leaders well beyond the original spontaneously formed communities of practice (for example, in the MillionTreesNYC tree planting initiative, PlaNYC 2009).

Conclusion: social learning and environmental education

Given the importance of both social and ecological memories in allowing an SES to 'exercise problem-solving skills, innovate, and adapt' in the face of catastrophic and other forms of change (Berkes, Colding, and Folke 2003a), and that a collective memory making process ensues following disaster to frame and historicize what has just occurred (Neal 1998), we have set out to explore the role of memory in post-disaster settings. In particular, we have examined how a recollection that the decision to turn to stewardship activities like community gardening and community forestry will increase individual and community well-being, is acted on, and becomes a source for both psychological–social and SES resistance and resilience following disaster. Further, we have suggested that civic ecology practices are manifestations of how social and ecological memories can be instrumentalized through social learning and communities of practice to foster SES resilience following crisis and disaster. Finally, we have proposed that civic ecology communities of practice serve as urban iterations of the collaborative and adaptive management practices that play a role in SES resilience described in more rural communities (Berkes, Colding, and Folke 2003b; Davidson-Hunt and Berkes 2003).

According to Carpenter and Gunderson (2001), 'education at many levels, ranging from K-12 environmental education to outreach programs for adults, may contribute to the collective learning or social flexibility needed for adaptive management' (457). However, in contrast to extensive scholarship on memory and social learning, the role of more formal education has not been widely explored in the resilience literature (for exceptions, see Krasny and Tidball 2009a, 2009b; Krasny, Tidball, and Sriskandarajah 2009). One explanation for this gap may be that formal education practices often contradict the self-organization, multiple forms of knowledge and governance, and other tenets of the resilience framework (see Plummer 2010). However, in a democracy, not only the direct resource users but also citizens far distant from the resource have a voice in determining resource management

practices. Furthermore, in urban and other more populated landscapes, learning as part of ongoing practice, such as occurred in the case of the rural Cree, may only be possible as part of an educational intervention that brings together youth with knowledgeable elders.

The self-organized stewardship communities of practice described here may provide a context for engaging young people in learning through informal participation and more formal environmental education programs (Krasny and Roth 2010; Krasny and Tidball 2009b; Sriskandarajah et al. 2010), and thus help to transmit memories of greening as a source of healing, which in turn become a mechanism for conferring SES resilience. Although largely absent from the literature on individual-level resilience in children (see, e.g., Clauss-Ehlers and Weist 2004; Waller 2001), evidence from studies reviewed by Louv (2006) suggests that opportunities for children to engage in nature stewardship alongside more experienced adults could promote both children's and adult's emotional well-being as well as environmental learning and stewardship. In short, such stewardship-based environmental education programs would be expected to foster SES resilience indirectly through building the agentive capacity and technical skills of participants, and directly through participants' stewardship actions leading to increased post-catastrophe ecological service provision. Thus, future work on civic ecology and resilience in post-catastrophe contexts may consider expanding a focus on social and ecological memories and adult social learning to incorporate educational programs that engage youth in these greening, or adaptive co-management, communities of practice.

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