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Urban home food gardens in the Global North: research traditions and future directions

John R. Taylor · Sarah Taylor Lovell

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Abstract In the United States, interest in urban agriculture has grown dramatically. While community gardens have sprouted across the landscape, home food gardens—arguably an ever-present, more durable form of urban agriculture—have been overlooked, understudied, and unsupported by government agencies, non-governmental organizations, and academics. In part a response to the invisibility of home gardens, this paper is a manifesto for their study in the Global North. It seeks to develop a multi-scalar and multidisciplinary research framework that acknowledges the garden's social and ecological or material dimensions. Given the lack of existing research, we draw on the more extensive literature on home gardens in the South and community gardens in the North to develop a set of hypotheses about the social-ecological effects of urban home food gardens in the North. These gardens, we hypothesize, contribute to food security, community development, cultural reproduction, and resilience at multiple scales; conserve agrobiodiversity; and support urban biodiversity. They may also have negative ecological effects, such as stormwater nutrient loading. Because of the entanglement of the social and the ecological or material in the garden, we review three theoretical perspectives—social ecological systems theory, actor-network theory, and assemblage theory—that have been or could be applied to the multi-scalar and multidisciplinary study of the garden. We also review sampling and analytic methods for conducting home garden research. The paper concludes with a discussion of opportunities to extend the research agenda beyond descriptive analysis, the primary focus of garden research to date.

Keywords Urban agriculture · Home garden · Global North · Ecosystem services · Food security · Resilience

Abbreviations

ANT	Actor-network theory
NGO	Non-governmental organization
RDD	Random digit dialing
SES	Social-ecological system

Introduction

In the United States, community gardens have long captured the imagination of a wide range of individuals and organizations, including grassroots activists, government officials, academics, and non-governmental organizations (NGOs) and their funders. These groups have shown less interest in promoting home food gardens as a way of addressing the same urban issues—community development, food security and access, public health, and the ecological functioning of urban systems—that community gardens are claimed to address. While funding and other forms of support for public forms of urban agriculture have blossomed, the few public outreach programs to urban home gardeners have withered. In our own study area of Chicago, IL, the city council passed a zoning amendment in 2011 expanding the allowable size of community gardens and permitting and regulating urban farms as a land use by right but excluding farms from residential districts (City of Chicago 2013). In 2012, the Mayor's Office announced a $1 million dollar investment in 60 school

J. R. Taylor (✉) · S. T. Lovell
Department of Crop Sciences, University of Illinois Urbana-Champaign, Urbana, IL 61801, USA
e-mail: jrtaylo2@illinois.edu

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learning gardens (Lansu 2012). And while the city no longer provides direct assistance to community gardens through its Greencorps program, it continues to subsidize public forms of urban agriculture by making city-owned lots available for community gardening and urban farming and by cosponsoring an urban farmer training program on city-owned land (Hinz 2013). At the same time, city government support for home gardeners is limited to a rebate program for rain barrels and compost bins. Furthermore, because of state government funding cutbacks, only one University of Illinois Cooperative Extension educator for horticulture now serves the entire population of 2.7 million residents. At the same time, recent work indicates that in Chicago, the aggregate production area of home gardens may far exceed that of community gardens and other forms of urban agriculture (Taylor and Lovell 2012).

Research on urban agriculture mirrors this bias. While a large number of research projects have examined social and/or ecological aspects of community gardens, only a handful of studies have been conducted on contemporary home food gardening in nonrural settings in the North (Kortright and Wakefield 2011). Following Kortright and Wakefield (2011), we define a "home food garden" as a fruit and/or vegetable garden on leased, owned, or borrowed land directly adjacent to the gardener's residence; it may include plantings in containers or on rooftops. We further restrict the definition to gardens managed by a single household. A recent review of the English language academic literature on community gardens, identified 46 research articles published between 1985 and 2011 on food producing urban community gardens in the United States (Guitart et al. 2012). A similar search for peer-reviewed articles on urban home food gardens in the United States yielded only five articles: two quantitative analyses of the spatial distribution of urban food gardens, including home gardens, in Chicago, Illinois (Taylor and Lovell 2012) and Madison, Wisconsin (Smith et al. 2013); a socio-demographic analysis of survey data from rural, suburban, and urban households with food gardens in the state of Ohio (Schupp and Sharp 2012); a qualitative study of Vietnamese home gardeners in Louisiana (Airriess and Clawson 1994); and a study of households participating in a home gardening program in San Jose, CA (Gray et al. 2013). The lack of interest in urban home food gardens is perplexing, particularly because the social, economic, and health benefits of home food gardens are well documented in the Global South, where these "homegardens" are reported to diversify diets (Cabalda et al. 2011), increase the food security of households and communities (Kumar and Nair 2004; Buchmann 2009), strengthen household and community resilience (Aguilar-Støen et al. 2009; Buchmann 2009), and support urban livelihoods and provide informal sources of income for households (Drescher et al. 2006; Kumar and Nair 2004; Méndez et al. 2001).

The neglect of these gardens as a focus of academic research and development policy has several possible origins. Researchers may assume residential landscapes—at least in the United States—to be dominated by turf and to be homogeneous (Harris et al. 2012), an assumption reflected in the literature's focus on suburban lawns. Alternatively, food gardens may seem too trivial for serious academic inquiry, like home gardens in general (Hondagneu-Sotelo 2010). The systems of knowledge, practice, and belief associated with them may be deemed to be irrelevant, because indigenous knowledge in the sense of "folk" knowledge has purportedly been displaced by science and technology in the developed world (Ellen and Harris 2000). The devaluation of household production because of (1) its traditional association with the unpaid labor of women and (2) the bias in a capitalist society toward the production of exchange value, of goods to be sold rather than used by their producer or her family, may also play a role (Gibson-Graham 2006). Certainly, NGOs and other groups often privilege the development of mainstream capitalist entrepreneurship or alternative capitalist ventures—such as urban farms—that combine social outreach and market production. In a neoliberal environment, NGOs and their funders may perceive market production as legitimizing urban agriculture as a form of self-help and a path to economic independence for disadvantaged populations. Even calling urban agriculture "agriculture" may be seen as a move to professionalize and even masculinize the practice and study of urban food production, which is often more akin to domestic gardening in scale than to conventional farming.

Conducting research on home gardening—and other forms of household self-provisioning such as hunting, fishing, and gathering—also presents unique obstacles that may in part account for the lack of research—and public policy—on urban home food gardens. Located on private property—often in backyards screened from researchers' view by privacy fences or on the balconies of apartment buildings—home gardens may in general be less visually and physically accessible than community garden plots and other forms of public or semi-public urban agriculture. Identifying and sampling gardens can be time consuming, requiring the screening of individual households for home food production (Smith et al. 2013; Kortright and Wakefield 2011). The sheer diversity of home food gardens in location, form, size, and function further complicates the formulation of research questions, sampling, and other research protocols. A recent city-wide study of urban agriculture in Chicago, for example, identified larger home gardens on rooftops, on vacant lots, in backyards and front or side yards, and in parkways, rights-of-way and other

interstitial spaces (Taylor and Lovell 2012). Smaller food-producing container gardens may be found on balconies, decks, or terraces. Gardens may be devoted entirely to annual vegetables and herbs or may include perennial ornamental, medicinal, or fruiting plants and other food production structures, including beehives and chicken coops. Gardens may be maintained for food, recreation, cultural reasons, barter, or profit or a combination of purposes (Kortright and Wakefield 2011; Mazumdar 2012; Schupp and Sharp 2012). While seemingly simple, home food gardens appear to be spatially, ecologically, and sociologically complex elements in the urban landscape. Thus, they can be difficult to study, requiring expertise—or at least familiarity—with diverse disciplines and research methodologies.

In part a response to the neglect of the home garden in research and policy circles, this paper is a manifesto for the study of urban home food gardens in the Global North. Eschewing a strictly functionalist interpretation of the garden, the paper seeks to develop a multi-scalar, multi-disciplinary research framework that acknowledges the social and biophysical (or material) dimensions of the garden and transcends traditional society/nature dualisms. The paper begins with a selective review of the existing literature on gardens, focusing on research with potential relevance to the study of social-ecological interactions in home food gardens. Because of the lack of research on domestic food gardens in the North, the review draws on and integrates selected findings from the more prodigious body of work on community (or allotment) gardens in the North and home gardens in the South. Based on this review, we begin to develop an agenda for the study of the urban home food garden in the North. We identify the considerable gaps in the existing literature on the urban home food garden in the North, outline potential areas of research, and develop complementary sets of hypotheses and questions about the social-ecological dynamics of the food garden. A brief discussion of the theoretical perspectives and sampling and analytic methods through which these research hypotheses and questions can be addressed follows.

The research hypotheses and questions we identify potentially apply not only to urban home food gardens in the North but to food gardens in general, including community gardens. Consequently, the paper provides a framework for food garden research in general and establishes a basis for comparing different forms of food production within and across regions or along an urban to rural continuum. The paper concludes with a discussion of additional research opportunities that pushes the urban home food garden research agenda beyond the descriptive analysis that has been the primary focus of garden research to date.

The social and ecological properties of the garden: a review of the literature

Our review of the literature draws on a wider range of published sources than the limited work on urban home food gardens in the Global North, including the literature on home gardens in the South and rural North and community gardens in the North. We recognize that the social, cultural, ecological, and economic contexts of home gardens in the North and South are very different, and the roles these gardens play in household and community reproduction and their ecological effects may also be very different. Home gardens in the South, for example, may be expected to make a greater contribution to food budgets and may be more likely to furnish livelihoods for households through the sale of garden products. The literature suggests gardens in the South are more structurally complex than those in the North and harbor a greater diversity of food plants and other species (Nair 2006). Gardens in rural areas may be attached to farms and can be expected to be larger than those in urban areas, where home lots are smaller and real estate development pressures higher. Differences in home food provisioning between rural and urban areas, however, may have diminished over time in developed countries (Schupp and Sharp 2012).

The processes associated with community gardens can also be expected to differ somewhat from those of home gardens, though the term "community garden" covers a broad range of garden types characterized by diverse spatial and ecological characteristics and ownership and management characteristics (Guitart et al. 2012; Jamison 1986) and has even been deemed to be "inchoate" by one scholar (Pudup 2008). At one end of the continuum, entire gardens may be managed collaboratively by a group of gardeners; at the other, gardens may be divided into individual plots resembling private property, and the entire garden may be managed by an independent party, such as an NGO or government agency. The research literature and our own fieldwork suggest that home gardens also exist on a public to private continuum. In densely populated urban areas, home gardens may be less private than is often assumed. They may be visually accessible to passersby from alleyways and sidewalks and to the residents of adjoining buildings through chain-link fences or from the windows of upper stories. Gardeners may share plants, produce, and information across the garden fence with neighbors or passersby (Taylor and Lovell, unpublished data), and evidence from both the North and the South suggests that home gardens may be a communal resource (Buchmann 2009) or may be produced, in part, through the activities of the larger community (Chevalier 1998).

The differences between seemingly disparate types of gardens in divergent contexts may thus be more of degree

than of kind, and some of the same or similar processes may be at work in urban and rural or home and community gardens in the North or South. Consequently, we include research on all of these gardens in the following review. Because of the wealth of published literature and "grey" material on these gardens, we have necessarily limited the review to published, English-language sources and have focused on the peer-reviewed academic literature. The focus of the review is further limited to research on the contemporary food garden. We recognize that research on home gardens can and should be grounded in the study of their specific historical context and development. Their form and function may be influenced by not only the personal history and cultural background of their owners but also larger scale structures and events, such as the patterns of exclusion and marginalization that characterize uneven urban development (Moore 2006) and technological innovations, e.g., the introduction of synthetic fertilizers and pesticides after World War II. Because the history of urban home food gardening actually comprises many individual histories specific to particular regions or cultural groups, a review of the relevant literature—much of which remains unwritten—is beyond the scope of this article. Useful entry points into the general history of urban gardening include: Bassett (1981) and Lawson (2005) on community gardening in the United States; Tucker (1993) on home or "kitchen" gardening in the United States; Gaynor (2006) on suburban food gardening in Australia; and Crouch and Ward (1988) on allotment gardening in Great Britain.

Other authors have offered literature reviews focusing on contemporary "residential landscapes" (Cook et al. 2012) or community gardens (Guitart et al. 2012). The current review differs in its integration of findings across garden types, regions, and urban–rural contexts and its specific focus on research with potential relevance to the multi-scalar and multidisciplinary study of the urban home food garden in the North. The review is guided by a broad conceptualization of the garden as a system, network, or assemblage of interacting social and biophysical elements. The properties of the system—including any positive or negative social, ecological, or economic effects—are the result of the relationships and interactions between its individual elements. This perspective, informed by actor-network theory and assemblage theory but not excluding social-ecological systems theory, helps to decenter the agency of the gardener in producing the garden and fosters a greater attention to the biophysical elements of the garden, including plants, soil, insects, and other fauna, and their role in the garden. The review is organized by seven reported properties or effects of the garden, with a focus on the social-ecological dynamics—or interactions between the social and material—giving rise to each.

Food security and access

Home and community gardens are reported to enhance household and community food security and access in various ways. In the Global North, community gardening increases household and community food security through the production and sharing of food, which may also be sold from garden plots (Vitiello and Nairn 2009; Baker 2004; Corlett et al. 2003). Gardens provide access to healthy food for low-income families who have limited food access or cannot afford fresh produce, and community gardeners reportedly consume more servings of fresh fruit and vegetables each day than non-gardeners (Alaimo et al. 2008; Twiss et al. 2003). Garden production supplements nutritional assistance from federal programs (Kantor 2001) and offsets income needs, improving the economic status of the household (Corlett et al. 2003; Baker 2004). Community gardens give neighborhood residents greater control over the food system, enhancing local food sovereignty and community self-reliance (Baker 2004).

Home gardens have also been reported to strengthen local control over the food system in the South, where home gardening may be a response to inadequate access to food through market sources (Buchmann 2009). These gardens increase the food security of individual households and enhance community food security through the distribution of plants and food through social networks (Kumar and Nair 2004; Buchmann 2009). Through these networks, home gardens may be "socially merged," distributing risk across the community and enhancing the resilience of the local food system (Buchmann 2009). By making nutritious foods easier to access, home gardens—like community garden plots in the North—are reported to diversify diets (Cabalda et al. 2011). They also support urban livelihoods and provide informal sources of household income through the sale of products from the garden (Drescher et al. 2006; Kumar and Nair 2004; Méndez et al. 2001).

In the North, the contributions of home gardens to local food systems have been under-characterized through either qualitative or quantitative methods, and research findings are equivocal on the relationship between home gardening and food (in)security. A large ($n = 523$) quantitative survey of rural and urban Iowa residents found significant positive correlations between the diversity and the number of servings of fruits and vegetables consumed and ownership of or access to a garden. Not surprisingly, a smaller percentage of urban compared to rural residents had a garden or had access to a friend or family member's garden (Morton et al. 2008). Gray et al. (2013) also found a self-reported increase in vegetable consumption among households participating in a home gardening program in San Jose, CA, due to the greater availability of fresh produce. Households reported

substantial—and possibly inflated—savings from vegetables produced through the program. Similarly, from a qualitative study conducted in Toronto, Kortright and Wakefield (2011) conclude—again based on the self-reports of gardeners—that home gardens contribute to food security at the household and community levels by making diverse and nutritious foods readily accessible to household residents and community members. (Kortright and Wakefield (2011, p. 41) define community food security as "a situation in which all community members are able to access a safe, nutritious, and culturally acceptable diet, achieved sustainably and in a way which maximizes community self-reliance and social justice," a definition which we adopt in our review.)

Home gardens' contributions to food security at either level, however, may be relatively small. Only one-third of gardeners in Kortright and Wakefield's study, for example, reported producing a "substantial" amount of food, and in general gardeners shared only a "small amount" of homegrown produce with neighbors and friends. The safety of this produce and the sustainability of the methods used to produce it are also questionable. Kortright and Wakefield's (2011) informants reported practicing organic cultural methods, which the researchers assume to be safe and sustainable. However, neither that study nor any other published study of urban home food gardens in the North has critically assessed the risk that contaminated garden soils pose to human health or the sustainability of gardening inputs and practices in terms of their environmental externalities, effects on ecosystem processes, or implications for community self-reliance and social justice.

The relationship between home gardening and household income or economic hardship, as a proxy for food insecurity in the most basic sense of a lack of consistent access to adequate food, is also equivocal. In a quantitative study of urban agriculture in Madison, Wisconsin, Smith et al. (2013) report a positive relationship between household income and home food gardening, which they attribute to household economic advantages. However, in their analysis of survey data from the 2008 Ohio Survey of Food, Agricultural, and Environmental Issues, Schupp and Sharp (2012) found no relationship between household income and gardening but did find a positive relationship between household economic hardship and participation in home gardening, suggesting gardening may be a response to and a strategy for reducing food insecurity.

Resistance and empowerment

The persistence of urban gardening in developed countries, it is claimed, challenges the "urban normative," a narrative that denies urban subsistence gardens are a legitimate and durable urban land use and dismisses them as a temporary response to crisis to be resolved through economic development (Moore 2006). Consistent with this claim, much of the literature on community gardens focuses on the ways in which community gardens are spaces of community empowerment and resistance to marginalization and dominant narratives of urban development. In these gardens, community groups become empowered through collective, place-based decision-making (Gottlieb and Fisher 1996), assert their right to the city (Smith and Kurtz 2003; Staeheli et al. 2002), and resist dominant paradigms of land use planning, urban development, and urban design (Baker 2004; Gottlieb and Fisher 1996; Punja 2009; Staeheli et al. 2002; Smith and Kurtz 2003; Schmelzkopf 2002).

Resistance and empowerment also occur at the individual level in the space of the garden. Interacting with and nurturing plants and witnessing the cycle of growth in community gardens can catalyze personal growth and transformation and promote resistance to social and economic marginalization and racism (Pudup 2008). Traditional or stereotypical gender roles may be reproduced but ultimately resisted in the space of the garden. Women, for example, may recruit men for heavy or labor-intensive tasks in the garden, but without relinquishing power to them. Success in the garden further promotes among women gardeners a sense of agency and self-efficacy, prompting them "to seek new opportunities or responsibilities outside their garden" (Parry et al. 2005, p. 183). Personal empowerment may lead to broader forms of social activism. White (2011) claims that for African American women in Detroit, community gardening and farming is a form of protest leading to such activism, "one where their energies not only feed their families and their communities healthy food, but also feed their need to be the change agent in their community" (p. 24).

Some community gardening programs, though, may have less salubrious effects. Pudup (2008) argues that contemporary community gardens are generally not sites of community resistance to marginalization like those of the 1970s and 1980s but are better characterized as "organized garden projects" where "non-state and quasi-state actors…deliberately organize gardens to achieve a desired transformation of individuals in place of collective resistance and/or mobilization" (p. 1230). Gardening as a form of social control and assimilation, however, has a long history, from its promotion among the middle and working classes as a form of labor discipline in Victorian England (Gaskell 1980) to the incorporation of school and community gardening into programs of assimilation for African American, Native American, and immigrant communities in the United States in the nineteenth and twentieth centuries (Lawson 2005).

Community development

A complementary research focus has been the contribution of community gardens to community development. Community gardening, according to the literature, fosters the development of dense and extensive social networks characterized by strong and weak ties, social capital, and a sense of community that extend beyond garden boundaries. The initial formation of a garden requires the enrollment of diverse groups in new social networks (Baker 2004). The ongoing communal work and democratic governance of the garden encourages further development of new social bonds and networks within the garden (Kingsley and Townsend 2006; Glover 2004; Firth et al. 2011), where increased contact between different groups fosters cross-cultural understanding and the development of a shared set of values and behavioral norms that fosters social cohesion (Kingsley and Townsend 2006), at least within the core group of gardeners (Glover 2004). The flow of plant germplasm within the garden, often from more to less experienced gardeners, reinforces internal social networks, producing a moral economy of exchange and reinforcing the dissemination and reproduction of horticultural knowledge in the garden (Ellen and Platten 2011). The needs of the garden (e.g., for compost or labor) create additional social relations of reciprocity between gardeners and social networks outside the garden (Glover 2004), as does the sharing of garden produce and the hosting of social and cultural events in the garden (Glover 2004; Vitiello and Nairn 2009; Saldivar-Tanaka and Krasny 2004). For gardeners, participation in community gardening promotes an attachment to—and potentially personal investment in—both the garden and the neighborhood (Holland 2004; Shinew et al. 2004).

In ethnic neighborhoods, community gardens contribute to community development through the reproduction of a shared culture in the space of the garden, and cultural practices and knowledge are reified in the material form of the garden (Saldivar-Tanaka and Krasny 2004). More generally, it has been argued, community gardens constitute "communities of practice" where social-ecological memory, or shared "ecological practices, knowledge and experience," is reproduced through participation in garden activities, the reification of practices and knowledge in the physical form of the garden and in garden artifacts, and the incorporation of external sources of social-ecological memory (Barthel et al. 2010).

Residential landscapes—though not specifically food gardens—in the North are also reported to contribute to community development at the local, neighborhood, and even national scale. Though a private space, the British suburban garden, for example, provides a setting for socializing with neighbors and friends, and competency in gardening establishes certain members of the community as experts, enhancing their social status. The garden recruits all residents into circuits of exchange of diverse social, cultural, and material elements, and through the circulation of these elements the neighborhood is produced and reproduced (Chevalier 1998). Similarly, American suburbanites produce community by participating in lawn care and are drawn into complex networks linking social, economic, and biophysical processes and elements. Community is produced through the shared practices and community ideology of the lawn, the networked system of ideas in which a well-cared-for lawn serves as a sign of neighborliness and good citizenship (Robbins 2007).

While no similar research has been conducted on home food gardens in the urban North, their counterparts in the South and rural North are reported to mediate the development of social, economic, and ecological networks in the South and rural North. In Brazil, for example, home gardens link urban and rural households, supporting rich social networks and a reciprocal flow of people, resources, and germplasm (WinklerPrins 2002). In rural Mexico, seeds and plants from home gardens are exchanged through gendered social networks, linking households and gardens at local and international scales (Aguilar-Støen et al. 2009). In rural villages in northeastern Spain, the exchange of vegetable seed encourages social interactions among gardening households, with garden species richness positively correlated with household participation in exchange. However, the intrusion of the market economy—in the form of commercially available seeds and seedlings—fragments these networks, with potential social and ecological effects ranging from a loss of social cohesion to reduced crop plant diversity to the erosion of household and community resilience (Calvet-Mir et al. 2012a). Conversely, a loss of access to market sources, as in Cuba after the collapse of the Soviet Union, may stimulate the intensification of garden-based networks of exchange such that home gardens become merged resources shared by the community (Buchmann 2009).

As a locus of conflict, home gardens may also undermine community cohesion. Gardeners may perceive adjacent, ill-kept properties to be a source of pests (Bhatti and Church 2001). The location of food gardens may be contentious, particularly in culturally diverse urban neighborhoods. Food gardens in unorthodox spaces (e.g., front yards) that contravene local landscape norms may earn gardeners the disapprobation of their neighbors (Airriess and Clawson 1994) or the ire of authorities when local ordinances or homeowners' association regulations are transgressed.

Social and cultural reproduction

Much of the classical garden scholarship focuses on the role of representation in garden-making. Even the humble food garden may be a site of representation for internal or international migrants, who re-create in gardens landscapes that evoke their place of origin through the materiality of the garden, the use and arrangement of particular plants, structures, and ornament (Head et al. 2004; Airriess and Clawson 1994; Corlett et al. 2003; Domene and Sauri 2007; Mazumdar 2012). These gardens support practices, including horticultural practices, ethnic foodways (practices of preparing and consuming food), traditional spiritual and healing practices, and neighborly reciprocity, through which the culture of the household's place of origin is reproduced (Airriess and Clawson 1994; Mazumdar 2012). These practices may represent a continuation of a former way of life, creating a sensual connection to the gardener's place of origin through the materiality of the garden and its daily rhythms (Head et al. 2004; Domene and Sauri 2007). Through these effects, gardening may facilitate assimilation or at least ease the migrant household's transition to a new country or place (Corlett et al. 2003; Airriess and Clawson 1994).

In general, however, our knowledge of the influence of home food gardens on household dynamics or the reproduction of gendered or other social roles in the urban North is quite limited, with only a single published study (Gray et al. 2013) examining the interplay of gardening and family process. The authors of that study report participation in a home gardening program in San Jose, CA, strengthened family dynamics through an increase in the amount of time family members spent on garden-centered activities, including the preparation of food from the garden. Participation in these activities was gendered, with women doing most of the work; women's contribution was almost twice that of men and nearly three times that of children (Gray et al. 2013). Home gardens in the South are also often the domain of women, who maintain and transmit knowledge of gardening practices (Aguilar-Støen et al. 2009; Howard 2004; Méndez et al. 2001). Gardening confers social status on women, and the cultivation of biodiversity may be one strategy for women to accrue social capital through the development of natural capital (Howard 2004). Gendered differences in gardening practices and in the plant diversity of gardens have also been found in the North in rural home gardens. In rural villages in northeastern Spain, women's gardens are reported to be smaller than men's, more diverse, more oriented toward household consumption rather than commodity production, and more likely to incorporate organic or traditional methods of production. These differences may originate in gendered cultural roles and behavioral expectations, and garden plant diversity in particular may reflect women's multiple roles in household reproduction (Reyes-García et al. 2010).

Biodiversity and other ecological properties

While claims are often made about the "sustainability" of community gardens in popular discourse and the professional discourses of landscape architecture and urban planning, the academic literature linking community gardens and biodiversity and ecological processes is relatively thin. Community gardens in the North are reported to be sites of native bee diversity relative to the surrounding depauperate built environment (Matteson et al. 2008; Pawelek 2009) and to provide ecosystem services—including pollination—related to arthropod populations and linked to management practices, institutional rules, and garden structure (Andersson et al. 2007). At the same time, community gardens may have negative ecological effects or create ecosystem disservices. Nitrogen, phosphorus, and potassium, for example, may accumulate in high concentrations in garden soils (Witzling et al. 2011) due to the indiscriminate application of fertilizers or compost, polluting urban stormwater runoff or groundwater. The impact on stormwater quality, though, may be mitigated by enhanced stormwater infiltration due to the increased porosity of tilled garden soils amended with organic matter (Wortman and Lovell 2013). Gardens may also provide lower levels of ecosystem services than other landscape types. Community gardens, for example, are reported to support lower levels of arthropod diversity (Gardiner et al. 2013) and biocontrol activity by arthropods than undisturbed vacant lots (Yadav et al. 2012).

The ecological dynamics of urban home food gardens in the North have received even less attention. Research has focused on lawns and landscapes dominated by lawn, per a recent literature review (Cook et al. 2012), and work on nutrient cycling has largely focused on the negative impacts of suburban lawn fertilization on air and stormwater quality (Cook et al. 2012). One exception, a recent study of Flemish gardens that included lawns and ornamental and vegetable gardens in urban to rural contexts, found that home gardens were potentially a source of negative environmental externalities. Excessive amounts of fertilizer and compost were applied to vegetable gardens—frequently on a yearly basis—leading to high levels of phosphorus and organic matter in garden soils. While 85 % of organic garden waste was retained on site, representing an ecosystem service of gardens, the application of large amounts of homemade compost of unknown chemical composition, the authors speculate, might have a negative impact on groundwater quality due to the leaching of nitrogen from decomposing compost (Dewaelheyns et al. 2013).

No studies have examined the biodiversity of these gardens in the urban North. Their counterparts in the rural South, however, have frequently been described as repositories for plant and other biodiversity, and in the North gardens in general have been characterized as contributing strongly to the plant diversity of cities. Largely non-native species accumulate across gardens at a higher rate than for other urban land use types because of the internal heterogeneity of gardens and the management practices of gardeners (Loram et al. 2008). This plant diversity may have implications for the diversity of other life forms in urban areas, because a diversity of plant species typically supports more wildlife (Maron and Marler 2007).

Agrobiodiversity

Edible plant diversity or agrobiodiversity—an important component of agroecosystems—has been a focus of home garden research in the rural North and South but has received limited attention in the research literature on community or home gardens in the urban Global North. Existing research suggests that the latter gardens may conserve agrobiodiversity at the species and infraspecies level, though infraspecies diversity has seldom been measured. An allotment garden study in the United Kingdom, for example, found—across eight plots—a level of edible plant species richness ($n = 80$) rivaling that of tropical home gardens in South America. Even on small plots, gardeners conserved folk varieties through seed-saving, which was largely limited to crops requiring little time or space to produce large numbers of seeds (e.g., tomatoes, beans). Gardeners, however, replaced saved seeds with seed of folk varieties from commercial sources after about 3 years of cultivation because of concerns about impurity or inbreeding (Gilbert 2012). Community and home gardens in the North may also conserve agrobiodiversity originating in the South, with rural-to-urban migrants from the South making a disproportionate contribution to urban agrobiodiversity. In a California community garden, for example, 18 Hmong gardeners were reported to grow 59 different taxa of traditional food plants plus 4 unidentified species (Corlett et al. 2003). A study of Vietnamese market gardeners in New Orleans identified 43 crop plant species, most of which were reported to be "[un]common in the Western diet" (Airriess and Clawson 1994, p. 20).

In the more extensive research literature on agrobiodiversity in the rural North and South, home gardens have been characterized as agrobiodiversity "hotspots" (Galluzzi et al. 2010), serving as refugia for traditional crop plant species and varieties that are exchanged through social networks of gardeners (Aguilar-Støen et al. 2009; Nazarea 1998, 2005; Galluzzi et al. 2010). The agrobiodiversity of temperate gardens in the North may be comparable to those of tropical gardens in the South. In the rural North, crop plant diversity has been found to be positively correlated with the total economic value of garden production (Reyes-García et al. 2013). In an agricultural context, home gardens may function as sites of experimentation, where farming households test, manipulate, and adapt new varieties—from the wild or from government institutions, neighbors, or commercial or international sources—for local conditions and uses (Aguilar-Støen et al. 2009). Across cultural contexts, agrobiodiversity and cultural diversity conservation are mutually reinforcing (Nazarea 1998). Agrobiodiversity in the home garden supports culturally important foodways and agricultural practices (e.g., seed saving, plant selection and breeding), and through those practices it supports cultural reproduction (Galluzzi et al. 2010; Nazarea 2005; Airriess and Clawson 1994).

Resilience

One of the reported effects of community gardens and home gardens in the Global South and rural North is social-ecological resilience, which has been defined as "the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure and feedbacks, and therefore identity, that is, the capacity to change in order to maintain the same identity" (Folke et al. 2010). Adaptation and transformation are key to maintaining resilience. *Adaptability* is the "capacity of actors in a system to influence resilience," while *transformability* is the capacity of the system "to cross thresholds into new development trajectories" and to become a different kind of system (Folke et al. 2010). Transformation may be desirable if the current development trajectory is undesirable (e.g., because it perpetuates social or economic inequities or is ecologically unsustainable).

Barthel et al. (2010) argue that the reproduction of social-ecological memory in the communities of practice of community gardens leads to good ecosystem stewardship within the garden, which in turn leads to enhanced ecosystem services in the larger urban context and a more resilient social-ecological system. Tidball and Krasny (2007) claim that urban community greening projects—including community gardens—even have the potential to enhance the resilience of cities to disaster if the projects "integrate natural, human, social, financial, and physical capital in cities, and…encompass diversity, self-organization, and adaptive learning and management leading to positive feedback loops" (p. 151). More modest claims have been made for the effect of home gardens on social-ecological resilience in rural contexts in the Global North and South. In these settings, resilience is a second order

effect of other effects of the home garden, including the conservation of agrobiodiversity and the development of garden-centered social networks based on the exchange of crop germplasm, food, knowledge, and other resources, which buffer the household and community from social, ecological, and economic disturbance (Buchmann 2009; Aguilar-Støen et al. 2009; Calvet-Mir et al. 2012a).

Opportunities for future research

As the literature review suggests, the home food garden represents a major lacuna in the growing literature on urban agriculture in the Global North and offers opportunities to conduct multidisciplinary research on a wide range of policy-relevant topics with social and ecological implications at larger scales. We review these opportunities below, following the same organizational structure as the literature review. To guide future research, we present at the end of each section a complementary list of hypotheses and, where appropriate, additional research questions, based on our review of the literature and on our own experience conducting home garden research.

Food security and access

Basic questions about the contribution of home food gardens to household or community food security remain unanswered in the research literature, despite the large contribution these gardens may make to urban food systems in the aggregate (Taylor and Lovell 2012). The magnitude of home gardens' material contributions to household food budgets, for example, is unknown. While limited attempts have been made to measure the total land area of home gardens in US cities (Taylor and Lovell 2012; Smith et al. 2013), no study has directly measured actual production or has attempted to estimate production based on total garden area or the area devoted to individual crops in these gardens. Researchers have instead relied on gardeners' self-reports of home production, which may be inflated. The nutritional quality and diversity of homegrown produce and the social and ecological factors (e.g., cultural food preferences, gardening practices, soil quality) that influence these key criteria of food security have also not been assessed.

The extent to which home gardening meets the criteria of producing "safe" food "sustainably" in ways that promote "community self-reliance" and "social justice," according to Kortright and Wakefield's (2011) definition of food security, is often assumed but not rigorously assessed by researchers, urban agriculture advocates, or policy makers. The collection of detailed data on production practices and soil quality—including soil contamination, a common problem in urban garden soils—along with data on food preparation and consumption practices are required to evaluate fully the safety of homegrown produce in studies of food gardens. Our own research with ethnic and migrant home gardeners in Chicago, including lower income households, suggests that many gardeners are unaware of the risks posed by exposure to soil contamination from working in the garden or from consuming contaminated produce. While raised beds are a common strategy to mitigate contamination in community gardens, their use is infrequent in home gardens, at least in the neighborhoods in which we work in Chicago. Knowledge of soil contamination issues may vary by socioeconomic or immigration status, raising the possibility that home gardening exposes vulnerable populations to increased environmental risk. Research on the safety of home garden production could help inform public outreach programs to these populations.

Political ecological analysis—including an analysis of the commodity chains and the local social networks to which gardens are connected—is also needed to assess the sustainability of home garden production practices and the implications of those practices for ecosystem health and community self-reliance and social justice. Such analysis would also help to clarify the relationship between access to resources—land, time, money, germplasm, and ecological knowledge—and participation in home gardening, which has not been rigorously studied. Future work in this area should focus on policy relevant groups, including lower income households—which are more likely to be food insecure or to have limited food access—and should include gardening and non-gardening households in order to better characterize barriers to home food gardening and to develop effective policies for lowering those barriers.

Research on the contribution of urban home gardens to food security at scales larger than the household is even less developed, with only one study (Kortright and Wakefield 2011) examining the relationship between home gardening and community food security. We know little about the character or spatial extent of the social networks through which home production is distributed, the kinds or quantity of homegrown produce entering the local food system, the nature of the transactions—barter, gifting, or sale—through which produce is exchanged, and the household and larger scale factors shaping garden-centered social networks. Network analysis is needed to trace, characterize, and quantify the connections between home gardens and the larger community created by the flow of produce and related flows of germplasm, people, materials, and knowledge. This research could help to identify ways to expand existing networks, facilitate the development of new networks, and enhance the contribution of home gardens to local alternative food systems. Such interventions

may be particularly appropriate and productive in urban areas where economic disinvestment has frayed the social and material fabric of neighborhoods, isolating gardeners socially and physically.

Our summary of hypotheses derived from the literature is as follows:

- Gardens enhance household nutrition through increased consumption of vegetables and fruit (Alaimo et al. 2008; Twiss et al. 2003; Gray et al. 2013; Morton et al. 2008) and dietary diversification (Cabalda et al. 2011; Morton et al. 2008).
- Gardens make culturally acceptable foods (e.g., "ethnic foods") accessible (Kortright and Wakefield 2011).
- Garden production offsets income needs (Corlett et al. 2003; Baker 2004).
- Gardens contribute to local food systems beyond the household through the barter, gifting, or sale of food (Vitiello and Nairn 2009; Baker 2004; Corlett et al. 2003; Buchmann 2009; Kumar and Nair 2004; Kortright and Wakefield 2011).
- Food is grown safely (Kortright and Wakefield 2011).
- Food is grown sustainably (Kortright and Wakefield 2011).
- Resource barriers limit home gardening as a strategy for addressing food insecurity (Smith et al. 2013).
- Gardening is a response to limited food access (Buchmann 2009) or economic hardship (Schupp and Sharp 2012).

Additional research questions include:

- How does access to land and social, economic, genetic, or material resources influence gardening practices, garden size and species composition, and the decision to garden?
- How does access to resources vary across households and across neighborhoods?
- How do perceptions of risk influence gardening practices, garden form and composition, and the decision to garden?
- What strategies do households employ to overcome resource limitations or barriers to gardening?

Resistance and empowerment

Whether home gardening has empowering effects similar to those reported for community gardening has largely been unexplored in the literature, though existing research suggests it may. For home gardeners, gardening itself may be a form of resistance to dominant systems of food production. Kortright and Wakefield (2011), for example, identify a desire to reduce the ecological impact of food consumption as a primary motivation for gardening for some households. Schupp and Sharp (2012) similarly report a positive relationship between home gardening and participation in the local food system (e.g., buying food from local farmers) and argue for additional qualitative work to explore the relationship between home gardening and food activism.

Gardening may also be a source of resistance and empowerment at the personal and household level because of its role in the reproduction of cultural or ethnic identity, which for marginalized groups can be a source of resilience (see the section on resilience below), and the cultivation of a personal sense of agency and self-efficacy in the space of the garden. At the neighborhood or community level, garden-centered social networks—whether occurring spontaneously or nurtured by grassroots or top-down programs—may facilitate the development of food-centered activism and other forms of social activism at the neighborhood or community level (Gray et al. 2013). Additional research of a longitudinal or historical nature is needed on how home gardens are or could be catalysts for transformative change at the personal, household, and larger scales. An exploration of the ways in which popular discourses of urban agriculture and food sovereignty intersect with the experiences and practices of home gardeners would further enrich this area of study.

Our summary of hypotheses derived from the literature is as follows:

- Gardens are sites of resistance to marginalization, neighborhood disinvestment, and dominant paradigms of urban planning, design, land use, and land ownership/commodification (Baker 2004; Gottlieb and Fisher 1996; Punja 2009; Staeheli et al. 2002; Smith and Kurtz 2003; Schmelzkopf 2002).
- Gardens foster personal growth and transformation through contact with nature, observation of growth cycles, nurturing of plants, and the development of a sense of agency and self-efficacy among gardeners (Pudup 2008; White 2011; Parry et al. 2005).
- Gardens are sites of and catalysts for resistance to dominant systems of food production through self-provisioning and engagement in local food systems (White 2011; Baker 2004; Schupp and Sharp 2012).
- Traditional gender roles are reproduced and challenged in the garden (Parry et al. 2005).
- Self-disciplining consumer-subjects are produced through the promotion of consumerist values and behavior norms by gardening programs (Pudup 2008).

Community development

Garden-centered social networks potentially contribute to community development, another gap in the literature on

the urban home garden in the Global North. Our fieldwork with ethnic and migrant gardeners in Chicago, IL, contradicts Kortright and Wakefield's (2011, p. 51) conclusion that "home gardening does not, in and of itself, contribute to community development." Gardens in the Chicago neighborhoods in which we work are often visually and physically accessible to neighbors and passersby because of a lack of privacy fencing (gardens are often enclosed only by low chain-link fences), the use of vacant land adjacent to the gardener's residence for food production, and the publicly accessible alleys that run behind backyards. As Gaynor (2006) reports for the front yard gardens of suburban Italian immigrants in Australia, these gardens often mediate relationships between the gardening household and other neighborhood residents. Pedestrians strike up conversations with household members as they work in the garden, and the owners of larger gardens frequently share food with neighbors, friends, coworkers, and even strangers passing by. These gardens function as a community resource (Taylor and Lovell, unpublished data), though to a lesser extent than that described by Buchmann (2009) for Cuba.

Like community gardeners, home gardeners may also constitute communities of practice, though no studies have explored this aspect of home gardening. This may be particularly true for neighborhoods with high densities of gardens, where opportunities for personal interaction and the direct exchange of social-ecological knowledge (and material resources such as plant germplasm) between gardeners are greater. The public visibility of urban gardens and the reification of practices and social-ecological knowledge in physical form in these gardens may further contribute to the reproduction of social-ecological practices and knowledge in the community. No less important—particularly for physically isolated gardeners—may be participation in garden clubs, master gardener programs, urban agriculture interest groups, and virtual communities of practice through listservs and other electronic social media. Through these communities of practice and the associated reproduction of social-ecological knowledge, the home food garden may contribute to community development and the building of resilience in urban systems beyond the garden gate in ways not currently recognized in the research literature or in policy circles. Home garden research could help to identify ways in which existing communities of practice could be strengthened and enlarged and new communities of practice created to enhance community development and resilience in urban neighborhoods, particularly disinvested inner city neighborhoods.

Our summary of hypotheses derived from the literature is as follows:

- Gardeners constitute communities of practice (Barthel et al. 2010).
- Social-ecological knowledge and practices are reified—and reproduced—through the materiality of the garden (Barthel et al. 2010).
- Gardens foster place attachment, to the garden and to the neighborhood (Holland 2004; Shinew et al. 2004).
- Gardens foster the development of social networks and social capital between gardeners and between gardeners and non-gardeners by providing a setting for social activities and through the sharing of food from the garden (Glover 2004; Vitiello and Nairn 2009; Saldivar-Tanaka and Krasny 2004), the flow of germplasm and social-ecological knowledge (Ellen and Platten 2011; Calvet-Mir et al. 2012a), and the recruitment of non-gardeners to fulfill material/labor needs of the garden (Glover 2004; Chevalier 1998).
- Gardening promotes cross-cultural understanding through interaction between gardeners and between gardeners and non-gardeners from different social groups (Kingsley and Townsend 2006; Glover 2004).
- Gardens foster social cohesion through the development of shared values and behavioral norms among gardeners (Kingsley and Townsend 2006; Glover 2004; Robbins 2007).
- Participation in the market economy erodes social networks, ecological knowledge, and agrobiodiversity because of a decline in plant-mediated social interactions and a loss of ecological knowledge with the loss of biodiversity (Calvet-Mir et al. 2012b).
- Gardens undermine community cohesion through conflicts over landscape aesthetics and negative landscape flows (Bhatti and Church 2001; Airriess and Clawson 1994).

Social and cultural reproduction

As we noted in the literature review, the influence of food gardening on family development or the reproduction of gendered or other social roles is largely unexplored in the urban North. Existing research has not examined in depth the dynamics of gardening in the context of household or family relationships. While the home garden may be the solitary effort of a single household resident or a couple, it is also potentially a household-wide effort involving multiple family members, including children (Gray et al. 2013). As such, the garden may be hypothesized to promote intergenerational communication and cooperation and the reproduction of familial and cultural traditions; these topics, though, have received scant attention in the literature. Even the role of

urban gardens in the reproduction of ethnic or family foodways has been only cursorily explored, with no studies tracing the journey of produce from garden to table. Qualitative research encompassing the full range of household activities connected to the garden—including the production, preparation, and consumption of home-grown food—would help to address these knowledge gaps and could inform policies and programs intended to strengthen family dynamics and the intergenerational transmission of social-ecological knowledge through home gardening. Critical gender analysis should be an integral part of this research (Zypchyn 2012). Ethnic or migrant households with food gardens in particular are potentially rich sites for exploring the interplay of culture, gardening, and family process.

Our summary of hypotheses derived from the literature is as follows:

- The garden supports the reproduction of the way of life of the gardener's place of origin through its materiality and the daily rhythms of garden-related practices (Head et al. 2004; Airriess and Clawson 1994; Corlett et al. 2003; Domene and Sauri 2007; Mazumdar 2012).
- Gardens support the reproduction of cultural identity through ethnic foodways, traditional spiritual/healing practices, neighborly reciprocity, and gardening practices (Airriess and Clawson 1994; Mazumdar 2012).
- Gardens facilitate the assimilation of migrants (Corlett et al. 2003; Airriess and Clawson 1994).
- Gardening practices are gendered (Aguilar-Støen et al. 2009; Howard 2004; Méndez et al. 2001) and reflect social roles, including gendered family roles (Reyes-García et al. 2010).
- The transmission of gardening knowledge is gendered (Aguilar-Støen et al. 2009; Howard 2004; Méndez et al. 2001).
- Gardening confers social status through the development of natural capital as a strategy for accruing social capital (Howard 2004).

Additional research questions include:

- How do migrants adapt traditional horticultural practices to a potentially radically new social and biophysical environment?
- What strategies do immigrant or ethnic gardeners employ to obtain traditional crop varieties?
- What role do traditional crop varieties play in the reproduction of cultural practices, including ethnic foodways?
- Are garden-related cultural practices transmitted intergenerationally, and if so, how?
- How do garden-related cultural practices evolve or change from generation to generation?
- Do later generations construct symbolic forms of ethnicity through gardening by, for example, growing heritage food plants acquired from commercial sources?

Biophysical and ecological properties

The biophysical or ecological properties and processes of the urban home garden have received even less attention than its social characteristics and dynamics, despite the clear interaction between and interdependence of the social and the ecological or material in the space of the garden. With one exception (Dewaelheyns et al. 2013), no studies have explicitly looked at topics such as species diversity or nutrient cycling in the context of urban residential landscapes in the North with food gardens or have examined the biophysical properties and processes of these garden in relation to the social. Research opportunities include, but are not limited to, work on: (1) the practices, factors, and processes influencing garden diversity (e.g., seed saving, networks of plant exchange, access to commercial plant sources, the "green" industries, the agency of plants themselves); (2) the influence of plant and non-plant diversity within and outside the garden on production-related ecological processes and services (e.g., pollination and nutrient cycling); (3) the influence of gardening practices on ecological processes (and vice versa); and (4) the larger scale ecological effects of home food gardens (e.g., stormwater infiltration and groundwater recharge, the nutrient loading of urban stormwater). By including aboveground and belowground elements, research can develop an even fuller picture of the social-ecological dynamics of the home garden and the ways in which these gardens contribute to—or could potentially contribute to—or impair the functioning of the larger urban ecosystem.

Our hypotheses derived from the literature include:

- Gardens have negative ecological effects (e.g., stormwater and groundwater pollution) because of the excessive application of fertilizers and compost (Witzling et al. 2011; Dewaelheyns et al. 2013) and a reduction in landscape structure compared to less managed habitats (Gardiner et al. 2013; Yadav et al. 2012).
- Gardens have positive ecological effects due to the partial closure of open nutrient loops through composting (Dewaelheyns et al. 2013).
- Gardens contribute to plant diversity through gardeners' acquisition (purchase, exchange, gifting) of plant species and their management practices (Loram et al. 2008).

- Gardens conserve animal diversity through increased landscape structure/diversity and management practices that promote diversity (Andersson et al. 2007; Matteson et al. 2008; Pawelek 2009) and through increased plant diversity.

Additional hypotheses might be:

- Gardens have negative ecological effects due to the use of inputs with direct negative effects and negative environmental externalities.
- Gardens have positive ecological effects in addition to diversity conservation (e.g., enhanced stormwater infiltration, nutrient cycling) due to increased soil porosity from tillage and increased soil organic matter from the addition of compost.

Additional research questions include:

- What are the characteristics of nutrient, carbon, and water cycles in home food gardens?
- What factors influence nutrient, carbon, and water cycling in the garden?
- Do home gardens help to close open loops, or does a reliance on external inputs undermine the sustainability of the garden?
- What impact do the ecological characteristics of the surrounding landscape have on processes within the garden?
- What are the legacy effects of urban soils? What, for example, is the impact of soil contamination on ecosystem processes?
- Do non-crop plants in the garden provide significant levels of production-related ecosystem services (e.g., pollination and predator control) for food plants?
- To what extent do food gardens rely on the larger landscape for production-related ecosystem services? What is the impact of diversity on ecological processes within the garden?

Agrobiodiversity

Crop plant diversity is of particular interest in agroecosystems, but no studies have examined the infraspecific diversity of urban home gardens in the North, and agrobiodiversity at even the species level has only been cursorily explored in a handful of studies. These gardens may at first seem unpromising as repositories of agrobiodiversity, unlike their counterparts in the South and rural North. However, migrants to urban areas may carry propagules of traditional varieties with them on their journeys of migration, or they may participate in informal local or international networks of horticultural exchange. This exchange is not necessarily unidirectional; with increasing transnationalism, crop plants and technology may be transferred from urban to rural areas or from North to South (Aguilar-Støen et al. 2009). Non-migrants may also grow traditional, folk, heritage, or heirloom varieties as a way of re-creating a distinctive sense of time or place or as elements in the reproduction of cultural identity. Alternatively, they may maintain them out of "affection" or a conscious concern for agrobiodiversity conservation (Galluzzi et al. 2010; Nazarea 2005). Characterizing the infraspecific diversity of home gardens—and its relationship to cultural diversity—will require the integration of traditional ethnobotanical methods and those of molecular genomics (e.g., gene sequencing). These methods can be used to explore the flow and transformation of crop germplasm within and between gardens. For ethnic and migrant communities in particular, germplasm conserved in the home garden could potentially serve as source material for participatory plant selection and breeding programs for culturally appropriate food plants adapted to urban growing conditions.

The political economy of seed and plant production also potentially exerts a strong influence on crop plant diversity in the urban home garden in the North but has received little attention in the literature on home gardens. The availability of commercially bred seed and commercially grown plants may be both enabling and disabling for home gardeners. It may, as in the rural North (Calvet-Mir et al. 2012a), limit choice, reduce agrobiodiversity, preclude the development of locally adapted varieties, and erode social-ecological knowledge and social networks. It may also lower barriers to gardening for gardeners without the resources (time, land, money, or knowledge) to produce their own seeds or plants. With the commodification of folk, heirloom, or heritage varieties, gardeners can also potentially more easily draw on them as a resource in symbolic forms of ethnic or regional identity construction, which can serve as a source of personal or family resilience. Research on the home garden can help to illuminate these processes, the role of agrobiodiversity in urban home gardens in general, and its relationship to cultural reproduction, with the goal of conserving and enhancing urban agrobiodiversity as a way of strengthening urban food systems.

Our hypotheses derived from the literature include:

- Gardens conserve crop plant diversity at the species and infraspecies levels through the exchange of germplasm through local (Aguilar-Støen et al. 2009; Calvet-Mir et al. 2012a) and national or transnational (Aguilar-Støen et al. 2009) social networks.
- The agrobiodiversity of gardens in the Global North is comparable to that found in the Global South (Reyes-García et al. 2013; Gilbert 2012).

- Agrobiodiversity and cultural diversity are mutually reinforcing (Nazarea 1998), with the former supporting ethnic foodways and traditional agricultural practices (Galluzzi et al. 2010; Nazarea 2005; Airriess and Clawson 1994).
- The gardens of migrants make a disproportionate contribution to the agrobiodiversity of urban areas (Corlett et al. 2003).
- Gardens are sites of cultural and biological adaptation, including experimentation with new varieties, species, and production technologies (Aguilar-Støen et al. 2009).
- Garden-mediated technology transfer is transnational and occurs through the migration of people and plants and the development of transnational networks (Aguilar-Støen et al. 2009).

Resilience

The unanswered question of whether and how urban home gardens in the Global North contribute to household and community resilience is one that can and should be asked in multiple research contexts. Home gardening potentially builds resilience at the household or community level through increased food security, individual and community empowerment and resistance to marginalization, community development, the reproduction of cultural identity, the enhancement of ecological processes, and biodiversity and agrobiodiversity conservation. The garden-mediated reproduction of cultural identity, for example, may enhance resilience at the household level, where traditional values and practices—idiosyncratic to the family or shared within an ethnic group—and ethnic identity are sources of meaning and resources that help family members negotiate the world around them and enhance individual and family resilience in the face of crisis and trauma (McCubbin and McCubbin 2005). As we discuss above in the section on community development, home gardeners may, like community gardeners, also constitute communities of practice, with similar positive impacts on ecosystem stewardship, ecosystem services, and social-ecological resilience. Home gardening may play a larger cultural role and have a larger impact on resilience in some urban communities than others. Existing research suggests that certain ethnic or migrant groups, such as Chinese migrants, may participate in urban home gardening in the United States at higher rates than other groups (Taylor and Lovell 2012). The cultural motivations for home gardening, however, have been undercharacterized and demand further exploration (Schupp and Sharp 2012). Future research should (1) examine the relationships between culture, gardening, and resilience and (2) explore how home gardening builds (or could build) the adaptive and transformative capacity of urban systems across scales through multiple social and ecological processes, particularly in marginalized or economically disadvantaged communities.

Our hypotheses derived from the literature include:

- Social-ecological memory is reproduced through gardens and enhances urban ecosystem services and system resilience (Barthel et al. 2010).
- Gardens enhance resilience to disasters by promoting "diversity, self-organization, and adaptive learning and management leading to and positive feedback loops" (Tidball and Krasny 2007, p. 151).

Additional hypotheses might be:

- Resilience at the household or community level is a second order effect of the other effects of the garden, including increased food security, individual and community empowerment and resistance to marginalization, community development, social and cultural reproduction, biodiversity, and agrobiodiversity.
- The garden-mediated reproduction of cultural identity enhances household resilience.
- Home gardening plays a larger cultural role and consequently has a larger impact on resilience in some urban communities than others.

Research approaches and methods

Research approaches

The research questions and hypotheses we have proposed can be approached from a number of different theoretical perspectives using a variety of analytical methods. While some researchers despair that "disparate disciplinary perspectives, analytical methods, and different scales of analysis render generalizations difficult and limit an integrated understanding of residential landscape dynamics" (Cook et al. 2012, p. 20), we believe that pluralism in perspectives and methods and a respect for disciplinary differences can be productive in the study of the home food garden. Following Turner (2009), we argue not for a "monistic vision" of unified social and ecological analysis but a pluralistic and pragmatic one in which the analyst's role is to "place different logics and epistemologies in parallel looking at congruencies and divergences without being captured by any one" (p. 184). In that spirit, we provide below a brief introduction and orientation to the theoretical perspectives that have been applied or have potential relevance to the integrated study of the social and the biophysical in the space of the home food garden. A fuller discussion of these perspectives is beyond the scope of this paper, and we refer

the reader to the sources cited in the text for additional guidance.

Social-ecological systems (SES) theory is the dominant paradigm in urban ecological research. SES attempts to integrate the social and the ecological as it seeks to describe and explain the complex interactions between humans and their environments. It does this in part through bridging concepts such as the *ecosystem services* concept. While ecological *function* and *process* are critical to assessing the quality of ecosystems from a natural sciences perspective, focusing on the services these systems provide humans highlights their social value. *Resilience* and *transformation*, introduced and defined in the discussion of resilience in the literature review, are additional key concepts describing the capacity of the system to persist (Holling 1973) or cross over into an alternative development trajectory following disturbance (Folke et al. 2010), respectively. The desirability of the current versus an alternative trajectory is evaluated based on the ecosystem services—or disservices—each trajectory provides or is expected to provide. Ultimately this is a political question; in planning for resilience or transformation the question of who gains and who loses from the persistence or transformation of the existing system must be weighed (Beymer-Farris et al. 2012).

SES has been used in diverse ways in studies of community gardens in the North and home gardens in the South and rural North. Drawing on SES, Calvet-Mir et al. (2012b) conceptualize the home garden as an agroecosystem and extend the ecosystem services concept to the valuation of gardens in rural villages in northeastern Spain. Aguilar-Støen et al. (2009) use SES as a theoretical framework for a mixed-method study focusing on the role of home gardens and local knowledge in promoting the resilience of an integrated land-use system in Candelaria Lochicha, Oaxaca, Mexico. Using ethnobotanical and qualitative methods, Buchmann (2009) examines the interactions among traditional ecological knowledge, biodiversity, and household and community resilience mediated by the home garden in the town of Trinidad, Cuba.

Cook et al. (2012) seek to develop a more integrated SES model for multi-scalar, interdisciplinary research on human-environment interactions in the residential landscape, potentially including those with food gardens. In this model, social drivers at multiple scales shape management decisions, which in turn influence ecological processes in the residential landscape. The model is intended to foster interdisciplinary collaboration by providing an integrated theoretical framework for social and natural scientists and by drawing on existing bridging concepts that link ecological and social systems (e.g., ecosystem services). Integration, the authors imply, requires an emphasis on quantitative social science methods and the standardization of methods, research perspectives, and measures across studies (Cook et al. 2012). This call for a quantitative and standardized methodology, however, may be premature for home gardens in the North, given Cook et al.'s (2012) acknowledgement that the social-ecological dynamics of backyards have not yet been adequately characterized.

Two theoretical perspectives from the social sciences, *actor-network theory (ANT)* and *assemblage theory*, also have potential relevance to the multidisciplinary study of the urban home food garden. The former has been applied to the study of ornamental residential gardens in the North (Hitchings 2003; Power 2005), while the latter has informed research on smallholder farms and farmers (Holloway 2002) but not the study of home food gardens. ANT accepts "things"—including physical objects, nonhuman organisms, ideas, discourses, virtually anything—as "full-blown actors" which, though they may lack human intention, still participate in courses of action (Latour 2005). Assemblages are also composed of heterogeneous human and nonhuman elements, and, like ANT, assemblage theory "seeks to blur divisions of social–material, near–far and structure–agency" (Anderson and McFarlane 2011, p. 124). Action is always conjoint, with the effects of an assemblage never reducible to the agency of any one element. The capacity of each element for action depends on both its own properties and its interaction with other members of the assemblage (De Landa 2006). Thus while SES emphasizes the agency of humans, from the perspective of ANT and assemblage theory the gardener does not act alone. As a produced space, the garden is the effect of the conjoint action of a swarm of things. Analysis through the lens of ANT or assemblage theory focuses in part on how networks or assemblages form, are stabilized, and fall apart. The political implication of assemblage theory and ANT is to expand the "public" to include nonhuman, living and nonliving entities in addition to humans (Bennett 2010). Because the effects of assemblages and actor-networks are the result of conjoint action, and humans cannot act alone, self-interest demands attention and sensitivity to the role and preservation of members of the assemblage that have no voice.

Sampling and analytical methods

Regardless of the theoretical perspective or framework to which the researcher hews, the complexity of the home food garden may act as a barrier to conducting multidisciplinary research on the urban home food garden. Consequently, in this section we offer guidance on potential research methods—from sampling households with food gardens to integrating social and biophysical data—based on the literature review and on our own research experience.

Sample selection

Because home gardens are dispersed across the urban landscape, often at low densities and in spaces inaccessible to the researcher, sample selection and recruitment can be challenging and time consuming. The chosen sampling approach—random or purposive—will hinge on the study's research questions and objectives. Random sampling allows the researcher to generalize findings from quantitative research to a particular population, while a smaller purposive sample will support the in-depth investigation of garden-related patterns and processes, garden-centered social networks, and the meaning of garden-related practices from the perspective of the gardener. Through purposive sampling, the researcher can also select and focus on rarer forms of urban gardening of particular interest (e.g., households with front yard food gardens or gardens on vacant land) that can help to illuminate the social and ecological dynamics of food gardening in ways that advance the often normative goals of urban agriculture research.

Constructing a sampling frame, particularly for a representative random sample, can be resource intensive and may require a multistage sampling and screening process. Multistage area probability sampling has been used to identify gardening households in at least two studies. In Toronto, Kortright and Wakefield (2011) randomly selected census blocks within two neighborhoods of interest and then randomly sampled and screened 125 households within those census blocks for home food gardening. Smith et al. (2013) identified a representative sample of home food gardeners in Madison, Wisconsin, by first stratifying US census tracts by mean household income quartile, randomly selecting tracts within each stratum, randomly selecting census blocks within each tract, and then screening all of the addresses in the selected census blocks for home food gardening. While Smith et al. (2013) stratified their sample by household income because they hypothesized it influenced propensity to garden, participation in gardening among urban populations may vary by other factors, such as ethnicity (Taylor and Lovell 2012), which can be used to stratify samples and to select representative subsamples that support comparisons between subgroups.

Random digit dialing (RDD), in which telephone numbers in a given area are randomly dialed, could also be used to contact and screen households for participation in gardening and to recruit them for field follow-up. Because of declining participation rates and shrinking landline coverage in RDD studies, address-based sampling—in which a sample is drawn from a nearly exhaustive list of mailing addresses—has been proposed as an alternative to RDD in the United States and has been used successfully to identify subgroups of interest through an initial screening questionnaire delivered to the household by mail (Brick et al. 2011).

Alternatively, manual aerial image analysis can be used to construct a sampling frame of larger food gardens without extensive field work (Taylor and Lovell 2012). For qualitative studies, snowball sampling can also be used to identify households with gardens and to construct networks of gardeners. Urban agriculture listservs and stakeholder groups offer another potential entrée into the gardening community for qualitative studies, though policy relevant populations (e.g., low income households or immigrant gardeners) may be underrepresented in these groups. In urban neighborhoods that lack privacy fencing, food gardens can be identified visually from alleys, streets, and adjacent parcels (Taylor and Lovell, unpublished data).

Analytic methods

The selection of analytic methods will be informed by the research objectives and the researcher's theoretical framework or perspective. The writing of accounts of actor-networks, for example, is central to ANT as an analytic tool (Latour 2005), demanding qualitative social science research methods such as case studies, unstructured or semi-structured interviews, focus groups, thick description, participant observation, historical research methods to reconstruct the development of actor-networks, and qualitative and quantitative methods from the natural sciences to develop full accounts of nonhuman actors. Studies employing SES as a theoretical framework may employ qualitative or quantitative methods from the social or natural sciences, depending on the research questions and objectives. However, given the underdeveloped tradition of home garden research in the Global North, studies employing purposive samples and qualitative social science methods complemented by appropriate biophysical methods may be advisable. Such studies can be a productive prelude to quantitative studies with representative random samples, allowing the researcher to determine the lay of the land before embarking on a complex, larger-scale study.

Qualitative social science methods have been employed routinely in studies of home and community gardens in the North and South, as have plant inventories and maps documenting the spatial distribution of plants and other garden features (see Vogl et al. 2004 for a discussion of ethnobotanical methods and home gardens). Plant lists, in fact, are considered to be an almost essential feature of studies of species-rich tropical home gardens, with researchers even described as being "obsessed" with exhaustively cataloging the plants present in study sites (Nair 2006). Lists may be summarized as species richness

(i.e., the number of species in a garden or group of gardens). The number of conspecifics in each garden may also be counted in order to evaluate the evenness of the distribution of plants across species. Indices of plant diversity (e.g., the Shannon index) can be calculated to simultaneously account for both richness and evenness, and similarity indices (e.g., Sørensen-Dice similarity index) can be calculated and phylogenetic trees constructed to compare plant assemblages across gardens or groups of gardens (e.g., the crop plant assemblages of different ethnic groups). Plant inventories can be augmented by the collection of ethnobotanical data on the origin, cultivation, and use of crops plants. Ethnobotanical surveys are essential to inventorying crop plant assemblages at the infraspecific level and to distinguish between commercially sourced varieties and those maintained through seed saving and seed exchange networks. Molecular genomic methods, such as DNA sequencing, can provide additional resolution on the infraspecific diversity of folk or heritage varieties of crop plants propagated by gardeners and can potentially be used to measure gene flow between gardens and plant populations and to re-construct the distribution of varieties through social networks.

Additional biophysical methods can be used to determine the effects of gardening practices on ecological systems and the provisioning of ecosystem services. These include insect surveys, pollination and predation studies, and the analysis of the chemical and physical properties of garden soils, including soil porosity, soil organic matter, water infiltration rates, and nutrient and heavy metal concentrations. Soil biota play an outsized—but often neglected—role in ecosystem processes including nutrient cycling (Lavelle et al. 2006; Barrios 2007). Their diversity and abundance can be measured through specialized techniques, including molecular genomic methods in the case of soil microbes.

These methods may require repeated visits to gardens throughout the growing season to document seasonal changes in crop plant assemblages and other dynamic social or ecological processes. Garden logs completed by gardeners on a daily basis during the growing season can be a useful complement to these methods. These logs can be used to collect data on gardening practices and to quantify garden inputs and outputs. The flow of produce from the garden to the dining table or to other households through social networks or the market can also be traced through logs. Along with ethnobotanical surveys, logs can be a resource in network analysis, the documentation of inputs and outputs for the measurement of the ecological footprint of the home food production, and the construction of a political ecology of home gardening that examines the influence of social, economic, and political factors on ecological processes in the space of the garden.

The analysis of social and biophysical data will also be influenced by the theoretical framework or perspective. In a quantitative study informed by social-ecological systems theory, for example, the researcher may seek to develop a mathematical model integrating social and ecological drivers of environmental change. Even in a study employing qualitative methods, data from unstructured or semi-structured interviews can be reduced and coded for use in exploratory quantitative analyses of biophysical data, correlating, for example, social variables with garden diversity. Alternatively, the qualitative researcher may employ a less structured and integrated approach, establishing instead a dialogue between the social and biophysical data, examining them in tandem for correspondences and contradictions. In an ANT analysis, this dialogue might involve multiple accounts of the garden, told from different perspectives—that of the gardener, the researcher, and nonhumans such as plants.

Conclusion

In this paper we have selectively summarized the literature on home and community gardens in the Global North and South in order to identify opportunities for future multiscalar and multidisciplinary research on the contemporary home food garden in the urban North. Based on the literature review and on our own experience conducting home garden research, we have developed research hypotheses and questions about the social-ecological (or sociomaterial) effects and dynamics of the home garden. These hypotheses and questions can serve as a guide for future descriptive research on these gardens, which represent a major lacuna in the growing literature on urban agriculture in developed countries. In the aggregate, home gardens may make a far greater contribution to urban food systems than other forms of urban agriculture such as community gardens and urban farms, which have attracted disproportionate attention and support from a broad range of actors including academics, government officials, NGOs, and private foundations. We hope this paper will bring greater attention to the numerous research opportunities afforded by home gardens and foster a more balanced approach to urban agriculture policy and research.

The findings from the literature review underscore the entanglement of the social and the ecological/biophysical/material (or human and nonhuman) in the space of the garden. Consequently, we have provided in this paper a brief overview of three research perspectives—social-ecological systems theory, actor-network theory, and assemblage theory—that have been or could be applied to the multidisciplinary study of the urban home food garden and its sociomaterial or social-ecological dynamics. While our

focus on these three perspectives is guided by our interest in the relationship between the social and the biophysical or material in the garden, other potentially complementary and productive approaches to home garden research exist but are not explored in this paper. These include: (1) economic approaches that attempt to assign a monetary value to the labor and material resources (and opportunity costs) associated with the production of the garden and to the ecosystem services (and disservices) it provides, and (2) approaches that examine the design and spatial configuration of gardens and the factors influencing their design. To facilitate the study of the urban home food garden, we have further provided an overview of the sampling and analytic methods with potential relevance to the study of the social-ecological dynamics of the home food garden.

Beyond the unplowed ground of descriptive analysis that has been a focus of this paper, the urban home food garden is a potentially fertile site for experimental and participatory forms of research. While home food gardens may make a substantial contribution to local food systems, urban gardeners face a number of unique social and biophysical challenges that potentially limit the productivity, sustainability, and social and ecological benefits of their gardens. Social challenges include a lack of access to land and other resources, including social-ecological knowledge, and the fragmentation of social networks in disinvested neighborhoods. Home gardening programs could be developed—and rigorously evaluated—through participatory research approaches designed to find ways of surmounting these challenges and "scaling up" home gardening to address urban problems (Gray et al. 2013).

Biophysical limitations include elevated temperatures due to the urban heat island effect, heterogeneous and contaminated soils of poor quality (Wortman and Lovell 2013), reduced light, depauperate pollinator populations, and pest and nutrient management constraints. These challenges could be addressed through plant selection and breeding and through research on crop production systems in urban residential environments. However, no existing public or private programs specifically address urban growers' needs. These needs might be best addressed through a multilocational, participatory research strategy that engages stakeholders—in this case home gardeners—as co-researchers and their gardens as research sites. Because such a strategy samples multiple social and biophysical environments, it has been effective in developing crop varieties in the Global South that are tailored to stakeholders' cultural preferences and adapted to high-stress, heterogeneous environments (Sperling et al. 2001).

Urban gardeners could also be engaged in "designed" experimentation (Felson and Pickett 2005) addressing a wide range of research questions and issues, including the ecological impact and productivity of various cropping systems, the effects of landscape interventions such as flowering pollinator strips on plant productivity and insect diversity, the in situ remediation of contaminated soils, strategies for on-lot nutrient cycling, and the development and dissemination of innovative production technologies. As in participatory plant selection and breeding programs, gardeners would be co-researchers working collaboratively with agronomists and, potentially, landscape designers, and individual gardens would function as experimental replicates, supporting rigorous statistical data analysis. The participatory nature of these research programs could have additional social benefits often associated in the literature with resilience, including co-learning and information sharing, adaptive management and learning, the creation of flexible social institutions, and the development of positive feedback loops and increased connectivity in social networks.

Research on the urban home garden has implications beyond the garden gate. Increasingly, the world is becoming a garden, an urbanized garden that must be actively managed at multiple scales for the benefit of humans and nonhumans. On a daily basis, humans confront the nonhuman world in the domestic garden. They practice already-acquired environmental knowledge, gain new practical knowledge, and learn to negotiate with nonhumans to achieve their objectives. For these reasons, research on the social and ecological dynamics of the garden has the potential to inform theory on society-nature relations and the design and management of other social-ecological systems, including existing ecosystems and the new, novel or "no-analog" ecosystems that will become increasingly important providers of ecosystem services in the future.

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Author Biographies

John R. Taylor is a doctoral candidate in the Department of Crop Sciences at the University of Illinois. His dissertation research focuses on the social and ecological dimensions of urban agriculture. He earned a BA in philosophy from the University of Chicago, a BS in horticulture from Michigan State University, and a Master's in Landscape Architecture from the University of Michigan. He managed federal education studies at the National Opinion Research Center at the University of Chicago, practiced landscape architecture in the Washington, DC area, and taught landscape architecture as a lecturer at the University of Massachusetts Amherst before returning to graduate school.

Sarah Taylor Lovell PhD, is an Assistant Professor of Sustainable Landscape Design in the Department of Crop Sciences at the University of Illinois. She earned a BS in Agricultural Sciences, followed by an MS and PhD in Agronomy from the University of Illinois. After working in industry for several years, Sarah studied to obtain a Master's in Landscape Architecture. She served as an Assistant Professor in the Department of Plant and Soil Science at University of Vermont from 2006 until 2009, when she returned to the University of Illinois.