Educating with Resilience in Mind: Environmental Education in Post-Sandy New York City

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Dune grass planting, Breezy Point, NYC, Fall 2013
Photo: Bryce DuBois

Summary
After Hurricane Sandy, the term resilience repeatedly popped up as New York City (NYC) educators talked about their environmental education (EE) programs. More broadly, resilience as a term appears to be gaining popularity in environmental and sustainability circles. But what do educators and other environmental professionals mean by the term resilience? We conducted interviews with 14 environmental educators in NYC to explore how they define and use the concept of resilience in their EE practice. We found that educators’ resilience definitions and practices varied, roughly reflecting psychological, community, ecological, and social-ecological systems resilience. This variation appeared to be related to variation in program goals, with psychological resilience found in programs that emphasized youth and community development, ecosystem and community resilience in environmental stewardship programs, and social-ecological systems resilience in programs that focused on learning about the city as a social-ecological system. Environmental educators did not appear to be familiar with formal resilience definitions, but rather their resilience practices were influenced by government planning documents, funding opportunities, and informal conversations with peers, volunteers and other community members. Further, educators closely linked resilience education and climate adaptation education. Our results suggest that EE has the potential to contribute to multiple types of resilience, depending on program missions and contexts, and leading to different outcomes. Additionally, given that resilience is an important area of research across multiple disciplines, and that environmental educators acting in isolation from researchers are developing unique resilience practices, a need exists for exchange between academics and practitioners to share perspectives, with the goal of furthering innovation in EE to address climate change and related disturbances.
INTRODUCTION
Two recent trends have marked the way scientists think about ecosystems. First is a recognition that change—including small disturbances like local droughts, and massive catastrophes like typhoons and tornadoes—is a constant in all ecosystems. Second is a questioning of the “intact wilderness” mindset, with the realization that all ecosystems are impacted by humans. The onset of climate change related disturbances and the urbanization of the global population have reinforced these shifts in thinking.

Scientists have adopted two terms to reflect these changes. First is resilience, which captures notions of ongoing adaptation to smaller disturbances and transformation in the face of disasters. Second is social-ecological systems. Here the idea is that due to the intertwined nature of humans and the rest of nature, it is impossible to look at social and ecological processes in isolation.

Interestingly, the term resilience is also being adopted by policy makers, including in cities. In 2007, Mayor Bloomberg issued PlaNYC with the subtitle “A Greener, Greater New York” (NYC 2011). After Hurricane Sandy struck the Atlantic shoreline in 2012, Mayor Bloomberg convened the Special Initiative for Rebuilding and Resiliency (SIRR) to produce a revised PlaNYC, this time subtitled: “A Stronger, More Resilient New York” (NYC 2013). A screen shot of the inside cover of the newer PlaNYC captures a formal definition of resilience, as well as a spirit of defiance or toughness embodied in the term resilience and in New York’s response to disaster.

The 2013 report goes on to say:

A resilient city is not one that is shielded from climate change all of the time—because, sadly, when it comes to nature’s powerful forces, that is simply not possible. But a resilient city is one that is: first, protected by effective defenses and adapted to mitigate most climate impacts; and second, able to bounce back more quickly when those defenses are breached from time to time.

After Hurricane Sandy, not only city government, but also environmental education (EE), environmental management, and youth development professionals in New York City were using the term resilience (DuBois and Krasny 2014). Because resilience is also used by academics researching the ability of individuals, communities, ecosystems, and social-ecological systems to bounce back, adapt, and transform (Folke et al. 2002, Masten and Obradovic 2008), we wondered: “What do environmental educators mean when they use...
the term resilience?” We also asked: “What source of information do environmental educators draw on in defining resilience?”

To find the answers to these questions, we conducted a study of 14 EE organizations in New York City (NYC) after Hurricane Sandy. The results of the study, reported below, provide insight into how environmental educators are changing their practices in response to climate-related disasters. This study is also part of a larger research and education initiative that seeks both to learn from EE practices, and to support environmental educators through workshops and online professional development (EECapacity, NAAEE and Cornell University 2015). Thus, these results are being shared and discussed in an effort to extend the lessons learned in NYC after Hurricane Sandy to other EE programs in the US and beyond.

We start with a short overview of the use of the term resilience and its previous applications in EE. Next we present the study methods and results, with an emphasis on how environmental educators are linking resilience to their organizational missions, the sources of information they are drawing on to define resilience, and how they are addressing climate adaptation. Finally, we discuss the implications of this study for EE, focusing on how environmental educators in a city that has experienced climate change-related disaster are adapting their practices to incorporate notions of resilience and climate adaptation.

Resilience
Ecosystem scientist Buzz Holling first proposed the term resilience in the early 1970s to describe processes of disturbance, adaptation, and radical change or transformation in forest ecosystems (Holling 1973). At about the same time, psychologists were starting to explore how some people who had faced extreme hardships were able to go on to live productive lives, a phenomenon they labeled psychological resilience (Luthar et al. 2000, Bonanno 2004). In addition to ecology and psychology, other disciplines use the term resilience including sociology (CARRI 2013) and engineering (Holling 1996) (Table 1).

The concept of social-ecological systems (SES) resilience gained popularity among ecosystem scientists at the turn of the 21st century as an alternative to the notions of sustainability and steady state (Berkes et al. 2003). SES resilience was meant to address the problems of managing for a steady state system, such as controlling wildfires to grow larger trees, which resulted in forests becoming more susceptible to insect attacks and extreme fires. 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, farm, marine, urban, and other SES would lead to more favorable environmental and social outcomes. Further, Folke and colleagues’ notion of resilience incorporated adaptation to small changes as well as transformation in systems that have crossed thresholds following large catastrophes. Important to EE, SES resilience emphasizes the role of learning, and adapting or transforming practices based on what is learnt about the outcomes of various management schemes (Berkes 2004, Armitage et al. 2008).
Table 1. Resilience Definitions

<table>
<thead>
<tr>
<th>Type of Resilience</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Community</td>
<td>The ability of communities to cope with and recover from external stressors resulting from social, political and environmental change (CARRI 2013)</td>
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<tr>
<td>Ecological</td>
<td>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)</td>
</tr>
<tr>
<td>Engineering</td>
<td>Rate at which a system approaches steady state following a perturbation (Holling 1996)</td>
</tr>
<tr>
<td>Psychological</td>
<td>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 and Obradovic 2008)</td>
</tr>
<tr>
<td>Social-Ecological Systems (SES)</td>
<td>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 et al. 2003)</td>
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Resilience and Environmental Education

Given the importance of psychological, community, ecological, and SES resilience in environmental management and youth development, it is important to explore the connections of resilience to EE. In a special issue of the journal *Environmental Education Research*, Krasny et al. (2010a) suggest four ways that EE can contribute to SES resilience:

- EE and environmental learning can foster attributes of resilient SES (for example, biological diversity, social capital, participatory forms of governance, Walker and Salt 2006).

- EE organizations can become part of larger governance and social-ecological systems. Governance systems that involve collaborations of formal city, state, and national governments with non-profit and community organizations offer more options for adapting to and bouncing back from small disturbance and major disasters.

- 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 (see Wals et al. 2008, Sterling 2010).

- Parallels among concepts used in 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, and SES resilience suggests that major disturbances can spur new approaches to environmental management (Mezirow 2000, O'Sullivan 2002, D'Amato and Krasny 2011).

Other scholarship has focused more specifically on ways that EE programs contribute to attributes of resilient SES including social capital (Krasny et al. 2013a), polycentric governance, and adaptive and collaborative resource management (Krasny and Roth 2010, Krasny et al. 2010b, Lundholm and Plummer 2010, Plummer 2010, Tidball and Krasny 2011). Importantly, McPhearson and Tidball (2013) posit that a major disturbance, such as Hurricane Sandy, creates a “niche” for new EE programs to emerge, which then play a role in SES resilience. Despite the scholarly literature on resilience and EE, little is known about how environmental educators are applying notions of resilience to their programs after a climate-related catastrophe like Hurricane Sandy.

**Study Questions**

We conducted a study to determine how EE programs in a city that experienced a major disturbance define resilience and apply notions of resilience to their programs. More specifically, we asked: How do environmental educators in post-Sandy NYC: (1) define resilience, (2) apply resilience in their practices, (3) describe influences on developing resilience practices, and (4) describe resilience education in relationship to climate adaptation education?

In addressing these questions, we used a “learning arenas” framework (Krasny et al. 2013b) that defines EE broadly as including both structured EE programs taking place in settings such as parks, nature centers, schools, and summer youth programs, as well as learning that takes place through less formal activities such as restoration and stewardship (e.g., community gardening), recreation, visits, and demonstrations (e.g., bike rides with an educational theme). Further, we draw on a typology for urban EE programs that distinguishes between youth development, environmental stewardship, and exploring the city as a social-ecological system (Russ and Krasny 2015), as well as academic definitions of resilience.

**METHODS**

*Settings and participants*

Participants were identified using a content analysis of 45 interviews from a previous research project described in DuBois and Krasny (2014). These interviewees represented stewardship and EE programs that were likely to have seen physical damage from Sandy or whose participants would have been impacted by the storm (for example, groups in lower Manhattan and shoreline areas of Brooklyn). Through the content analysis we identified 18 programs that had described incorporating resilience or climate adaptation after Sandy. We were able to recruit 14 educators from this list for the current study.
**Data collection**
We used semi-structured interviews that lasted from 45 to 90 minutes and were recorded and transcribed verbatim. The first author (DuBois) asked environmental educators (interviewees) about their programs’ use of resilience (including giving an example), their definitions of resilience, and their source or information about resilience (see Appendix I). Prior to the interviews, we gave 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 (Appendix II).

**Data analysis**
We first coded all transcripts for instances where the interviewees talked about resilience and adaptation (Miles and Huberman 1994, Braun and Clarke 2006). We then used descriptive coding to categorize emergent codes related to resilience or climate adaptation (Saldaña 2013). The two authors coded the interviews separately and subsequently compared and discussed them until consensus was reached regarding the final themes that most accurately captured the meanings of the interviewees (Bradley et al. 2007).

**Data validation**
We asked our interviewees to “member check” our results (Lincoln and Guba 1985) by reviewing and commenting on how we characterized their programs in a draft version of this paper.

**FINDINGS**
Despite the fact that programs were chosen for this study because resilience was a focus of their work following Hurricane Sandy, the educators did not seem to draw from academic publications about resilience or demonstrate familiarity with formal resilience definitions. When asked to define resilience, they sometimes struggled to articulate a formal definition. However, their working definitions of resilience as manifested in their practices roughly mirrored multiple forms of resilience discussed in the academic literature, including psychological, community, ecological, and SES resilience (Table 2). In incorporating resilience into their programs, educators were responding to policy documents, funding opportunities, and conversations with peers and community members. None reported drawing from the academic literature on resilience. Finally, educators’ descriptions of climate adaptation education practices were similar to their descriptions of resilience education practices. We discuss these results in more detail below.

**Resilience Practices in Environmental Education**

*Psychological resilience*
Some programs attempted to equip individual participants with the skills to respond to future disturbances. For example, The Nature Conservancy’s (TNC) Leaders in Environmental Action for the Future (LEAF) program helps youth develop conservation
and work place skills. After Sandy, LEAF continued its emphasis on 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.

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.

This educator’s focus on individual or human resilience as addressing climate change related trauma like flooding is similar to psychological resilience in that the scale is the individual and the focus is on individual traits. Whereas the origins of psychological resilience in the academic literature lie in bouncing back from family and other types of interpersonal trauma (Luthar et al. 2000, Bonanno 2004), the TNC LEAF program’s focus on individual recovery from environmental disturbance is consistent with a call to link psychological and SES resilience in disaster contexts (Masten and Obradovic 2008). This educator also linked psychological with community resilience, suggesting that communities that have experienced stresses are likely to be resilient to new stresses brought about by climate change.

Community resilience
Programs designed to familiarize participants with local people and places (including green infrastructure), we classified as 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 several bike and walking explorations 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. They felt their mapping and tours of the Lower East Side neighborhood created such community connections (Green Map 2015). It is unclear whether Green Map’s programs simply operated at the scale of the community and thus seem consistent with community resilience, or actually focused on how their community programs helped NYC communities to “cope with and respond to” the hurricane as an “external stressor” (see CARRI 2013).

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 through the use of “soft” infrastructure. For the Northeast Chapter of the Littoral Society, resilience was defined in terms of the ability of Jamaica Bay communities and marshes to withstand future storms. Their practices focused on the ecosystem benefits of marsh restoration in order to stem future wave inundation and flooding in the neighboring community.

**Social-ecological systems resilience**

Some educators focused specifically on connecting ecological with human or social systems. Their programs incorporated resource stewardship similar to the programs categorized as ecological resilience, but added education and community outreach. For example, The Lower East Side Ecology Center is supporting the city in constructing a berm along the East River to protect against waves and future storm surges, plans education and stewardship opportunities to maintain the berm, and conducts educational programs for the local community about green infrastructure projects. GreenThumb helped to 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 (for example, incorporating bioswales and other green elements to reduce storm vulnerability, GrowNYC 2014). Finally, Breezy Point Land Management Committee created dune-planting opportunities for the community, while developing a community of practice focused on learning about ecosystem services of sand dunes and coastal forestry, and engaging in the actual stewardship practices to put that learning into action.

The New York Restoration Project, which has as its mission to transform open space in low income communities to create a greener, more sustainable NYC, spoke about resilience in terms of social and ecological components relating to people feeling secure and to improving the city’s environment. Following Sandy, they sought to incorporate design elements into new projects to help prepare communities for 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.

Three programs located near the water and conducting water and waterfront education talked about oysters as producing multiple ecosystem services related to SES resilience. While 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 Conservancy Urban Farm incorporated oyster restoration into their practices in response to Sandy, which they related to a new emphasis on resilience as a guiding concept for their farm-based education program. All three organizations included interpretation and education about oysters in addition to hands-on restoration. In short, we categorized programs that incorporated stewardship and provided learning opportunities to give participants knowledge and skills to engage in future action under SES resilience.
What Influenced NYC Resilience Practices after Hurricane Sandy?

After Hurricane Sandy, a series of government policy documents and calls for funding emphasized resilience. Nine out 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...Build it Back, all of those [NYC government] programs, they are promoting the idea of resilience. 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)

In addition to mentioning formal documents, 10 of 14 educators spoke about interactions and collaborations as influencing their resilience definitions, and half of the programs (7/14) drew directly from the community that they work with to inform their resilience practice. For these programs, their understanding of resilience and the scale at which they applied this to their work was a direct response to the community’s needs as identified through community interactions.

These organizations drew on the expertise of volunteers representing 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. (Breezy Point Land Management Committee)

Several educators drew on other organizations with particular expertise or practices that support resilience education. For example, Battery Conservancy 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. (Battery Conservancy Urban Farm)
In contrast to the majority of educators getting information from government and funding documents and interactions with other professionals and community members, no educators mentioned academic literature or think tanks such as the Resilience Alliance (2009) as a source for knowledge about resilience.

**Climate Adaptation Education**
Most educators struggled to identify differences between climate adaptation education and resilience education in their practice. They viewed their resilience efforts as a process of responding to climate change, which was also interpreted as climate adaptation. For example, “the idea of resilience is based on the projections of future sea-level rise. Climate change is a factor.” (American Littoral Society, Northeast Chapter)

The fact that the NYC programs are located in a coastal area and that educators were interviewed after coastal flooding may explain why they equated resilience as adaptation to climate change and sea level rise. Talking about resilience and adaptation, one educator said:

> For us they are the same, but I can see how in different places it can be a lot of different things. We’re a coastal city, but both of them are similar... Like protecting our neighborhood and storm surge and rising waters, as well as protecting water quality. (Lower East Side Ecology Center)

Educators were hesitant to define climate adaptation in their programs, which they attributed to a lack of knowledge about how to make real strides toward climate adaptation. This sometimes led to a feeling of being overwhelmed.

> It’s especially problematic for our park in some ways. Our park is built to be flooded--but we don’t know how to best speak about it--so it leaves people feeling overwhelmed that our parks won’t exist. (Hudson River Park Trust)

Further, educators recognized the limited aspects of resilience that their programs could address in light of larger climate adaptation issues.

> ... I imagine there is a broader response to climate change that connects to resiliency. In my mind those things are extremely connected for us... They’re [park administration] acknowledging that these changes are here to stay and that we’ve adapted to this climate that’s changing when we go forward. (Battery Conservancy Urban Farm)

**DISCUSSION**
After Hurricane Sandy, EE programs in NYC implemented changes in lessons and activities that may provide examples for other EE programs grappling with how to address climate change. While most educators do not appear to be questioning the
foundational assumptions of their programs in light of the hurricane disaster, they are incorporating various notions of resilience in responding to climate related disturbance. Perhaps not surprising given Hurricane Sandy’s destructive flooding, educators linked resilience to adaptation to storm events and sea-level rise.

A major force driving incorporation of resilience into EE practice appears to be the NYC government, which has embraced the concept of resilience in their planning and practices (McPhearson et al. 2013, McPhearson et al. 2014), working in tandem with the US Department of Housing and Urban Development (HUD). NYC’s post-Sandy planning efforts, including PlaNYC: A Stronger, More Resilient New York drafted by Mayor Bloomberg’s newly formed Special Initiative for Rebuilding and Resiliency, were boosted by HUD’s Rebuild by Design regional planning and design competition (Hurricane Sandy Rebuilding Task Force 2013). The winners of this competition were directly linked with federal Community Development Block Grant Disaster Recovery funding to implement their designs, many of which overlapped with EE programs and settings such as the Billion Oyster Project and the Battery Park Conservancy Urban Farm.

We categorized the varying resilience practices as psychological, community, ecological, and social-ecological resilience. However, our classification system may partially reflect the scale of programs rather than the academic resilience definitions. For example, programs that focused on individuals were classified under psychological resilience, programs that focused on stewardship of a particular resource (for example, marsh restoration) were classified as ecosystem resilience, and under SES resilience we included programs that integrate environmental stewardship and education or outreach. The fact that the educators’ definitions of resilience differed from those of researchers is not surprising given that most educators did not appear familiar with the academic literature. An opportunity exists for further exchange between practitioners and academics to expand and apply definitions that reflect real-life situations as well as the research literature.

The varying approaches to resilience mirror different approaches to urban EE as outlined in Russ and Krasny (2015). For example, the LEAF program’s focus on psychological resilience is consistent with a youth and community development trend in urban EE (Schusler and Krasny 2010), whereas the focus on engaging program participants in dune restoration at Breezy Point is consistent with an environmental stewardship approach to EE. Organizations that incorporate green infrastructure stewardship and community outreach, such as the Lower East Side Ecology Center, reflect an approach that seeks to foster understanding of cities as social-ecological systems and to help students reimagine how to manage cities to achieve desired environmental and social outcomes. The resilience EE practices more generically addressed two additional urban EE trends identified by Russ and Krasny’s (2015): problem-solving and city as classroom.

In all programs, educators linked resilience education practices to an explicit effort to contribute to the ability to respond to future disturbances, in short to adaptation. 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 et al, in review). At the beginning of the programs, the participants’ cognitive maps emphasized damage caused by flooding, whereas by the end of the program their cognitive maps focused on solutions to flooding problems (that is, adaptation). This provides preliminary evidence that engaging youth in post-disturbance stewardship activities may develop their ability to respond to future disturbances.

Whereas our results are consistent with previous suggestions that EE programs may respond to “educational niches” or new educational opportunities that open up post-disturbance (McPhearson and Tidball 2013), the actual changes in NYC EE programs can be described as “adaptive” rather than transformational. Some educators talked about reframing their ongoing programs to be consistent with resilience policy and funding opportunities, whereas others added program activities in responding to Hurricane Sandy (for example, oyster restoration or bike rides to see hurricane damage). We did not see radical questioning of the foundational assumptions underlying their programs as one might expect in transformational change. Further, educators expressed confusion and a lack of specificity regarding resilience meanings. Some educators described using the word resilience instead of sustainability only because it was in vogue. Rather than large sudden changes in EE programs after a catastrophic disturbance, program change appears to be influenced by multiple interrelated factors, including long-held EE beliefs and practices, growing realization of the importance of climate change, funding opportunities, as well as personal experiences with disasters such as Hurricane Sandy.

Although educators struggled to identify the source for resilience definitions used in their programs, their “ground-up” approach where ideas about resilience were co-produced between the educators and community members offers important lessons for resilience practitioners and scholars. This process of co-production of meanings is consistent with studies on practice innovations in civic ecology (Krasny et al., 2015) and in consumer behaviors (Seyfang & Haxeltine 2012; Pantzar & Shove 2013). It suggests the need for further examination of how EE professionals and their audiences who experience climate related disturbance are creating their own EE innovations to address climate change.

CONCLUSION

When faced with a climate-related disaster, environmental educators generated new lessons and stewardship activities, and adapted their programs to take advantage of new opportunities for messaging and funding. Their “ground-up” practice innovations coupled with their lack of awareness of the academic literature about resilience suggest an opportunity for greater interaction among practitioners and researchers focusing on multiple types of resilience and resilience EE practice. Such interactions can result in a greater understanding of scientific views of resilience among practitioners, and of resilience applied to practice among scientists. Such interactions also may generate richer understandings and further innovations related to both practice and research, which are sorely needed in our attempts to address climate change.
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<tr>
<th>Program</th>
<th>Resilience Definition (quotes from educator interviews)</th>
<th>Resilience-Related Education Practice</th>
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<tbody>
<tr>
<td>Psychological Resilience</td>
<td><strong>The human skillsets. When we look at the skillsets, it is 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 skill sets? 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.</strong></td>
<td><strong>LEAF emphasized youth-development aspects of their program model in their resilience-related practices, which led them to develop opportunities for young people to lead an urban tree inventory of impacted areas of NYC and incorporated other programming to support the development of “soft skills” such as resume writing and other job skills.</strong></td>
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<tr>
<td>The Nature Conservancy, LEAF Program</td>
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<td>Community Resilience</td>
<td><strong>Well it has always been about impact reduction, but part of what we’ve always looked at are community-based resources. Where you Can actually get hands on-experiential and first hand, and just breaking down (not barriers necessarily), but all of us don’t know everybody we don’t know how to work together yet. I’m very fortunate to live in a neighborhood with community gardens. Where they are kind of little epicenters of this kind of building. Because we are literally hands on in the soil, helping one another overcome a series of small problems that help us prepare to overcome bigger problems.</strong></td>
<td><strong>Created map and biking/walking tour to interpret impacts of Sandy and sea-level rise on Lower East Side community.</strong></td>
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<td>Green Map</td>
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Table 2. Resilience Definitions and Practices Categorized by Resilience Type
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<th><strong>Ecological Resilience</strong></th>
<th><strong>Social-ecological Systems Resilience</strong></th>
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| **American Littoral Society, Northeast Chapter** | **Interviewee 1**: when we branched out to oysters and the pollinators in the park, in the other parts of park that really established the specific concepts of resilience after sandy. It connects back to sustainability that we have already been teaching, because of cycles...  
**Interviewee 2**: Looking at the whole ecosystem. However things interact with each other, there could be one simple cycle, like the water cycle, but how does that interact with something like decomposition and the plant life cycle-and you can look at those more difficult focuses and how do they all feed into each other.  
**Interviewee 1**: And how they are affected by people. |
| *Restoring habitat and re-creating marshes where they have fragmented so they can in turn help the surrounding communities.* | Continuing with volunteer opportunities restoring marshes and other habitat in Jamaica Bay, but explicitly linking ecological restoration with ecosystem service benefits to the nearby communities.  
Change in focusing on ecosystem services in the farm and surrounding Battery Park, which includes building/stewarding oyster reefs and providing learning opportunities about the history of the park’s waterfront. |
| Billion Oyster Project | Resiliency wise, I mean it is the best we can do. Right, we’re not going to rebuild the damage we’ve done over 400 years in our lifetime. I don’t think that’s a real mistake in how nature works. So 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, because it is this whole, umm. So All that is mostly social resilience. You’re Educating, training, making New Yorkers more aware. And yeah, there are some other elements. We’re working on Billion Oyster Project is part of this rebuild by design team led by SCAPE. | Continued place-based inquiry using scientific methods, but working with other organizations to incorporate oysters into their work. |
| Breezy Point Land Management Committee | I would say that there is a heightened awareness. That resilience is a heightened awareness and that there is motivation of the resources, tools, and action- to take motivation and related resources and tools to support action, direct action. That involves people, so community residents, and that directly improves the physical environment, so engaging in a better understanding of the social-ecological integration. | Developed dune planting activities and community-led coastal protection planning. |
| Brooklyn Bridge Park Conservancy | Well I think that would be a two-part answer. Resilience is a concept and so in terms of interacting students resilience is definitely abstract, in terms of the concept of relaying the concept of resilience. So there is a lot in the green design that they can’t see a lot that isn’t concretely visible. And so it is sort of an introduction for the students as far as resilient design in a green space. Resilience internally is the actual barebones of it, the construction of it and engineering of it. And of course there is a lot of trial and error, the park is pretty new. And so there are a lot of obstacles along the way in terms of the resilient design. Some stuff has had to be reworked. | Developed a course about oysters focused on the history of oysters and the ecosystem services that oysters provide. This course also incorporates science-based inquiry with participants measuring the growth of oysters living along the park’s shoreline. |
| GrowNYC | I think it is not just responding to the storm, but about being prepared for the storm or some kind of disaster. So preparedness is as much of thinking behind that booklet as what do you do after the storm. It is about being prepared. That’s our take on being resilient. If you’re prepared then you’ll be better able to handle whatever nature or the city, or whatever throws at you. Rather than just flopping in the wind and have to respond to emergencies, respond during emergencies rather than being prepared. | Developed resilience guide that has suggestions for community gardeners to prepare the garden and their community of practice for future storms and other disturbances. |
GreenThumb (GreenThumb resilience definition reflects ecological resilience but their practice integrates education and thus is more consistent with social-ecological resilience)

| By resilience we’re aiming to mean what is the infrastructure of the garden so that it is supported and if there was to be another disaster of sorts and we want to be sure that the garden doesn’t get destroyed in the ways that has happened, especially in those high needs areas. So we’re looking at these sustainable measures of materials and supplies, which includes anything from fencing, to the buffers, to the actual plants. And how the gardens, the gardens play a vital role in the climate. And especially when we have large storms they can act as bio swales almost to really absorb a lot of this water. So we really wanted to create the infrastructure within the garden to be more active as a utility in these natural disasters, rather than just being something that can easily be disrupted. | Supporting community gardeners to repair gardens impacted by Sandy and developed materials and other support to help prepare community gardens to respond to future impacts due to sea-level rise. |
For us we’re always talking about resilience in 2 specific realms; the biophysical resilience of a system, but also the social resilience of a system. We highlight how these 2 factors are then informing our full definition of resilience and how within an ecosystem we have to look at all of the networks between both the biological elements and the social elements. Those aspects are 100% put out there and then applied with the hands on lessons that we do.... For the biophysical or ecological, we’re talking a lot about the health over time and the impact on actual wildlife and how the human connection of how we can support the health over time. And then in terms of the social, more in the community speaking about how our participation in helping the system, the more biophysical system, will only strengthen the communities understanding and appreciation and building thinking about the park as an environment that provides resources and services for the community. And how that impacts the health of the system as people that use the park or people that live around the park.

Created two new courses: 1. Climate change course focused around the science and impacts of sea-level rise; 2. A course on oysters and the role that oysters have historically played in the Hudson River, and the role that they could play in building resilience to sea-level rise impacts. In addition, the park trust increased stewardship opportunities to support learning about the shoreline and to help maintain their green infrastructure projects.
<table>
<thead>
<tr>
<th><strong>Lower East Side Ecology Center</strong></th>
<th>[We’re] 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.</th>
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<tbody>
<tr>
<td><strong>New York Restoration Project</strong></td>
<td>Ok so social resilience, the way that we use it, basically 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 is really a sense of comfort and a sense of place. And then the environmental resilience kind of that standard definition of the ability to bounce back after an event like Sandy. So especially with Gil Hodges, the green infrastructure that we put on that site is meant to not only stay neutral in its environment-improve the environment by diverting storm water runoff from the sewer system. And the way that I understand it is that Deborah sees our work as working towards both of those goals and make trying to make them as unified as possible, the social and environmental components.</td>
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<td>Incorporated learning opportunities around green infrastructure projects along the East River shoreline, increased emphasis on community collaboration and educating about ecosystem services at East River Park, and working to create volunteering opportunities to maintain new plantings in the park. Developed green infrastructure monitoring programs with nearby university students and created volunteer opportunities with NYC residents to build neighborhood resources, such as solar panels and community gathering spaces</td>
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<tr>
<td>Organization</td>
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<td>Rockaway Waterfront</td>
<td><em>I don’t think we go into it, ‘let’s really focus on resiliency.’ I think it is just more about making the Rockaways a better place to live and making more opportunities for young people and the community members to make sure they have a say in the determination of their neighborhoods.</em></td>
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<tr>
<td>Alliance</td>
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<tr>
<td>Solar One</td>
<td><em>I would say that Resiliency is building capacity for adaptation. We can build resiliency through education and community-based work. We’re trying to build the cities capacity to adapt to the different situations that the changing climate might give us. We want to build that capacity so that we’re able to adapt in a safer way.</em></td>
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ACKNOWLEDGEMENTS
This work was supported by the USDA National Institute of Food and Agriculture, Multistate project NC1190. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the National Institute of Food and Agriculture (NIFA) or the United States Department of Agriculture (USDA).

We thank the resilient environmental educators in NYC who shared with us their practices.
Appendix I.
Interview Questionnaire

Resilience Meanings and Practices
1. Start with the quote from their interview. Can you tell me more about this?
2. What specific resources do you work with in these examples?
3. What do you mean by resilience?
4. What are the most important aspects of resilience for your work? If it helps, you can refer to the fact sheet that I have shared with you.
5. Are there other examples at your program that incorporate ideas of resilience?
6. What specific resources do you work with in these examples?
6a. At what scale is this work?

Sources and Resources for Resilience
7. What are particular skills that you feel have made it possible for you to incorporate these new ideas?
8. Where are your ideas about resilience coming from?
9. Who influenced you or are major influences in incorporating resilience in your work?
10. What other people or programs have you worked with to develop these new environmental learning opportunities?

Adaptation
11. Do you also incorporate climate adaptation education in your environmental learning opportunities? If so, can you please describe them?
12. How does climate adaptation relate to the work that you do that focuses on resilience?
12a. How do you define climate adaptation?
12b. Do you see a tension between your organization’s environmental values and your work on adaptation?
Appendix II.
Resilience Definitions handout shared with educators prior to interviews.
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.1

The magnitude of disturbance that a system can experience before it moves into a different state with different controls on structure and function. 4

The ability of communities to cope with and recover from external stressors resulting from social, political and environmental change. 3

Rate at which a system approaches steady state following a perturbation. 2

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 5, 6

Check out: www.resalliance.org

Check out: torrensresilience.org

Check out: www.resilientus.org

Check out: www.sebokwiki.org

Check out: www.APA.org
**PSYCHOLOGICAL RESILIENCE:** The concept of psychological resilience came out of research on young people in difficult situations. More specifically, in the 1980s, Ann Masten studied the children of schizophrenic mothers. Masten found that despite the fact that children of schizophrenic mothers received inferior caregiving, some of these children thrived. This led Masten to ask what about their psychology helped them to respond to this adversity, or to be psychologically resilient.

**SOCIAL-ECOLOGICAL SYSTEMS RESILIENCE:** In the early 2000’s, scientists recognized that the notion of sustainability, or managing for a steady state system, did not take into account the ongoing large and small changes that systems inevitably face. Social-ecological systems resilience was offered as a framework for thinking about how to manage systems taking into account such change, and the need to constantly learn and adapt our management practices as new information becomes available.

**ADAPTIVE CYCLE:** Ecosystems scientist Buzz Holling coined the term adaptive cycle to describe how ecosystems go through a sequence of rapid growth followed by a more stable or conservation phase, and then collapse, release, reorganization, and once again rapid growth. In the conservation phase, resilient social-ecological systems respond to change with small-scale adaptations. But if a major disturbance results in a system crossing a threshold and shifting into the release phase where social and ecosystem processes are radically changed, then major reorganization or transformations are needed for the system to be resilient.

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**For more information check out these sources:**

LITERATURE CITED


NAAEE, and Cornell University. 2015. EECapacity.