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Urban Environmental Education From a Social-Ecological Perspective: Conceptual Framework for Civic Ecology Education

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Abstract

A variety of environmental education practices are emerging to address the needs of an increasingly urban population. Drawing from social-ecological systems and social learning theory, we propose a conceptual framework to stimulate research questions in urban environmental education. More specifically, our conceptual framework focuses on environmental education programs that are nested within and linked to community-based stewardship or civic ecology practices, such as community forestry, streamside restoration, and community gardening. It suggests ways in which educational programs, stewardship practice, and other social-ecological system components and processes interact through feedback loops and other mechanisms, as well as means by which urban environmental education might lead to local ecosystem services and human and community well-being. Human and community outcomes may in turn result in pressure to change environmental policies.

Keywords

Urban; environmental education; social-ecological systems; civic ecology

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INTRODUCTION

Given the importance of nature-based experiences to pro-environmental behaviors, support for environmental policies, and human and community (Kuo et al. 1998, see Louv 2006 for a review of evidence) well-being, coupled with rapid rates of urbanization dictating that such experiences for much of the world's population will necessarily occur in cities, the question arises of how to provide urban nature-based and environmental education experiences. Frank et al. (1994) provide pedagogical support for environmental education in cities, claiming that programs in which youth are taken outside their urban surroundings may communicate that cities are unnatural, are separated from the otherwise integrated functioning of the planet, and offer nothing to teach or learn about. The recent expansion of environmental education to encompass Education for Sustainable Development, which seeks to “encourage changes in behavior that will create a more sustainable future in terms of environmental integrity, economic viability, and a just society for present and future generations” (UNESCO 2002), further suggests a need for educational approaches that take place within the context of communities, including in cities, so as to better foster learning about social as well as ecological processes. Similarly, calls for a place-based education that is rooted in local bio-physical as well as social place (Ardoin 2006) reinforce the need to explore models of linked community-environmental experiences for the over 50% of the world's population that lives in cities. Finally, recent international declarations demonstrating the commitment of cities worldwide to manage for ecosystem services and biodiversity provide potential opportunities situating learning experiences within urban environmental management practices.¹

Environmental education has been defined as “a process aimed at developing a world population that is aware of and concerned about the total environment and its associated problems, and has the attitudes, motivations, knowledge, commitment and skills to work individually and collectively towards solutions of current problems and the prevention of new ones” (Tbilisi Declaration, as summarized in Stapp, 2001). Broadly conceived, environmental education encompasses diverse and sometimes contradictory pedagogical approaches. For example, some environmental educators ascribe to behaviorally oriented practices such as teaching about recycling or how to reduce energy use, while others foster decision making and critical thinking skills with the goal of developing citizens capable of participating effectively in a democratic society (Chawla and Cushing 2007). Still other programs provide opportunities for students to experience nature directly, for example through spending unstructured time exploring the outdoors, through wilderness adventure programs such as Outward Bound, and through field instruction in natural history.

Perhaps in part due to this variability in approach, results from over 30 years of environmental education research present a complicated picture. For example, Kollmuss and Agyeman (2002) review evidence suggesting that whereas participants in programs designed to foster pro-environmental behaviors may not immediately change their behaviors, they may become more accepting of pro-environmental government policies. In another example, studies suggest that youth or adults who participate in wilderness adventure programs removed from their everyday environment often undergo profound personal transformations, yet do not necessarily engage in pro-environmental behavior when they return to their normal lives (Hattie et al. 1997; Kellert 1998; Haluza-Delay 1999; Marsh 2008). At the same time, a retrospective study of adults found that unstructured time in nature as a child was a significant predictor of adult pro-environmental attitudes and behaviors, whereas there were no significant relationships between presumably more structured environmental education experiences and adult pro-environmental attitudes and behaviors (Wells and Lekies 2006); the authors suggest that this result may be due to limitations in the operationalization of environmental education in their study.

¹ <http://www.cop10.jp/citysummit/english/images/top/declaration.pdf>; <http://www.cbd.int/nagoya/outcomes/>

A number of approaches to urban environmental education have been developed, based largely on adaptations of environmental education approaches used in other settings (e.g., Frank et al 2004, see also literature review below). However, we have found little in the way of theory to guide such efforts, despite the call by Dillon (2003) to develop and apply theory to guide environmental education research and practice. Drawing on our interests in urban social-ecological systems, in this paper we propose a conceptual framework that describes the interactions of one type of urban environmental education with processes and institutions in the surrounding environment, and focuses on community and ecosystem in addition to individual outcomes. As such, the proposed framework offers an alternative to and may complement existing frameworks that focus on predictors of individual environmental and citizenship behaviors (e.g., Hungerford and Volk 1990).

Further, we offer our framework in what we hope will be constructive opposition to forms of environmental education that teach only about the negative impacts of humans on the environment, that are based on assumptions about a human/nature dichotomy and human exemptionalism or exceptionalism (cf. Tidball In Press), and which use outcome measures that may be inappropriate or confusing for urban residents.² Rather our conceptual framework, which emerged out of our work in urban community gardens, community forestry, and similar community-based stewardship or civic ecology practices (Tidball and Krasny 2007; Krasny and Tidball 2010), reflects an integrated social-ecological systems perspective in which human activities may have positive outcomes for the environment and community. As such, our framework is consistent with recommendations by Potter (2010) that environmental education be considered as one of a suite of tools available to management agencies to improve environmental quality, and that studies should examine the outcome of environmental education programs on measurable changes in environmental quality.

In developing our framework, we look to the literature on complex, nested, and integrated social-ecological systems, which emphasizes feedbacks across scales over time and space (Berkes and Folke 1998; Gunderson and Holling 2002; Walker et al. 2006; Wimberley 2009), to explore how existing models used to inform natural resource management might be adapted to include the interactions of environmental education with other components of a social-ecological system. More specifically, we turn to the work of the United States Long-term Ecological Research (LTER) network in developing conceptual models for ecosystem processes in social-ecological systems including cities (Grimm et al. 2000; LTER 2007). We also draw briefly from the interactive (Illeris 2007) and social (Pahl-Wostl and Hare 2004; Wals 2007) learning literatures that describe learning as an outcome of interaction with the social and bio-physical environment (see also Alexander et al. 2009). Finally, in building our conceptual framework, we focus on one particular type of urban environmental education, i.e., civic ecology education, which refers to educational programs that engage participants in community-based stewardship activities, sometimes leading to engagement in the local environmental policy process (Krasny and Tidball 2009; Krasny et al. 2009; Krasny and Roth 2010).

The conceptual framework we present is intended to serve three purposes: (1) suggest how environmental education might become integrated with other activities that foster sustainability or resilience in social-ecological systems, and in so doing, enable us to see the value of environmental education at the scale of a local social-ecological system or small urban community; (2) propose research questions and testable hypotheses for environmental education, including questions that cross disciplines linking environmental education to ecosystem science, natural resources management, environmental sociology, and human health and well-being; and (3) propose a means to ground urban environmental education practices in ecosystem theory. Prior to discussing our conceptual framework for environmental education, we first present a brief overview of types of urban environmental education and then introduce two conceptual frameworks drawn from ecosystem science, which provide the foundation for our civic ecology education framework.

² E.g., the New Environmental Paradigm scale where agreement with statements such as the following are considered to reflect a pro-environmental outlook: “When humans interfere with nature it often produces disastrous consequences” or “Mankind is severely abusing the environment;” Dunlap and Van Lierre 2008.

URBAN ENVIRONMENTAL EDUCATION

Frank et al. (1994) describe urban environmental education as having “the same objectives as traditional environmental education: to encourage awareness, knowledge, attitude formation, skill development, and participation in solving environmental problems,” while also being “unique because it happens in *urban areas*, with *urban people*, and deals with *urban environmental systems and issues*.” These authors go on to suggest three approaches in urban environmental education: studies of the natural environment (e.g., inventories of city birds, trees and insects); studies of the built environment (e.g., understanding issues related to waste and water treatment in cities); and service learning and action projects (including making direct improvements such as planting community gardens, investigating environmental issues, and community action such as distributing flyers on water conservation). Other approaches to urban environmental education have similarly adapted traditional approaches to an urban setting. For example, Outward Bound runs urban outdoor adventure programs in which participants hike, take public transportation, and sleep in museums, tree-houses, and churches, while partaking of many course elements from more traditional wilderness expeditions (e.g., Leave No Trace™, map reading, and journaling);³ and a Cornell University Cooperative Extension program takes teens for an overnight to Governor’s Island in the NYC Harbor, where they learn about the cultural, historical, and environmental resources of the Island and sleep in tents with a view of the Manhattan skyline (Liddicato, pers. communication). In an example of a more science oriented program, the Boston Urban Ecology Field-based Studies encompass a suite of inquiry activities, including water quality monitoring, measuring avian diversity, and coyote and turtle ecology and behavior studies (Barnett et al. 2006). Cornell Laboratory of Ornithology’s Celebrate Urban Birds provides an example of a science focused program that has adapted traditional citizen science data collection activities to incorporate art contests, community service projects, gardening, and other activities that might attract young, urban participants.⁴

More recently, several groups concerned with social justice in urban and minority communities have incorporated environmental education, often with an emphasis on media, arts, and green jobs training. For example, Green Guerillas Youth Media Tech Collective in Ithaca NY engages young people, many of whom have been incarcerated, in activities such as making films that connect social, political, economic and environmental issues, engineering bio-fuel based cars, and nature exploration and photography⁵. A similar group, Grind for the Green, uses hip-hop culture, green jobs training, and connecting to the national and international eco-equity movement as vehicles to move “youth of color from the margins to the epicenter of the environmental movement.”⁶

A number of urban environmental education initiatives have integrated community development, environmental improvement, and science learning in community gardens and pocket parks (Fusco 2001; Krasny and Doyle 2002; Doyle and Krasny 2003; Elmerdnorf and Rios 2008), urban forests (Wolf and EarthCorps 2007), and other settings (Bouillion and Gomez 2001; Mordock and Krasny 2001). Perhaps the most comprehensive of these was the Chicago River Project, in which 5th grade classes embarked on a multi-disciplinary effort integrating science learning, parents’ practical knowledge, stewardship activities, data collection, and policy action (e.g., letter writing, community forum), which led to the clean-up and beautification of what had been neglected open space along the Chicago River.

³ <http://www.outwardboundbaltimore.org/documents/peerleadershipURBANoverview09.pdf>.

⁴ <http://www.birds.cornell.edu/celebration/join-us/about>

⁵ <http://www.guerrilla-griots.org/greenguerrillas.html>

⁵ <http://www.grindforthegreen.com/>

⁶ <http://www.grindforthegreen.com/>

CIVIC ECOLOGY EDUCATION

At Cornell University, we have coined the term “civic ecology education” to describe urban environmental education programs that engage youth in community-based stewardship to restore vacant lots, brownfields, streamsides, and other degraded habitats (Tidball and Krasny 2007; Krasny and Tidball 2009; 2010). Such programs integrate several long-standing environmental education approaches, including nature contact and democratic deliberation, while also reflecting the fact that the activities take place in *urban areas*, with *urban people*, and deal with *urban environmental systems and issues* (cf. Frank et al. 1994). In particular, civic ecology education considers urban areas as linked social-ecological systems, includes opportunities for young people to learn from the practical and diverse knowledge of urban stewards (e.g., community gardeners), and focuses on restoration of urban social-ecological systems. Where possible, it incorporates other elements of environmental education, including science learning, reflection on stewardship practice, communication skills (Kudryavtsev et al. In Press), and engagement in decision-making and policy processes. Programs in which youth and college students participate in planning and implementation of community gardens and pocket parks (Bouillion and Gomex 2001; Fusco 2001; Elmendorf and Rios 2008; Krasny and Tidball 2009), oyster-bed restoration, planting trees, and creating green-roofs,⁷ provide examples of civic ecology education. The commonality among these initiatives is that they engage students in a stewardship practice that represents a local civic asset in terms of community engagement in small-scale land use management. That such environmental education practices are not uncommon is suggested by a survey of 135 urban community-based stewardship organizations in six northeastern US cities, which found that the majority of these organizations incorporate youth programs and environmental education into their work (Svendsen and Campbell 2008).

The underlying principle of civic ecology education is that rather than viewing humans as acting principally to destroy otherwise healthy systems, humans can be seen as nested within (Wimberley 2009) and able to take action to improve communities and ecosystems. Thus, civic ecology learning can be recognized when participants have a measurable impact on the communities and ecosystems, or social-ecological systems, in which they live. Our particular interest is how civic ecology education programs might contribute to the social-ecological resilience of the community in which they take place (Folke et al. 2002; Walker and Salt 2006; Tidball and Krasny 2007; Krasny et al. 2009; Krasny et al. 2010a; Plummer 2010), through such processes as contributing to feedbacks and virtuous cycles (Powell et al. 2002; Matthews and Selman 2006; Selman 2006) that reinforce social connectivity, ecosystem services, and adaptive learning (Tidball and Krasny 2008). Although we focus primarily on outcomes at the level of communities and ecosystems, we contend that such outcomes are consistent with positive outcomes on participants (cf. Wals et al. 2008). For example, young people engaged in the Garden Mosaics civic ecology education program may benefit by enhancing their understanding of ecosystem science and their gardening skills, and by forming connections with elder community gardeners in their neighborhood. At the same time, they contribute to community enhancement and ecological restoration through their work in the gardens alongside elders (Krasny and Tidball 2009).

Although numerous approaches to urban environmental education are possible, situating educational activities in community-based stewardship activities allows programs to connect with growing movements focusing on urban ecological citizenship (Light 2003) and civic renewal (Sirianni and Friedland 2001). Further, such educational programs can be viewed through the lenses of current work in social-ecological systems and social learning as described below.

CONCEPTUAL MODELS FOR URBAN SOCIAL-ECOLOGICAL SYSTEMS

Grimm et al.’s (2000) conceptual model can be adapted to explain the interactions of a civic ecology practice, such as community forestry, in an urban social-ecological system (Figure 1). A (land management) decision to plant or restore a community forest constitutes a social process, which leads directly to changes in land

⁷ <http://urbanee.wordpress.com/>

use, ecological patterns and processes, and ecological conditions. This decision is made within an environmental context of lack of green space in cities and ongoing societal policies more or less favorable to community forestry, which also influence land use and ecological patterns and processes. Changes in the environment as a result of the community forest (e.g., spaces for people to observe and enjoy nature) may lead to changes in human perceptions and attitudes. These in turn impact additional decisions about land use, for example whether or not to develop vacant lots for commercial or open space purposes, setting in motion a virtuous cycle that feeds back to the social-ecological system through time (Tidball and Krasny 2008).

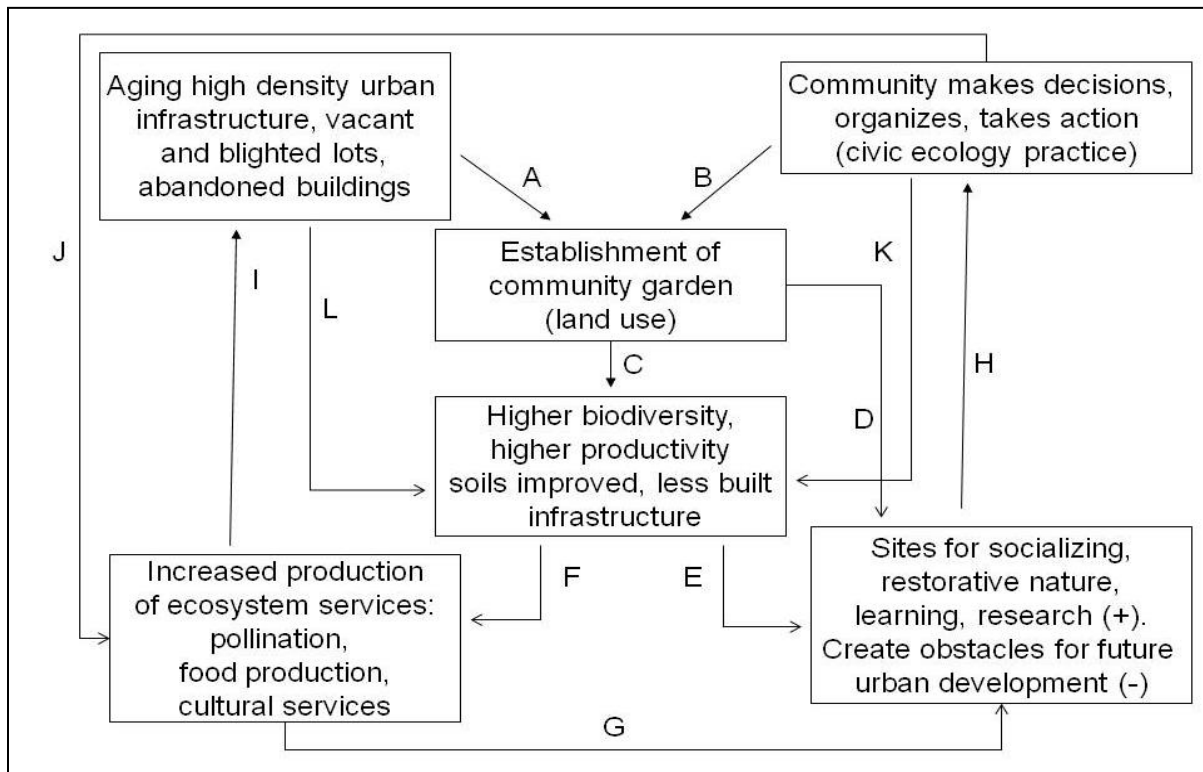


Figure 1. Conceptual scheme for integrating civic ecology practice with ecological and social processes in urban environment. (Adapted from Grimm et al., 2000.) Civic ecology practice is represented by upper right hand box: “community makes decisions, organizes, and takes action.”

Figure explanation. Letters preceding each step correspond with letters in the figure.

- A. Urban environmental context sets range of possibilities for land use.
- B. Societal decisions and human behavior are the direct drivers of land use change.
- C. The pattern of land use determines ecological patterns and processes.
- D. Humans perceive and react to land use change.
- E. Humans also perceive and react to ecological patterns and processes.
- F. Ecological processes as affected by land-use change result in changed ecological conditions.
- G. Changes in ecological processes may result in changes in attitudes as changed ecological conditions are perceived as good or bad by humans.
- H. Changes in perception and attitude feed back to the social system to influence decision-making, and this part of the cycle begins anew.
- I. In some cases, changed ecological conditions can alter the coarse-scale environmental context, resulting in a feedback that is relatively independent of human response.
- J, K. When a societal response to changed ecological conditions is deemed necessary, the society can act directly on the changed conditions (J) or on the underlying ecological patterns and processes producing the problem (K).
- L. Finally, the environmental context influences ecological patterns independent of land use.

More recently, the LTER network has proposed the Integrated Science for Society and the Environment (ISSE) framework, which builds on the earlier Grimm et al. (2000) framework to encompass recent work on ecosystem services (MEA 2005), and to further integrate the social sciences (LTER 2007). The ISSE framework includes a human template comprised of human outcomes and behaviors, as well as a bio-geophysical template encompassing community structure and ecosystem function. The human and bio-geophysical templates are linked through drivers, including short-term pulses (e.g., fire) and longer-term presses (e.g., climate change, increased human resource use), and through ecosystem services (LTER, 2007, Figure 2). The ISSE framework is being used to define research questions that link the social and ecological sciences and that focus on three areas fundamental to LTER research: land and water use change related to the dynamics of urban, exurban, and working systems; climate change, variability, and extreme events; and nutrient mobilization and species introductions (Textbox 1).

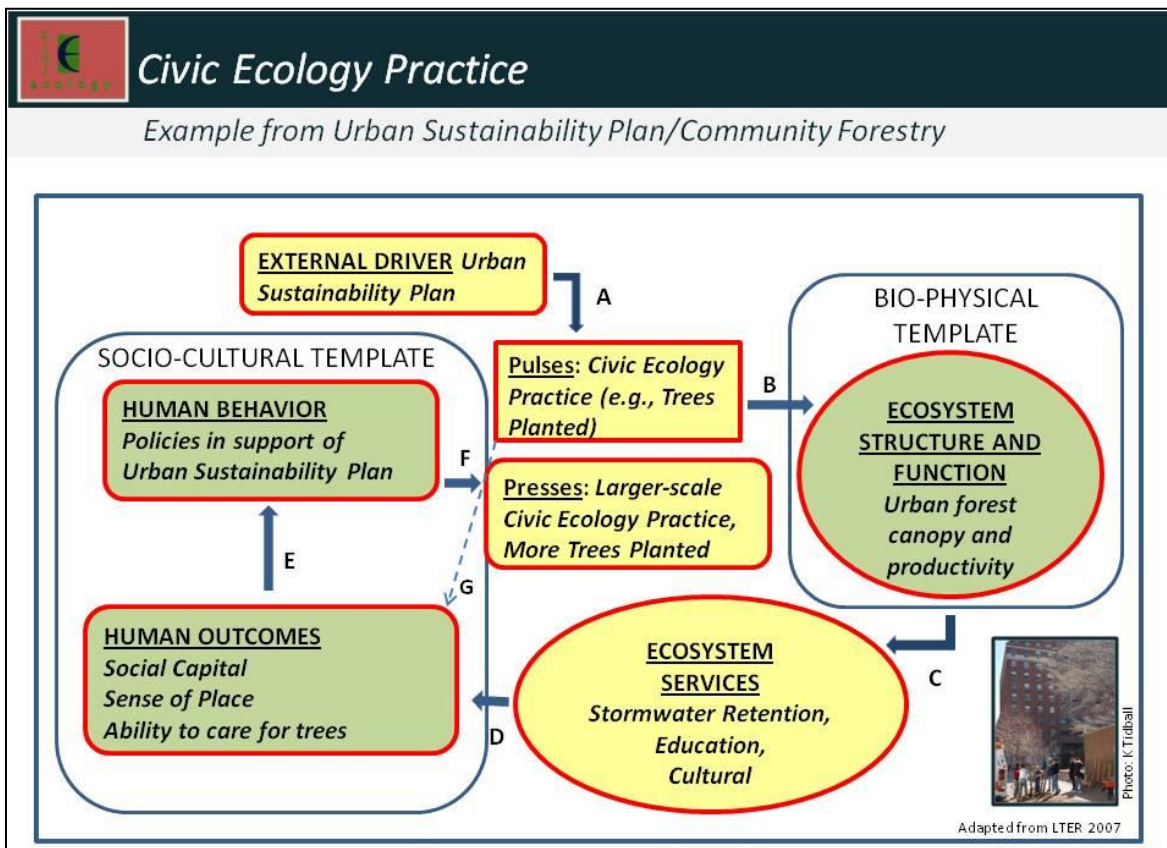


Figure 2. Conceptual Framework for Civic Ecology Practice. (Adapted from the Integrated Science for Society and the Environment Framework; LTER 2007.)

Figure explanation. Letters preceding each step correspond with letters in the figure.

- A. Urban Sustainability Plan fosters tree planting and care.
- B. Newly planted trees change urban forest canopy and productivity.
- C. Urban forests provide ecosystem services including opportunities for education and cultural activities and stormwater retention.
- D. Recreational and cultural opportunities foster social connectedness, sense of place, and ability to care for trees.
- E. Individuals experiencing benefits of urban forest canopy become supporters of tree planting and broader sustainability plan.
- F. Urban forestry and sustainability policies provide greater opportunities for civic ecology practices.
- G. Civic ecology practices may lead directly to human outcomes (interaction not in original ISSE model).

Land Use

- How do human activities cause change in working and urban systems and how does this change affect human activities?
- What are the causes of human activities that are linked to change in urban and working systems, and how do feedbacks from ecosystem change influence future causes?
- How does effective knowledge exchange occur?
- How can public policy and private management decisions be informed by knowledge of the impacts of human settlement and management on ecosystem characteristics and services?
- What are the causes of change in working and urban systems?
- By what mechanisms do humans directly or indirectly drive system dynamics?

Climate Change

- Does the probability of social action in response to changes in ecosystems or ecosystem services depend on the likelihood that social action will have a short-term effect?
- Is social action to address changes stemming from local drivers more likely than social action to address changes stemming from global drivers?

Textbox 1. Example Ecosystem Research Questions from ISSE Framework (Source: LTER 2007).

Such questions can be applied to the study of civic ecology practices (Figure 2). In the case of civic ecology, land use change comes about through community gardening, community forestry, and related activities in which groups of civically-minded individuals act as stewards of their local environment. Thus human activities impact the bio-geophysical template (ecosystem structure and function) in urban systems through creating more vegetation, which in turn generates ecosystem services such as the provision of food, mitigation of stormwater run-off, and educational opportunities (cf. MEA, 2005). The services in turn have outcomes for human health and well-being, such as understanding urban ecology, creating sense of place, and spending more time in the outdoors. Although not depicted in the ISSE conceptual framework, civic ecology practices may have direct outcomes on the “human outcomes” box (Figure 2), in addition to those mediated by ecosystem services (Tidball and Krasny 2008).

For example, simply by bringing community members together in productive activity, civic ecology practices provide opportunities for social connectedness and volunteering (Putnam 1995), or for spontaneous memorialization in communities affected by a disaster (Tidball et al. 2010). Regardless of their origin, human outcomes in turn may influence the human behavior “box” in the ISSE framework, as when a community of practitioners focused on urban forestry becomes engaged in the policy process by advocating for changes in government sustainability plans. Should the number and impact of these behaviors expand, the resultant social action may become a larger and longer-term pulse influencing system dynamics (Figure 2).

The ISSE conceptual framework can be used to describe potential relationships between the drivers of civic ecology practices and drivers of social action. For example, local drivers of civic ecology practices may include pulses such as Hurricane Katrina in New Orleans, which led to community forestry as a means of symbolic and social resilience (Tidball 2009), or the 9/11 terrorism attack, which led to the creation of Living Memorials in NYC and other communities across the US (Svendsen and Campbell 2005). Local drivers may also include presses, such as when gradual and large-scale urban decline resulted in neglected open space, which led to the community gardening movement of the late 1970s in northeastern cities (Lawson 2005) and a similar

resurgence of urban community agriculture in Detroit and other cities today.⁸ Several lines of research provide indirect evidence for how such local drivers of practice may become drivers of social action. These include studies of how active engagement of urban residents in transforming vacant lots into community gardens may lead to empowerment at the individual, organizational, and community level (Westphal 2003), providing the potential for engagement in local policy processes. An example is community garden activism in NYC in the late 1990s, which led to the recognition of community gardens as providing critical services to urban residents and thus worthy of protection (and may have been one among many factors contributing to Mayor Bloomberg's MillionTreesNYC and other PlaNYC⁹ sustainability initiatives).

BUILDING A CONCEPTUAL FRAMEWORK FOR URBAN ENVIRONMENTAL EDUCATION

Thus far, we have applied Grimm et al.'s (2000) and the more recent ISSE (LTER 2007) frameworks depicting drivers, feedbacks, and other ecosystem components and processes to understanding the role of community forestry and related civic ecology practices within an urban social-ecological system. Such an ecosystem approach is reflected in the term “civic *ecology*,” which suggests not only specific urban stewardship practices, but also the potential to study such practices from an ecosystem perspective. Consistent with this approach, and with the notion that educational programs can be situated or nested within stewardship practice, we have proposed an “ecology of environmental education” to describe the interactions among education and other ecosystem components (Tidball and Krasny 2009).

Whereas the work of Grimm and her LTER colleagues is useful for depicting the natural resources implications of civic ecology education, a learning theory perspective is also critical to developing a conceptual framework for urban environmental education. In this regard, we draw from interactive and social learning theories, which suggest that learning is situated in activity and occurs through interaction of the learner or a group of learners with their environment, including the people, built and natural features, and ecological and social processes (Pahl-Wostl and Hare 2004; Illeris 2007; Chawla 2008). Social learning theory also links interactive learning processes among youth with similar processes among adult stakeholders engaged in resource management. In a review of the social learning literature in both education and resource management, Muro and Jeffrey (2008) describe the parallels between social learning defined as students learning through imitation of and interacting with more experienced practitioners, and social learning defined as an iterative process involving natural resources management stakeholders in “the generation of new knowledge, the acquisition of technical and social skills as well as the development of trust and relationships (that) may form the basis for a common understanding of the system or problem at hand, agreement and collective action...”. This and other definitions of social learning from the natural resources management literature are intriguing in their redefinition of learning from being an individual cognitive process to becoming a deliberative process among groups of stakeholders leading to a management or a policy action (Schusler et al. 2003; Pahl-Wostl and Hare 2004; Blackmore et al. 2007).

Wenger's descriptions of how learners move from being peripheral and inexperienced to more skilled, core members of a community of practice (Lave and Wenger 1991; Wenger et al. 2002) are consistent with social learning theory and can be readily applied to understanding environmental education programs situated within civic ecology practice. For example, in the Garden Mosaics education program, youth become part of ongoing communities of practice with experienced gardeners and community activists (Krasny and Tidball 2009). Learning in such youth programs is highly experiential and may lead to both ecological (role of plants in generating ecosystem services) and civic (how to work with other gardeners, contributions of stewardship to community well-being) understandings.

⁸ <http://www.csmonitor.com/The-Culture/Gardening/2010/0428/Detroit-leads-the-way-in-urban-farming>

⁹ <http://www.nyc.gov/html/planyc2030/html/home/home.shtml>

Whereas Garden Mosaics takes advantage of an existing community of practice, in other instances, such as the Chicago River restoration education project described earlier (Bouillion and Gomez 2001), a new stewardship community of practice may emerge as a result of the educational program. Such fledgling educational communities of practice often become linked to other communities of practice focused on stewardship action and policy, as might occur when a newly initiated youth community forestry program becomes connected to a city-wide million trees initiative. Both the nesting of educational programs in, and linking of such programs to, ongoing communities of practice that support educational innovations are critical to leveraging program impacts and to helping sustain the educational innovations beyond short-term impacts (cf. Schlager and Fusco 2004).

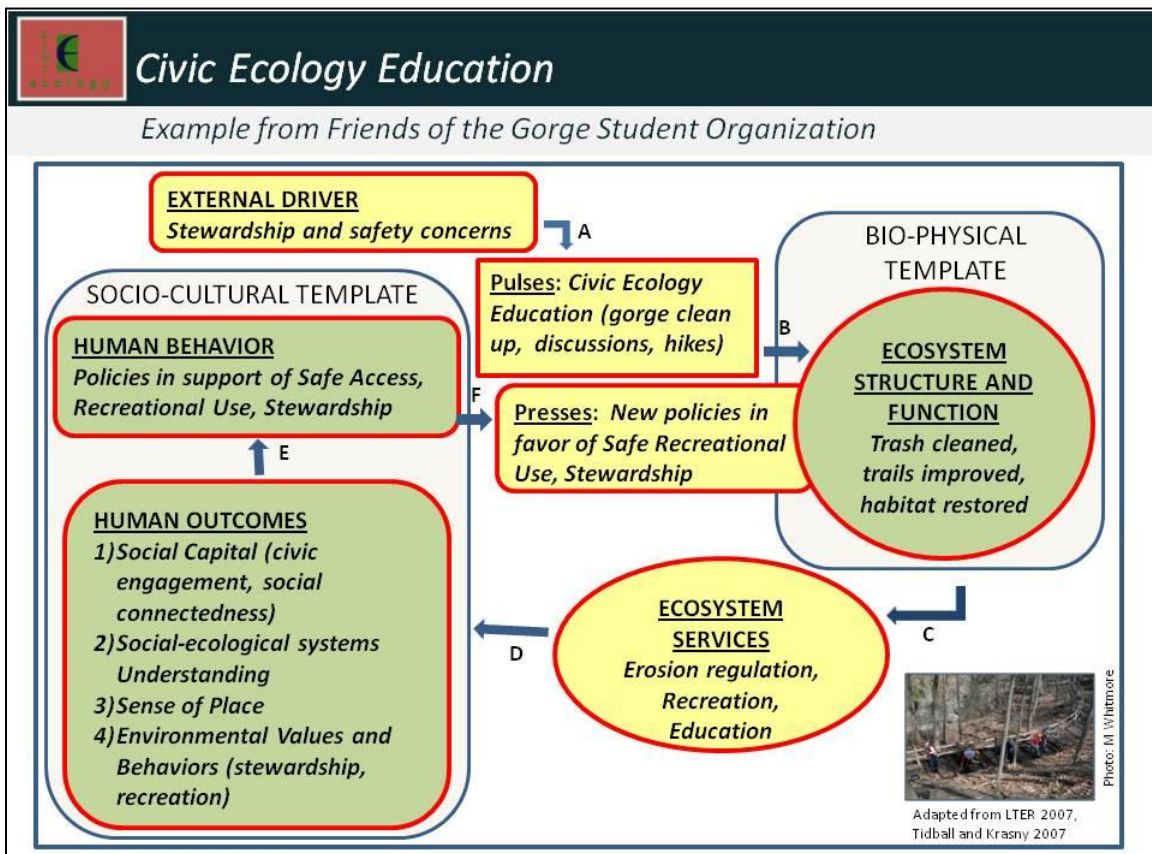


Figure 3. Conceptual Framework for Civic Ecology Education. (Adapted from the Integrated Science for Society and the Environment Framework; LTER 2007.) Note that consistent with social learning theory (see text), the educational program occurs within the context of resource management practice.

Figure explanation. Letters preceding each step correspond with letters in the figure.

- A. Concerns about dumping in gorges, student drownings and suicides, and University response to drowning (fencing and cutting-off access to gorge trail) prompt formation of Friends of the Gorge student organization. Activities include gorge clean ups, trail improvements, discussions with campus administrators, and hikes.
- B. Improvements to gorge trails and habitat.
- C. Enhancement of ecosystem services provided by gorge, including erosion regulation and more rewarding recreational opportunities.
- D. Recreational activities foster social capital, understanding of gorge social-ecological system and related management issues, sense of place, and further stewardship and recreational behaviors.
- E. Students become much more involved in discussions of campus natural areas policy issues.
- F. New policies regarding safety considered by University. Policies regarding stricter enforcement of dumping regulations implemented.

Given that learning in these civic ecology education programs is situated in ongoing or newly created civic ecology communities of practice, we can readily adapt the ISSE framework to elucidate the interactions between the educational programs and other ecosystem components and processes (Figure 3). In the example outlined in Figure 3, a new student organization was formed to address issues related to the safety and stewardship of natural areas (deep gorges with creeks running through them) on the Cornell University campus. Students began with stewardship activities (e.g., gorge clean-ups, trail improvements, invasive species removals), but quickly became participants in campus-wide discussions of natural areas management policy. Whereas Friends of the Gorge is emerging as a new community of practice, it also is linked with ongoing communities of practice such as those focusing on student mental health, as well as with new communities forming over increasingly important issues within the Cornell community related to balancing safety with access to natural areas.¹⁰ In this way, what started as relatively small, short-term efforts focused on steward practice have become part of larger and longer-term processes driving university natural area policy (Figure 3). In short, whereas any one stewardship activity is limited in its impact, additional outcomes may result from ties with community organizations and more formal institutions. In another example, youth in a civic ecology education program focusing on stream restoration connected with farmers, scientists, and citizen water monitoring groups, and in so doing leveraged their own ability as well as that of the other groups to become drivers of policy and social action (Krasny and Roth 2010). Pahl-Wostl (2007) has described similar feedbacks among groups of resource management stakeholders engaged in social learning, leading to management and social outcomes, which in turn feed back to effect changes in the governance structure and natural environment that provide the context for learning.

Educational programs situated in ongoing stewardship activities may become part of and intensify the outcomes of the feedback loops and virtuous cycles described earlier for civic ecology practices (Figures 1 and 2). For example, youth participation in community gardening becomes part of a social system feedback loop, in that the young people's work alongside gardeners fosters social connections and recognizes the importance of the elder gardeners' contributions, which in turn may encourage adults to become more engaged in community gardening. These human feedback loops interact with an ecological feedback cycle, for example, through increasing urban plant and pollinator diversity, and thus food production and other ecosystem services (Tidball and Krasny 2008).

Grimm et al. (2000) drawing from Grove and Burch (1997) also suggest that learning may contribute to resource management feedbacks:

Humans, as individuals and groups, are self-aware, capable of learning quickly, and engaged in extensive networks of rapid communication. These features of the human components of urban systems mean that the feedback among the biological, human, infrastructural, and the larger physical contexts can be strong, and in many cases, rapid. This is one reason that education has been incorporated into the structure of urban LTER programs. We hypothesize that learning about the heterogeneity and function of an urban area can be a tool that citizens and institutions can demonstrably use to improve their neighborhoods, city, and region through management, planning, and policy...

Incorporating data collection efforts, such as those of citizen science programs (Dickinson and Bonney In Press; Krasny and Bonney 2005), with civic ecology education, may help to provide the information needed to allow such rapid feedbacks to occur. In an example of such an effort, a Cornell graduate student helped youth and educators participating in oyster-bed, green roofs, community gardening, and related restoration efforts in the Bronx understand the concept of ecosystem services, and attempted to develop measures of both cultural and biophysical ecosystem services that the youth activities provide (Kudryavtsev et al. In Press).

¹⁰ <http://www.cornellplantations.org/our-gardens/natural-areas/friends-of-the-gorges> (The second author on this paper is faculty advisor for Friends of the Gorge, and is reporting on her personal observations.)

Thus, we have seen how an urban environmental education program and associated social learning can be situated in civic ecology practices, and how both the education program and stewardship practice in turn are nested within a larger social-ecological system. Through the lenses of social learning theory, we can envision multiple communities of practice, starting with those focused on relatively short-term efforts such as planting community gardens, restoring oyster beds, or cleaning up trash, and scaling up to become drivers of natural resource policy. Through their multiple emphases on individual learning and collective action, social learning theories also provide a means for linking outcomes of civic ecology education programs for individual learners, with outcomes for the larger social-ecological system.

In summary, despite global demographic and environmental changes, environmental education goals, practice, and research largely have remained focused on the behavior of individual participants. We propose that environmental education might draw from the work of ecosystem and social scientists to develop frameworks that view environmental education as part of ongoing social and ecological processes, including as contributing to virtuous cycles and feedbacks between the social and biophysical aspects of the environment, as fostering ecosystem services and human health, and as one among a number of drivers of social-ecological system processes. Such a perspective has implications for practice; for example, it might suggest that environmental education programs be designed to contribute to and reinforce positive feedbacks represented by already existing stewardship communities of practice, rather than act independently of the urban or other social-ecological systems in which education takes place. This perspective might also imply that in addition to linear logic models¹¹ of short-term impacts and longer-term outcomes, we incorporate feedbacks among various components of learning, education, and resource management systems into our understanding and design of educational programs.

The question remains as to whether this ecological view might be useful in understanding other types of urban environmental education, such as urban Outward Bound, citizen science, social justice, and green jobs training. Given that these programs generally include multiple elements (such as a service learning component on an Outward Bound expedition), the potential exists to explore the interactions of these initiatives with other ecosystem components and processes using the proposed or an adapted integrated social-ecological systems framework. Further, similar to civic ecology education, these programs provide opportunities to develop a sense of competence or empowerment (e.g., through seeing the results of one's data collection, habitat restoration, and civic activities). Given research suggesting the importance of sense of competence or empowerment in influencing environmental behaviors (Hungerford and Volk 1990; Chawla and Cushing 2007), the potential exists for civic ecology and other urban environmental education programs focusing on more local issues (e.g., neighborhood land use) to provide the basis for subsequent engagement in social action to address larger issues (e.g., climate change; cf. Dickinson 2009).

TOWARD AN URBAN ENVIRONMENTAL EDUCATION RESEARCH AGENDA

How might we create an environmental education research agenda that builds on questions being posed by integrated teams of social and ecological scientists (LTER 2007)? We might posit a series of research questions that follow the processes depicted in our conceptual model (Figure 3, Textbox 2). These include questions related to the outcomes of environmental education on ecosystem structure and function and subsequent ecosystem services, questions which directly address Potter's (2010) call for research to determine the direct impacts of environmental education on environmental quality. Other questions relate to how environmental education programs might mediate the outcomes of ecosystem services for humans (e.g., through providing more opportunities to access green space with subsequent outcomes for human health). Finally, we pose questions about how environmental education efforts can be scaled up to influence policy and how they may play a role in feedbacks and virtuous cycles (Textbox 2).

¹¹ <http://meera.snre.umich.edu/plan-an-evaluation/plonearticlemultipage.2007-10-30.4643560864/step-2-clarify-program-logic>

Outcomes Related to Ecosystem Structure, Function and Services

- How might different types of environmental education directly impact ecosystem structure and function?
- What ecosystem services are protected, enhanced, or restored as a result of various approaches to environmental education?

Outcomes Related to Humans and Social Systems

- How can environmental education mediate the use of recreational ecosystem services so that people are more likely to use those services (e.g., through fostering use of urban green space among families and friends)?
- How might individuals using ecosystem services restored as a result of an urban environmental education program experience changed sense of place or social connectedness?
- What are the individual, organizational and community health and well-being outcomes of different approaches to urban environmental education?

Scaling up from Stewardship Practice to Public Policy

- How can environmental education mediate choices about acceptable neighborhood structures, resulting in changes in city government behavior related to management of green space in cities?
- What is the relationship between youth engagement in local stewardship projects and engagement in policy related to land use?
- What is the relationship between youth engagement in local stewardship projects and engagement in policy related to other environmental issues (e.g., climate change)?
- What factors in addition to knowledge and values might influence engagement in the policy process (e.g., sense of place, social capital)?

Feedbacks and Virtuous Cycles

- What feedbacks exist between stewardship participation, environmental education, and policy engagement?
- In what situations does environmental education become part of and intensify ongoing feedback processes brought about by ongoing civic ecology practices?
- In what situations do changes in policy brought about through environmental education create additional opportunities for stewardship, connecting with social-ecological systems, and learning?

Textbox 2. Example Research Questions for Environmental Education Suggested by Conceptual Framework.

Another research question is whether civic ecology practices might become a more important driver of social action related to environmental policy (e.g., climate change) compared to educational efforts that engender negativity and feelings of powerlessness. Results reviewed by Dickinson (2009) demonstrate the role of fear, such as might be engendered by climate change and some forms of environmental education, in stimulating actions that are counter-productive to environmental sustainability (e.g., consumerism to enhance self-esteem, unquestioning devotion to charismatic leaders, outright denial). We might hypothesize that asset-based approaches to environmental education, which attempt to foster a sense of competence, self-esteem, and bonding social capital, may also lead to bridging social capital with institutions and organizations (cf. Dale and Onyx 2005), creating opportunities to influence policy. Interestingly, education is mentioned in several of the ISSE research questions focusing on climate change, including: “Will changes in public education and awareness alter the human drivers

of climate change? How will people organize to affect the pace of climate change in response to extreme events, and what sources of motivation (educational, informational, cultural, and economic) will be key to changes in behavior and attitudes? What is the relative importance of natural disasters, education, iconic species, and changes in economic incentives for altering climate-changing behavior and policy?" (LTER 2007).

The next step in creating a research agenda will be to engage a larger community of scholars and practitioners in more formally posing questions, and in developing appropriate research designs and measurement tools. In our Civic Ecology Lab at Cornell University, we have begun to develop tools for measuring changes in environmental education program participants, and in their local community and ecosystem, which are consistent with this framework. These measures include surveys of sense of place and of social capital that have been tested for reliability with youth audiences, and measures of ecosystem services that are suitable for small scale urban restoration projects (Krasny et al. 2010b; Kudryavtsev et al. In Preparation). A related research project, conducted as a collaboration between the Civic Ecology Lab and Cornell Human Dimensions Research Unit, is focusing on understanding the environmental views held by urban environmental educators, in the hopes of expanding our perspective on what constitutes environmental education in urban settings (Tidball and Lauber 2010).

CONCLUSION

Practical considerations regarding the need for environmental education to act as one of a suite of "tools" to enhance environmental quality (Potter 2010), plus work that calls for non-linear solutions that take into the account the complexity of social-ecological systems (Walker et al. 2006; Liu et al. 2007), suggest the importance of understanding the interactions of educational programs with other system components and processes (Tidball and Krasny 2009). The conceptual framework presented in this paper was developed as a means to place our work in community gardening, urban community forestry, and related civic ecology practice and education within a larger context of efforts to address urban natural resources management. Two components of this framework are critical. First, rather than starting with an assumption that humans act primarily to degrade more "natural" ecosystems, we start with social-ecological systems that are already compromised in terms of their ability to produce many ecosystem services, and draw on recent work on urban environmental stewardship in the United States (Svendsen and Campbell 2008; Tidball et al. 2010) and Europe (Barthel et al. 2005; Ernstron et al. 2008; Cramer 2010; Wals and van der Waal In Press) to examine the actions taken by humans at a local scale to enhance such systems. Second, we draw on learning and ecological theory to suggest that learning can be viewed as a system of interactions among learners and their social and bio-physical environment, and that learning can occur within an environmental education program that is nested in a stewardship or resource management practice, which is in turn nested in and interacts with a larger social-ecological system (cf. Wimberley, 2009). Interactions within and across systems take the form of various types of drivers, feedbacks, and outcomes related to ecosystem services, human well-being, and policy.

We recognize several next steps in the process of developing urban environmental education practices and theory. These include further integration of learning and management frameworks, development of new kinds of logic models that include feedbacks and other non-linear interactions, and undertaking research to understand the processes and outcomes of civic ecology and other forms of urban environmental education. We are hopeful that the framework presented will stimulate discussion, programs, and research focused on environmental education and learning situated within community-based stewardship and management efforts in cities with potential outcomes at the individual, community, and ecosystem levels.

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