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RESEARCH ARTICLE

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## Educating with resilience in mind: Addressing climate change in post-Sandy New York City

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### ABSTRACT

How educators adapt their programs following a climate related disturbance can provide insights into potential climate education practices. Therefore, we used semi-structured interviews to explore changes in environmental education practice in NYC following Hurricane Sandy. Educators adopted new language to reflect funding opportunities and incorporated new practices and collaborations, including those focused on resilience. Educators' resilience practices reflected the psychological, community, ecological, and social-ecological systems resilience academic literature. Overall practice changes appeared to be adaptive, although some educators reflected more deeply about transforming their practice. Our findings point to the need for further exchange among practitioners facing climate-related disturbance, and between practitioners and researchers, to facilitate co-production of EE practice innovations that address climate change.

### KEYWORDS

environmental education;  
urban; resilience; disaster;  
climate change, practice  
theory

### Introduction

Environmental education (EE) practices have evolved over the past 100 years in response to societal and environmental change. For example, an early focus on nature study was a response to rural-urban migration and resultant loss of opportunities for children to learn in nature (Bailey, 1909; Comstock, 1911), and following the devastating droughts of the 1930s Dust Bowl, EE incorporated conservation education (Disinger, 2001). EE further expanded in the 1960s and 1970s as concern about pollution spurred problem-solving and praxis pedagogies (Stapp, 1969; Stapp, Wals, & Stankorb, 1996; Sauvé, 2005), and more recently EE has incorporated environmental justice (Bowers, 2002), youth development (Schusler & Krasny, 2010), and democratic participation (Reid, Jensen, Nickel, & Simovska, 2008), among other approaches. Despite these and other changes, EE practitioners and researchers have maintained interest in factors that foster pro-environmental behaviors and related decision making.

Today we are grappling with a new set of disturbances—those brought about by climate change. Two related questions arise: How are EE practices evolving in response to climate change? And as they evolve, how are practices addressing the need for climate adaptation, while maintaining a focus on reducing our environmental footprint more consistent with climate mitigation (Krasny & DuBois, in revision)?

Because flooding, drought, and other disturbances are a manifestation of climate change impacting communities around the world, one way to address questions about how EE is changing is to explore EE programs in places that have experienced significant disasters. Thus, in this study, we address questions about EE response to climate change in the context of EE programs in a city that experienced massive flooding and loss of life as a result of a climate related disaster. More specifically we asked: What, if any, new practices did EE programs in New York (NYC) adopt following Hurricane Sandy? We hypothesized that given the devastating impact of Hurricane Sandy, EE programs would alter their message and approach. Further,

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given the intense media and political attention to climate change generated by the storm, we posited that the program modifications would involve critical reflection about the effectiveness of current EE approaches in addressing the scale and immediacy of climate change, and thus would be transformational, similar to how conservation education emerged as a new form of EE following a devastating drought.

The concept of psychological resilience is important to understanding individuals' recovery from trauma, whereas social-ecological systems and other forms of resilience help us understand how larger communities and systems respond and transform in light of disturbance (Krasny, Lundholm, & Plummer, 2010). In our examination of EE programs in NYC, resilience emerged as a common term used by educators when referring to EE curricula and practice post-Sandy. However, it was unclear what the NYC educators meant by resilience. Because resilience is an important construct in multiple disciplines, but little is known about its application in EE practice, we added a second question to our study: How did NYC environmental educators define and apply resilience in their EE practice after Hurricane Sandy? While recognizing that we report on only one example of post-disturbance EE practices in one city, we hope that the lessons learned will shed light on possible roles for EE in addressing climate change beyond education focusing narrowly on climate science.

## Literature review

We next present an overview of the use of the term resilience and of previous resilience scholarship in EE.

### Resilience

In the early 1970s, psychologists began exploring how a subset of people who faced extreme hardships were able to live productive lives, in part by drawing on positive emotions rather than focusing on problems, a phenomenon researchers labeled psychological resilience (Luthar, Cicchetti, & Becker, 2000; Bonanno, 2004). Research has demonstrated the importance of emotion- and problem- focused coping strategies in psychological resilience (Compas & Epping, 1993), and that people respond to stress through primary control efforts to problem solve, secondary control efforts to cognitively adapt to stress, or by disengaging from coping through denial (Wadsworth et al., 2004). Focusing on greening in post-disaster settings such as the aftermath of hurricanes, Okvat and Zautra (2014) argue that positive emotions are particularly important in resilience. They applied the Dynamic Model of Affect to suggest that engagement in community gardening enhances positive emotions, cognitive capacity, and community engagement, and thus plays a role in reducing distress and fostering psychological resilience. Further, Ingulli and Lindbloom (2013) demonstrated a correlation between feelings of nature connectivity and self-perceived psychological resilience among some populations. Given that EE commonly incorporates nature stewardship activities, such as community gardening (Krasny & Tidball, 2009), as well as time spent in nature that may lead to nature connectivity (Mayer, Frantz, Bruehlman-Senecal, & Dolliver, 2008), EE could play a role in psychological resilience.

In addition to psychology, other disciplines use the term resilience including ecology (Holling, 1973), sociology (CARRI, 2013), engineering (Holling, 1996), and important to EE that incorporates social and environmental learning, social-ecological systems (SES). SES resilience gained popularity among ecosystem scientists at the turn of the 21st century as an alternative to notions of sustainability and to the problems of managing for a steady state (Berkes, Colding, & Folke, 2003). Scientists led by Carl Folke of Stockholm University proposed that because systems face ongoing small as well as larger changes, actually managing for change in forest, marine, urban, and other SES would lead to more favorable environmental and social outcomes (Folke et al., 2002). Further, Folke and colleagues' notion of resilience incorporated adaptation to small changes as well as transformation in systems that have crossed thresholds following major catastrophes. Important to EE, SES resilience emphasizes the role of learning and of adapting or transforming practices based on what is learnt about the outcomes of various management schemes (Berkes, 2004; Armitage, Marschke, & Plummer, 2008). (See Table 1 for resilience definitions.)

**Table 1.** Resilience definitions from the academic literature.

Type of Resilience	Definition
Community	The ability of communities to cope with and recover from external stressors resulting from social, political and environmental change (CARRI, 2013)
Ecological	The magnitude of disturbance that a system can experience before it moves into a different state with different controls on structure and function (Holling, 1973)
Engineering	Rate at which a system approaches steady state following a perturbation (Holling, 1996)
Psychological	The processes of, capacity for, or patterns of positive adaptation during or following exposure to adverse experiences that have the potential to disrupt or destroy the successful functioning or development of the person (Masten & Obradovic, 2008)
Social-Ecological Systems (SES)	The capacity of a social-ecological system to continually change, adapt, or transform so as to maintain ongoing processes in response to gradual and small-scale change, or transform in the face of devastating change (Berkes, Colding, & Folke, 2003)

Academics are not the only ones offering definitions of resilience; international agencies and governments addressing disaster have adopted the term. For example, the United Nations International Strategy for Disaster Reduction defines resilience as: “ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions” (UNISDR, 2007). Another definition comes from a report created by former Mayor Bloomberg’s Special Initiative for Rebuilding and Resiliency, which defines resilient as: “1. able to bounce back after change or adversity; 2. capable of preparing for, responding to and recovering from difficult conditions;” or simply “tough” (NYC, 2013). Finally, Norris, Stevens, Pfefferbaum, Wyche, and Pfefferbaum (2008) point out that resilience is not only an outcome but also a process that leverages adaptive capacity to respond to continual disturbances, and is thus a counterpoint to vulnerability and processes of persistent dysfunction.

### **Resilience and environmental education**

Given the importance of psychological, community, ecological, and SES resilience in human development and environmental management, it is important to explore the connections of resilience to EE. In a special issue of the journal *Environmental Education Research*, Krasny, Lundholm, and Plummer (2010) suggest four ways in which EE overlaps with resilience:

- EE and environmental learning can foster attributes of resilient SES (cf. Walker & Salt 2006) including social capital (Krasny, Kalbacker, Stedman, & Russ, 2013), and adaptive and collaborative resource management (Krasny & Roth, 2010, Tidball & Krasny, 2011, Monroe & Allred, 2013).
- EE organizations can become part of larger governance systems. Polycentric governance systems, which involve collaborations of government agencies with non-profit and community organizations, offer more options for addressing social and environmental change (Ostrom, 2010).
- Resilience suggests a “way out” of EE’s instrumental/emancipatory split—that is, the controversy over whether EE is an instrument to promote behavior change and environmental improvement or a means to foster critical thinking and empowerment. This is because EE programs can foster SES resilience and psychological resilience simultaneously (cf. Wals, Geerlin-Eijff, Hubeek, van der Kroon, & Vader, 2008; Sterling, 2010).
- Parallels among concepts from learning theory and SES resilience may contribute to badly needed cross-disciplinary approaches to address linked social and environmental problems. For example, learning theory suggests that discrepant or unexpected events foster transformational learning (Mezirow, 2000; O’Sullivan, 2002; D’Amato & Krasny, 2011), and SES resilience suggests that major disturbances can spur new approaches to environmental management (Gunderson & Holling, 2002) and EE (McPhearson & Tidball, 2013).

Despite the scholarly literature on resilience and EE, little is known about how environmental educators are applying notions of resilience to their practice after climate catastrophe like Hurricane Sandy.

## Methodology and methods

We draw on practice theory, which provides a middle ground between a focus on individual agency and a focus on structure (Schatzki, 2000), in our exploration of EE post-disturbance. We view new practices that emerge following or in response to disturbance as practice innovations (Biggs, Westley, & Carpenter, 2010), which entail new ways of combining existing meanings, skills, technologies, and social relationships (Pantzar & Shove, 2010; Kemmis & Mutton, 2012). Applying practice theory enables us to explore how practices that incorporate environmental learning, rather than EE programs more narrowly, change in response to disturbances such as those related to climate change. In our definition of EE practices, we draw on the social learning literature in the context of environmental management, which suggests that in addition to programs officially designated as EE, environmental learning occurs among those engaged in resource management practices (Blackmore, Ison, & Jiggins, 2007) and that this embedded learning is one form of EE (Krasny, Tidball, & Sriskandarajah, 2009). Thus, in identifying our study sample, we defined EE broadly as encompassing both structured EE programs taking place in parks, nature centers, schools, and summer youth programs, as well as learning embedded in activities such as hands-on stewardship (e.g., community gardening, oyster restoration), recreation and demonstrations (e.g., bike rides with an educational theme), and community engagement in disaster planning and response (cf. Krasny, Lundholm, Lee, Shava, & Kobori, 2013).

As described in detail in the next section, we used a snowball sampling scheme to identify EE practitioners who had experienced a climate-related disaster. We then used qualitative interviews to learn from educators how they were changing their practice and the patterns of meanings in their constructions of resilience. Because our larger purpose is to help the field of EE understand potential practice innovations in light of the scale and immediacy of climate change, we were less concerned with a representative sample of educators or quantitative data; rather, we employed methods that would generate insights into the types of changes possible. Our interest also was in understanding educators' meanings of resilience as social constructions and social representations, and how they were interpreting and applying scientific resilience frameworks in everyday practice (Moscovici & Markova, 1998). Because we relied as much as possible on the participants' views and sought to inductively develop a pattern of meaning regarding those perspectives, our epistemology most closely resembles constructivism/interpretivism using a grounded theory methodology (Creswell, 2013). We sought to identify and label where relative consensus had formed around a construction (Guba & Lincoln, 1994), in this case resilience.

The following text reviews methods and findings of Study 1, which addresses the question: What, if any, new practices did EE programs in NYC adopt following Hurricane Sandy? We next review methods and findings of Study 2, which addresses the question: How did NYC environmental educators define and apply resilience in their EE practice after Hurricane Sandy?

## Study 1. Methods

### Study organizations

Lacking a database that inventoried EE programs after the hurricane, we initially identified study organizations through selective sampling of 796 stewardship organizations in the U.S. Forest Service STEW-MAP database (Svendsen and Campbell n.d.), the majority of which engage in some form of EE (Svendsen & Campbell, 2008), which were likely to have seen physical damage from Sandy or whose participants would have been impacted by the storm (e.g., lower Manhattan residents were more impacted than Bronx residents). We also attempted to sample the large environmental organizations in NYC, such as The Nature Conservancy, along with the most networked organizations that were identified through STEW-MAP (Campbell, 2014) such as GreenThumb. We pursued additional

informants through the Environmental Education Advisory Council of NYC and through snowball sampling where initial interviewees were asked to identify organizations that may have adapted their work post-Sandy. Our final sample of 44 organizations was purposefully skewed to capture the organizations most likely to have made changes in their programs post-Sandy based on the above criteria, and thus is not a representative or random sample of all organizations that conduct EE in NYC.

The first author contacted programs and requested interviews with the environmental educator or the best person to speak about EE. For each organization, he interviewed one educator or program leader, with the exception of two organizations that deemed it necessary to speak with more than one person to gain a comprehensive understanding of their program changes. In these cases, we conducted interviews with three staff members but combined interviewee responses in reporting results.

### **Data collection**

We used a semi-structured interview protocol to conduct interviews in-person or by phone when necessary. The interview questions focused on the organizations' typical work and on changes in the type of work, sites where work was conducted, messages conveyed through their programs, and any other changes in their work as a result of Hurricane Sandy. Interviews took place 12–16 months following the hurricane.

### **Data analysis**

We first coded all transcripts for instances where interviewees talked about changes that they made in the content (e.g., incorporated examples of resilience in their educational materials) or practices (e.g., created new stewardship activities) (Miles & Huberman, 1994; Braun & Clarke, 2006). We then used descriptive coding to categorize emergent codes related to these changes (Saldaña, 2013). Both authors coded the interviews separately and subsequently compared and discussed codes until consensus was reached regarding the final themes that most accurately and parsimoniously captured practice change categories across all organizations (Bradley, Curry, & Devers, 2007).

### **Data validation**

The first author conducted field visits and participant observation to ground-truth findings, and asked interviewees to review the initial findings. We received feedback from 39 programs and in all cases where study participants made changes, they indicated addressing more practice change codes (e.g., reinforce existing content, see Table 2) than we had assigned to their organization. Although we use the higher numbers in reporting, the trends in frequency of types of changes were similar to those generated by researcher coding only.

## **Study 1. Findings**

### **Organizational profiles**

Consistent with our broad definition of EE programs as encompassing both formal EE and environmental learning opportunities embedded in stewardship action, most organizations (28/44) have an explicit EE focus, and nearly half include environment-focused community engagement (21) and/or hands-on stewardship and restoration (19). Others engage in environmental advocacy (18), conservation (16), community planning or design (11), science and research (9), recreation (6), waste or energy (5), youth development (5), and disaster relief (2).

### **Response to Hurricane Sandy**

All but one organization implemented changes in their EE and related stewardship programs and/or implemented organizational changes in response to Hurricane Sandy. The most common practice

**Table 2.** Example program content and organizational changes in NYC environmental education and stewardship organizations after Hurricane Sandy.

<b>Changes in Program Content</b>
<i><b>Reinforce Existing Content</b></i>
Green Map, which engages people in participatory mapping of environmental features, created maps showing Hurricane Sandy high water lines and damage in NYC, and conducted bike tours of Sandy-impacted sections of lower Manhattan.
Queens Botanical Garden, which prior to the storm taught third graders about energy, adapted their lessons to incorporate the children's personal experience of losing power and awareness of how their power was produced and transported. Similarly, this organization adapted its wetlands lessons to use Sandy as an example of the importance of planning for wetlands and for water and sewer management.
Trees New York used their network of citizen pruners to gather data about tree health to report to city contractors engaged in forest restoration, and advocated for use of structural pruning as a way to limit tree damage during severe weather events.
<i><b>Stewardship/Restoration Activities</b></i>
Breezy Point Land Management Committee conducted volunteer dune restoration projects along the heavily-impacted Breezy Point beaches.
Lower East Side Ecology Center conducted tree planting activities to replace damaged or lost trees and created a large bioswale.
Rockaway Waterfront Alliance engaged youth in mapping and dune stewardship to support the development of soft-infrastructure coastal protection in Rockaway.
<i><b>Resilience</b></i>
GrowNYC developed the "Resilient NYC Community Garden Guide" to help community gardens recover from the storm, with suggestions encompassing preventive pruning, green infrastructure design and construction, permeable paving, bioswales and rain gardens, plant selection, storm resistant structures, and storm planning.
Rockaway Waterfront Alliance created an environmental resilience curriculum for their environmental education school workshops.
Hudson River Park Trust sought out collaborations with resilience scholars and tried to obtain funding to build additional artificial oyster reefs to reduce wave action.
Governor's Island Harbor School considered replacing sustainability with resilience in their curriculum.
Uprose established Sunset Park Climate Justice and Community Resiliency Center, possibly the first grassroots-led, climate adaptation and community resiliency planning project in the city.
<i><b>Other New Content/Activities</b></i>
Rockaway Waterfront Alliance partnered with a local artist and schools to create the Sea-Song Memorial, a driftwood sculpture that serves as a "metaphor for the strength of community and cooperation."
Solar One's community solar program supports the development of cooperatives to leverage community buying power to purchase solar panels.
<b>Organizational Changes</b>
<i><b>Reinforce or advocate for existing message</b></i>
Trust for Public Land NYC Playgrounds Project used Sandy as an example during community design sessions to drive home the message of the need for green infrastructure in NYC neighborhoods.
The River Project used Hurricane Sandy to emphasize the role of shallows and reefs in the health and resilience of the NYC harbor and its estuary.
<i><b>Engage New Audiences</b></i>
Liberty Science Center used their Global Microscope to transmit an electronic field trip about Hurricane Sandy to students in China, using NOAA and NASA data to create a three-dimensional mapping visualization of the storm surge.
<i><b>New Partnerships</b></i>
Hudson River Park Trust, whose extensive network of green space along the Hudson River was heavily impacted by the hurricane, engaged in new partnerships to seek funding for green infrastructure projects, including using living shorelines and oyster reefs as coastal barriers.
<i><b>Engage New Volunteers</b></i>
Clean Ocean Action developed Waves of Action for the Shore, which engaged nearly 14,000 volunteers in cleaning up marine and storm debris in over 100 communities in NY and NJ.
Hudson River Park Trust strove to accommodate an overwhelming influx of volunteers from within and outside the city in the first several months after the storm.
<i><b>Obtain Funding</b></i>
The Battery Park Conservancy, which is home to Battery Urban Farm, received a federal <i>Rebuild by Design</i> grant, through which they will construct a series of swales and berms that will be integrated into Battery Park, and will protect a newly designed farm. Battery Urban Farm also conducted a crowd-sourced funding campaign through Indiegogo, and raised \$16,077 to repair and replace items damaged or lost in the storm.

change was using Sandy as an example to reinforce lessons that had been taught previously, including climate change, energy, and wastewater management (25 organizations, see [Table 2](#) for examples). Programs also added new stewardship activities specifically focused on adapting to climate change and mitigating future storm impacts (22).

Organizational changes included leveraging awareness of Hurricane Sandy to reinforce or advocate for the organization's message (20), adding new audiences (17) or volunteers (14), partnering with other organizations to try to obtain funding or to better develop responses to climate change (17), and seeking new funding sources (14, see [Table 2](#) for examples). Although funding for large green infrastructure projects that became available after the hurricane was not specifically focused on EE (e.g., the federal Rebuild by Design competition), organizations that obtained this funding were creating new environmental learning opportunities through engaging people in planning for green infrastructure, hands-on stewardship, and related activities.

Eighteen programs incorporated resilience into new curricula (e.g., Rockaway Waterfront Alliance), educational materials (e.g., GrowNYC), stewardship opportunities (e.g., Hudson River Park Trust), or as the focus of a new center (Uprose). Because resilience emerged as a focus for a large subset of programs, as well as for government planning documents and funding calls, we designed a second study to understand the meaning of resilience in the context of the NYC EE programs.

## **Study 2. Methods**

Based on the results from study 1, we identified 18 programs that described incorporating resilience after Sandy. We were able to recruit 14 educators from this list for the second study.

### ***Data collection***

We used semi-structured phone interviews to investigate how environmental educators were defining and incorporating resilience in their programs. The first author asked environmental educators about their programs' resilience definitions and meanings, applications, and information sources. Prior to the interviews, we sent interviewees a handout with academic definitions and example applications of multiple types of resilience, and asked them to review and reflect on their programs' use of resilience in relationship to these definitions ([Table 1](#)).

### ***Data analysis and validation***

We applied a similar coding strategy to study 1, and used a descriptive coding scheme focused on emergent themes relating to resilience (Saldaña, 2013). We asked our interviewees to "member check" our results (Lincoln & Guba, 1985) by reviewing and commenting on how we characterized their programs in a draft version of this article.

## **Study 2. Findings**

### ***Organizational profiles***

A higher proportion of organizations focused on hands-on stewardship and restoration (12 of 14) relative to the first study, whereas similar proportions explicitly focused on EE (11) and community engagement (9). Other foci included planning and design (6), advocacy (5), conservation (5), youth development (5), science/research (3), waste/energy (3), and disaster relief (1).

### ***Resilience working definitions and practices***

When asked to define resilience, educators struggled to articulate a formal definition but instead described a working definition based on their practice. Despite not drawing on the academic literature

about resilience, the meanings that educators ascribed to resilience in their practice oriented around themes that fit with academic definitions of psychological, community, ecological, and social-ecological systems (SES) resilience. However, the educators' working definitions often extended beyond a single academic definition, for example by including green space stewardship as part of community resilience and thus linking community to ecological resilience. In incorporating resilience, educators were responding to policy documents, funding opportunities, and conversations with peers and community members.

Below we describe how educators' working definitions and practices related to forms of resilience in the academic literature. Nearly all programs incorporated more than one type of resilience, or described integrated efforts that reflect SES resilience. In other words, a program might focus on green infrastructure and thus be categorized as ecological resilience, but also incorporated education and community engagement, which fall under psychological and social resilience; incorporating green infrastructure and community engagement also reflects SES resilience. Such incorporation of social elements into programs that previously had focused more narrowly on the environment was common.

### **Psychological resilience**

Programs that equipped individual participants with the skills to respond to future disturbances mirrored formal definitions of psychological resilience. For example, The Nature Conservancy's (TNC) Leaders in Environmental Action for the Future (LEAF) program helps youth develop conservation and workplace skills. After Sandy, LEAF continued its work in youth development but added a focus on helping participants gain the ability to "bounce back" from future disturbances. The LEAF program director described her approach to resilience as:

...thinking about the human skillsets. When look at the skillsets, it's the communities that are most resilient in their own networking and the human resilience that are able to bounce back from these natural disasters. So how do we develop the capacity for young people to grow those skillsets? Not only the knowledge of those natural systems and the work that has to be done, but also the professional skill sets and personal strengths. (12/5/2014)

She went on to ask:

But what is that element to allow them to withstand major trauma and how do we help to prepare and equip young people to have those skillsets? ... it is sort of the grit, and the idea of the resilience of the human capacity. (12/5/2014)

While focusing on how to build youth's skills to withstand trauma associated with climate disturbance, this educator suggests that communities that have experienced stresses are likely to be resilient to new stresses. In this way she goes beyond psychological resilience to link to community resilience.

### **Community resilience**

Programs designed to familiarize participants with local people and places (including green infrastructure), and to support community participation in planning, reflected community resilience. For example, Green Map produces maps showing places to enjoy nature and live more sustainably in NYC. After Hurricane Sandy, this organization led biking and walking tours through the Lower East Side of Manhattan to educate people about hurricane damage and low-impact lifestyles. Green Map used the term "*everyday resilience*" to emphasize the need for opportunities for community members to connect with one another on a daily basis while working on local problems, and felt their mapping and tours created such opportunities.

Battery Urban Farm (a project of The Battery Conservancy) offered the following definition of community resilience and how it connects to green space stewardship.

... having green space and an urban farm where people can actively do work is in itself a form of resiliency. Not in a direct environmental way, but in a community way. So if people in the city have a space where they can come to do work in greenspace—and have a connection to it and really learn to care about it—then that is for the resiliency of the population. And over time, the more people fostering the care for these spaces the more these spaces will exist. (12/16/2014)

Similarly, New York Restoration Project (NYRP), which builds community gardens, connected resilience to having access to and developing an attachment to urban green space:

[resilience] means the ability for people to feel a part of the neighborhood and feel secure in that environment. And the way that we address it is by providing these spaces that we try to make as open to the public as possible and providing opportunities for them to make it their own. So we allow people to host their own events, take ownership over individual garden beds. So it's really a sense of comfort and a sense of place. (12/04/2014)

In short, programs that reflected community resilience included neighborhood tours to connect people with each other (and build the social connections needed to respond to future disturbances), and using green space to foster place attachment and stewardship action. By including green spaces, these programs were expanding existing definitions of community resilience to link to ecological resilience.

### **Ecological resilience**

Programs involving hands-on stewardship emphasized how green infrastructure and natural areas could enhance the ability of local ecosystems to withstand future disturbances. A common focus was protecting against storm surges and sea level rise using “soft” infrastructure. For example, Brooklyn Bridge Park Conservancy spoke about resilience of the park as “*the actual barebones of it, the construction of it and engineering of it.*” (12/08/2014)

NYRP talked about resilience as “*kind of that standard definition of the ability to bounce back after an event like Sandy.*” As a result of the storm, this organization shifted from a focus on biodiversity to emphasizing ecosystem services provision, which they related to resilience.

Instead of increasing diversity—looking at the structure and diversity of forest to withstand intense storm events and recover without degrading to intensive vineland. Provides ecosystem services in terms of stormwater management and carbon sequestration—how to build a forest in terms of storm events. Ecosystem services that are more critical with increased precipitation. Intense environmental stresses that we predict and are already seeing. A natural restoration project—but have added a layer around the increased storm events and resilience of forest. (12/09/2014)

Organizations recognized that they could no longer focus on building green infrastructure without consideration of the social context. The Northeast Chapter of the American Littoral Society, which focuses on the health of Jamaica Bay, described this realization:

So although we still do strictly ecological work, not everything has a social component per se, but a lot more does now it seems like. And people are connecting more to the communities. And the people around the bay feel connected to what's happening. So we're not just doing it just for birds. (12/03/2014)

This educator's definition of resilience also went beyond conserving green infrastructure to incorporate education.

When we talk to students and other people, and talking to planners too, we bring in the need to make things more resilient. You bring them back but you build them better. You build them to be able to withstand a future storm event, as much as possible. So it's kind of infused as the educational process, as well as the actual restoration work as well as the advocacy. (12/03/2014)

In short, although educators talked about the importance of building green infrastructure to reduce future flood impacts, they linked these efforts to human communities and to education. These comments stop short of describing ecological and social aspects of practice as an interconnected system; however, they suggest how educators added community resilience to work that had been oriented around ecological resilience.

### **Social-ecological systems (SES) resilience**

Similar to Northeast Chapter of the American Littoral Society, Rockaway Waterfront Alliance added a stronger focus on community engagement after the storm.

We are really just doing everything that we have been doing in the past but we are just opening it up to more people and providing more opportunities for the community to be more actively involved. But we're not necessarily calling ourselves an environmental organization anymore. It's more of a youth development/community development organization that focuses on the environment. (12/10/2014)

Programs commonly linked community and ecological resilience through education and community engagement around green infrastructure. NYRP described the connections:

So I think in all of our work we don't try to make it just about the people or just about the trees, kind of bridging the two aspects through community engagement. (12/04/2014)

NYRP also incorporated design elements into new projects to address community security in the event of future storms. For example, they sought funding for solar panels that would enable people to have power when the city grid goes out, and constructed *casitas* that could be used as gathering places in the event of disasters. Similarly, Lower East Side Ecology Center's definition of resilience integrated the idea of safety:

... finding ways that both protect the people in NYC from damages having to do with either climate change or any other emergency, but doing it in a way that also enhances the environment. (11/25/14)

Several additional programs linked green infrastructure with education or community engagement. For example, Lower East Side Ecology Center planned educational and stewardship programs around the city's design for a berm along the East River, which will allow flooding of green spaces but protect built infrastructure. GreenThumb helped rebuild community gardens that had been physically damaged by the storm, provided workshops, and consulted with community gardeners to help them prepare for future storms. Similarly, the non-profit GrowNYC developed a best practices guide about resilient gardening that included bioswales and other green elements to reduce storm vulnerability (GrowNYC, 2014). Finally, Breezy Point Land Management Committee engaged community members in dune restoration after the storm, and is developing a community of practice focused on learning about ecosystem services provided by sand dunes and coastal forests through engaging in stewardship practices. These activities are reflected in the program's definition of resilience:

Resilience is a heightened awareness and that there is ... motivation and related resources and tools to support action, direct action ... that directly improves the physical environment. So engaging in a better understanding of the social-ecological integration. (12/08/2014)

Programs located near the water and conducting water and waterfront education also talked about oysters as producing multiple ecosystem services related to SES resilience. Although Hudson River Park Trust and Brooklyn Bridge Park Conservancy had been restoring oysters prior to Sandy, both emphasized this work to a greater degree after the hurricane. Battery Urban Farm incorporated oyster restoration into their practices after Sandy, which they related to a new emphasis on resilience as a guiding concept for their farm-based education program. This organization saw resilience as relating to "*the whole ecosystem. How things interact with each other [cycles]...feed into each other...[and] how they are affected by people.*"

Educators saw engagement in oyster restoration not only as important to build and maintain green infrastructure, but also as opportunities for learning:

... we're investing in education. Getting kids to connect and understand a little more about what's happening in the marine environment and the harbor, and reconnect them to the waterfront, and understand what it is like to access the waterfront, and see how the edge is shaped literally. (Billion Oyster Project, 12/03/2014)

In short, environmental organizations that incorporated resilience into their programs after Hurricane Sandy saw strong connections between building green infrastructure to reduce flooding impacts, engaging youth and community members in stewardship of green infrastructure, and education. Their focus on the interconnectedness between people and the larger ecosystem reflected SES resilience.

### ***What influenced EE resilience practices after Hurricane Sandy?***

After Hurricane Sandy, a series of government policy documents and calls for funding emphasized resilience. Nine of the 14 programs attempted to connect their ongoing work to these new policy documents, and six of the educators talked about taking advantage of new funding opportunities.

... Because everybody now is talking resilience, any conference we go to, any programs that are looking to get funding. So it comes from the government too. All levels of government are thinking about resiliency in their work ... . And of course if you want a grant you have to incorporate some aspect of resilience that satisfies that term. Even though it's something we have been doing all along. But now we have to flesh that out of our wording. (American Littoral Society, Northeast Chapter, 12/03/2014)

Educators relabeled ongoing work to fit with the new buzzword.

(I)t could partially be true that we are kind of adapting our mission to fit in with resiliency because it is so hot right now. I definitely think that's a big part of it. But also at the time of Sandy, a majority of our staff lived in the neighborhood and saw the problems and so that also feeds into it. But I think a lot of it is things that we would even before Sandy and before resiliency was a buzzword—things that we would have wanted to do anyway. And in my mind it's not stretching it—it's just relabeling it. Because we were promoting green infrastructure [before Sandy] (Lower East Side Ecology Center, 11/25/2014)

Lower East Side Ecology Center also saw resilience as replacing sustainability.

Preparation for storms or disasters as opposed to just thinking of we're doing this as a way of promoting sustainability. So it's tweaking the language a little bit, but we're kind of doing the same thing we were doing before. (11/25/2014)

Interactions and collaborations with community members and scientists also influenced organizations' resilience definitions. Some organizations responded to local needs as identified through community interactions, while others drew from interactions with natural resources managers and university scientists, but none mentioned academic literature or think tanks such as the Resilience Alliance (2009) as a source for knowledge about resilience. Breezy Point Land Management Committee drew on the expertise of its volunteers who represented diverse professions.

The skills and abilities of my peers in our volunteer work here are tremendous and are just surfacing as a consequence of this great need. So it's scientists, educators, engineers, contractors, business people, some planning expertise... It's the collaborative spirit combined with a multi-disciplinary experience, expertise and credentials of the volunteers coming together. It's like we're on a mission. (12/08/2014)

Several educators drew on other organizations with particular expertise or practices that support resilience education. For example, Battery Urban Farm learned from the Billion Oyster Project about oysters and “soft” structures to protect shorelines.

I first heard about the Billion Oyster Project, Living Breakwaters, off of Staten Island, being one of the three to get funding for resilience projects. And they did a workshop for teachers how to get kids involved in this learning process. And with the classroom, how to build not the breakwater sized reefs that they're building in Staten Island, and again coming back to understand one simplified piece of the puzzle and the oysters are a vehicle to talk about that, eventually. (12/16/2014)

Personally experiencing the storm was another influence on educators' work post-Sandy.

I still get tears in my eyes when we talk about protection. And Bryce I have to fight it back, and I know so many individuals that have suffered with huge levels of anxiety, stress and illness, where I haven't. And so the impact to people—it's their wellbeing—the physical housing structures and the vibrancy of the community, but it's the personal lives and the quality of these people's health is enormous. We can have a conversation with someone and they can freak out. People are still afraid. And there are people like me that have found opportunities to act and taken them. ... it's like I'm still just washing clothes [muddied in the storm]. It's like you don't have opportunity until a particular point. So you are working with other organizations that aren't living it, but they are the providers in the community. And so they are well positioned because they can retool, refocus, and provide. Whereas we had to recover. That's the resilience. (12/08/2014)

## Discussion

Whereas our study of how educators are responding to climate related disturbance is limited to just one city at one point in time, the results do suggest ways in which EE can address climate change adaptation consistent with its commitment to the well-being of program participants and to improving environmental quality. In particular, a focus on resilience at multiple scales points to how EE might address ongoing environmental and new issues raised by climate change. For example, psychological resilience helps to address trauma experienced by program participants, either because they are from vulnerable populations, because they are experiencing climate related destruction of their homes and communities, or both. Community and SES resilience address larger-scale community stresses and ecosystem damage. Future research might explore practice innovations emerging not just in wealthy countries, but also in countries like Bangladesh and Philippines where poverty, frequent storm events, and low lying topography aggravate the impacts of natural disasters and seemingly limit response options to those that immediately save lives.

In NYC, educators both adapted their practices to address post-hurricane political realities, and more substantively transformed their programs to take into account challenges faced by participants, communities, and social-ecological systems. Program adaptations included reframing ongoing work to demonstrate consistency with resilience as the latest “buzzword” without reflecting on the need for deeper change. Organizations that questioned their previous narrower focus on green infrastructure and incorporated community engagement, and thus linked social and ecological elements, appeared to implement more transformational changes. Whereas educators struggled with the bigger issues climate change poses for coastal cities like New York, in the absence of successful models to address these enormous risks they developed practices that reflected what they could feasibly do to try to protect their park, shoreline, or other resource. Examples included restoring oysters, dunes or marshes, or rebuilding more “flood-resistant” community gardens.

### *Disturbance and expanding environmental education practice*

Scholars have suggested that transformative learning or change occurs when a “disorienting dilemma” challenges our current experience and assumptions (Engeström, 2001; O’Sullivan, 2002), not unlike how disturbance can lead to transformations in social-ecological systems (Gunderson & Holling, 2002). In response to a disorienting dilemma, our cognitive systems search for ways to reorganize until constructs are discovered that guide actions more consistent with the new reality (O’Sullivan, 2002; Sterling, 2010). For this to occur, several elements must be present including opportunities for critical self-reflection, participation in constructive discourse, planning for action, and building competence and self-confidence in new roles and relationships as a result of taking action (Mezirow, 2000). Hurricane Sandy provided the “disorienting dilemma” and it appears that educators had opportunities to plan for action and assume new roles as they adapted their practices to respond to the flooding disaster. Although experiencing the storm led educators to reflect on their existing approaches, it is possible that greater opportunities for self-reflection and constructive discourse might further expand the conversation from a focus on responding to a single flooding event to a broader discussion of how EE can address climate change in vulnerable communities.

Social innovation (Mulgan, 2007) and practice theory (Reckwitz, 2002), which focus on co-production of knowledge among practitioners and scholars, provide a lens for thinking about practice transformations on a larger scale. In this study, educators created working definitions of resilience through interactions with community members and natural resources professionals, and taking into account government planning documents and funding calls, but appeared to have little familiarity with resilience scholarship. The educators’ “ground up” approach could be expanded upon by creating possibilities for co-production of meanings and practice among a larger group of practitioners, and among practitioners and researchers, consistent with studies on practice innovations in civic ecology practices (Krasny et al., 2015) and consumer behaviors (Pantzar & Shove, 2010; Seyfang & Haxeltine, 2012). Creating opportunities for such interactions is also consistent with Masten’s (2011) call to increase knowledge of resilience processes through deliberate and theory-informative change research involving researchers and practitioners.

## Resilience and EE practice

Although the educators did not talk about the academic resilience literature per se, the fact that they integrated community and ecological resilience is consistent with a growing body of literature about linked social-ecological systems and SES resilience (Folke et al., 2010; Gunderson & Holling, 2002; Walker & Salt, 2006; ). Further, the TNC LEAF program's focus on individual recovery from environmental disaster reflects research on psychological resilience in the face of adversity and is consistent with calls to link psychological and SES resilience in disaster contexts (Masten, 2011; Masten & Narayan, 2013; Masten & Obradovic, 2008).

The incorporation of SES and psychological resilience into EE practice reflects several ongoing EE trends. Programs that engaged participants in hands-on dune, oyster, community garden, and other forms of green infrastructure restoration and stewardship are consistent with the praxis tradition in EE, in that they reflect "learning in action, by action, and for the ongoing improvement of action" (Sauvé, 2005, p 22). According to Sauvé (2005, p 22–23), the praxis form of EE "is not a matter of developing knowledge and skills beforehand, in view of potential action, but rather of placing oneself into a situation of action and learning through, by, and for that project. Such learning calls for reflexivity throughout the project. Praxis essentially consists of integrating reflection and action such that they feed one another." Action research for community problem-solving is an approach to praxis EE developed in the 1990s, which entails participatory initiatives to resolve social-environmental problems, and integrates reflection about strategies and outcomes for the environment, community, and learners (Stapp, Wals, & Stankorb, 1996). The post-Sandy NYC programs expand earlier EE action research conducted by Stapp and others (Mordock & Krasny, 2001) to the global problem of climate change, while retaining action research's focus on local actions. However, only a few NYC programs incorporate the full cycle of action and reflection about strategies and outcomes. One example is the Hudson River Park Trust, which incorporates data collection, reflection, and further action when participants use data they collect to suggest optimal placement for artificial oyster reefs. This and other organizations supplemented learning embedded in coastal dune, estuarine, marsh, or community garden restoration with more formal curricula. Undoubtedly, opportunities exist for more structured lessons and reflections focusing not only on impacts of the participants' local actions, but also on the most effective ways to address climate change mitigation and adaptation.

The focus on psychological resilience in TNC's LEAF program, along with engaging youth and community members in stewardship and restoration in organizations such as Rockaway Watershed Alliance and NYRP, reflect an emerging trend linking environmental action with youth and community development (Schusler, Krasny, Peters, & Decker, 2009; Schusler & Krasny, 2010; Aguilar, Price, & Krasny, 2015). As suggested by the TNC educator, young people who engage in restoration and similar environmental action programs post-disturbance develop a skillset that may prove useful in responding to future disturbances. An in-depth study of programs involving NYC youth in dune restoration after Hurricane Sandy, and youth restoring trails following destructive flooding in Colorado, demonstrated that participants changed the ways in which they framed climate change and disturbance (Smith, DuBois, & Krasny, 2015). At the beginning of the programs, participants' cognitive maps emphasized damage caused by flooding, whereas by the end of the programs their cognitive maps focused on solutions to flooding problems. Their ability to articulate solutions suggests increased locus of control, which is one of many protective factors that help individuals respond to stress (Luthar et al., 2000) as well as an important factor in promoting pro-environmental behaviors (Hungerford & Volk, 1990).

## Conclusion

We embarked on a study to discover whether a major climate related disturbance—Hurricane Sandy in NYC—would result in transformational changes in EE practice. Environmental educators leveraged the Hurricane to reinforce existing practice, took advantage of new opportunities for messaging and government funding, and incorporated new practices focused on psychological, community, and social-

ecological systems resilience. The new practices expanded on ongoing EE trends, including action research and youth and community development, to encompass climate change.

Whereas the incorporation of resilience into EE programs could be a first step toward a broader discussion about how EE is responding to climate change, overall the practice changes we observed do not appear to have transformed EE in NYC let alone more broadly. However, the educators' interest in resilience as a response to climate change, coupled with their lack of familiarity with the academic literature about resilience, suggest an opportunity for interaction among practitioners and researchers focusing on multiple types of resilience and resilience EE practice, which could lead to further practice innovations. Given that research on psychological and SES resilience has been conducted among vulnerable populations in wealthy and developing countries, the possibility exists for expanding our work to other highly vulnerable but less wealthy settings where the educational response to disaster has necessarily focused on immediate student safety and school infrastructure.

However, given the immediacy, frequency, and magnitude of climate related disasters, a need exists for action not only conducted by youth participants within EE programs, but also action research conducted by educators and researchers. Such action research in climate vulnerable communities can be a means to generate richer understandings of EE practice, while simultaneously strengthening practices and sharing them broadly with the global community. We cannot afford to wait for the long process of conducting and publishing research that may eventually influence practice; instead, action research to explore and strengthen practice innovations is needed now to address climate change.

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