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Vacant lots: An underexplored resource for ecological and social benefits in cities

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ABSTRACT

Vacant lots make up a large proportion of urban land and are of interest to many stakeholder groups. While they are often viewed as dangerous or unsightly, they can be an economic, social, and ecological resource. Here we present a literature review focused on restoring biodiversity in vacant lots, emphasizing the intersection of human and wildlife needs. We focus on the benefits, challenges, and processes of restoration in vacant lots and synthesize ecological, social, and economic information across these domains. We suggest that fast, inexpensive restoration techniques could be implemented in vacant lots and would be well suited to increasing greenspace in low-income areas. Furthermore, we emphasize that land managers, ecologists, sociologists, urban planners, and local communities must work together to conceptualize, carry out, and monitor restoration projects, as these projects are often characterized by disparate goals and insufficient follow-up. Vacant lot restoration is best addressed by an interdisciplinary approach that combines economic, social, and environmental needs and concerns into a holistic urban land use paradigm.

1. Introduction

As cities grow, development often occurs outwards. Without corresponding net population growth, this can leave vacant buildings and land in the dense urban matrix (Bowman and Pagano, 2004; Bontje, 2004). These vacant spaces come in many forms and sizes, and include everything from severely contaminated brownfields to foreclosed residential properties where buildings may have been partially or completely demolished. Sometimes called greenfields, wastelands, or abandoned, derelict or uncultivated land, these spaces comprise an extensive network in urban areas. While these various classes of land have subtle differences, they are often lumped together because there is no single, broadly accepted definition for vacant land (Bowman and Pagano, 2000; Bowman and Pagano, 2004; Kremer et al., 2013).

Cities with more than 250,000 inhabitants generally have between 12.5-15% vacant land by area at any given time (National Commission on Urban Problems, 1968; Bowman and Pagano 2000). These vacant lots do not occur randomly throughout the urban matrix but tend to be concentrated in low-income neighborhoods (Brulle and Pellow, 2005; Kremer et al., 2013). Vacancy is usually perceived negatively and typically correlates with increased crime and reduced property values (Hoffman et al., 2012). In extreme cases, the negative connotations of high vacancy can overshadow positive community assets (Garvin et al., 2013). However, studies in New York City demonstrate that vacant lots can also be viewed as a valuable resource for local economies, communities, and environments (Bowman and Pagano, 2004; Kremer et al., 2013). For this reason, there has been interest in transforming these spaces into informal greenspace (Burkholder, 2012; Rupprecht and Byrne, 2014) within the urban matrix. Such transformations could increase urban sustainability, by improving the balance among environmental protection, economic development, and social well-being (Wu, 2010), and promoting development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland, 1985).

2. Objective and approach

This review was motivated by the three pillars of sustainability (i.e., environmental, economic, and social; UN, 2002; Andersson, 2006) to take an interdisciplinary approach to evaluating vacant lot restoration. We seek to synthesize ecological, economic, and social motivations, methods, and outcomes of restoring biodiversity to vacant lots and to pose recommendations for future projects. We focus specifically on vacant lots as they are fundamentally different

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from other kinds of urban green space (e.g., community gardens, parks, etc.) in terms of human involvement. Other reviews have explored biodiversity (Bonthoux et al., 2014) and potential to provide ecosystem services (Kim, 2016) in vacant lots, and tools for evaluating brownfield restoration projects (Pediaditi et al., 2010). Relatedly, a recent brief produced by the Vacant Property Research Network (Heckert et al., 2015) highlights benefits of the broader field of 'urban greening'. However, no paper focuses specifically on restoring biodiversity in vacant lots. Furthermore, while there is certainly multi-disciplinary interest in restoring vacant lots, true interdisciplinary work bridging ecological, economic, and concepts in restoration is limited.

In this review, we seek to synthesize ecological, economic, and social literature on the following topics: (1) benefits of restoring vacant lots, (2) challenges associated with restoration, and (3) evaluating success of restoration projects. We end the review with some recommendations for future restoration and research efforts. We selected these topics to span the conceptual and practical realms of restoration, to provide distinct points for comparing interdisciplinary perspectives, and to present empirically-based recommendations for sustainable use of this land resource.

To find literature, we performed searches using Web of Science© and Google Scholar© that included combinations of key terms "vacant lots" "greenfields", "biodiversity", "urban", and "restoration" along with discipline specific terms including "public health", "value", "ecosystem services", "greening", and "cost". Using these search terms, we found 24 papers focused specifically on biodiversity and restoration in vacant lots. From these initial resources, we utilized bibliographies and searches of other publications by relevant authors to compile an interdisciplinary works cited that includes 117 sources focused mostly on Europe (n = 22) and the United States (n = 34) when they were geographically explicit. Many papers were interdisciplinary, but over half (n = 64) addressed aspects of ecology, 35 addressed social sciences, 21 urban planning, 18 economics, and 8 public health. Because there is not a large body of literature specifically on restoring biodiversity in vacant lots, we also draw from other relevant bodies of literature when helpful, but maintain a focus on peer-reviewed literature.

For consistency with the restoration ecology literature, we define "restoration" as a process of assisting recovery of an ecosystem that has been degraded, damaged, or destroyed (SER, 2004). However, we want to emphasize that goals for restoration are site-specific and the traditional mentality of returning to pre-development conditions is generally unrealistic in urban ecosystems (Hourdequin and Havlick, 2016). Instead, we refer to measures that increase biodiversity or ecosystem functioning without the end goal of recreating historic site (Balnerva et al., 2006).

2.1. Ecological, economic and social benefits of restoring vacant lots

Several common uses exist for vacant lots. Although they are often used for parking, makeshift athletic fields and play areas, or junkyards, they are occasionally incorporated into the ecological fabric of the city via community garden development or habitat restoration (Kremer et al., 2013; Németh and Langhorst, 2014). In this section, we review the potential benefits of restoring habitat in vacant lots from ecological, economic, and social perspectives, each in turn.

Biodiversity conservation in the face of global urbanization is a critical concern for ecologists (Chapin III et al., 2000). For many taxa, particularly birds, urban areas have fewer species than nearby natural areas or suburbs (Blewett and Marzluff 2005; McKinney 2006; Garaffa et al., 2009). These trends are caused by multiple factors, including reduced habitat (Le Roux et al., 2014), changes in predator-prey dynamics (Fischer et al., 2012), novel threats such as collisions with buildings (Bayne et al., 2012) or vehicles (Gunson et al., 2011), pesticide inputs (Fry 1995; Savard et al., 2000), and non-native competitors and predators (Rebele 1994; Loss et al., 2014). On the other hand, some generalist taxa do very well in cities worldwide, even while their historic-range populations decline (Shaw et al., 2008). This is especially true for generalist birds like pigeons (*Columba livia*), European Starlings (*Sturnus vulgaris*) and House Sparrows (*Passer domesticus*). There has been a recent interest in native species resurgence in urban areas as well. Evidence suggests that raccoon (*Procoyon lotor*) and coyote (*Canis latrans*) populations are increasing in urban areas of the United States (Gehrt 2004). Vacant lots that are allowed to grow wild (unmowed) or that are restored have the potential to increase urban biodiversity and may even contribute to conservation of rare and endangered species (Harrison and Davies, 2002; Muratet et al., 2007). They can act as refuges for endangered plants (Vessel and Wong, 1987), and can provide suitable habitat for some species of small mammals (Magle et al., 2010), insects (Uno et al., 2010; Gardiner et al., 2013; Gardiner et al., 2014), and birds (Ortega-Álvarez and MacGregor-Fors, 2009). Additionally, a diverse belowground community has been shown to thrive in vacant lots in Cleveland and Akron, Ohio, USA (Grewal et al., 2011; Yadav et al., 2012). These habitat patches can also contribute to the overall connectivity of urban ecosystems (Herbst and Herbst, 2006) and provide stepping stones for species such as migratory birds or butterflies travelling between larger habitat preserves (Angold et al., 2006).

Restored vacant lots also have potential to offer economic benefits to urban residents through the provision of ecosystem services, primarily from increased plant abundance (Pimentel et al., 1997; Kim, 2016). Increased vegetation and biodiversity can contribute to a number of ecosystem services with direct economic value (Bolund and Hunhammar, 1999), such as stormwater retention (which can reduce basement flooding; Walsh, 2000), increased pollination services (which can increase crop yield of home gardens; Lowenstein et al., 2015), and bio-remediation of contaminated sites (which can reduce public health concerns such as lead exposure; Weitzman et al., 1993). Because vacant lots tend to be in low-income neighborhoods, restoration could also potentially increase property values and draw in local businesses in areas where need is arguably the strongest (Accordino and Johnson 2000; Groot et al., 2013). A study in Pittsburgh, Pennsylvania (USA) showed that homes near untended vacant land can appraise for up to 20% less than homes further away from these spaces, and that this is almost completely reversible when lots are planted and maintained (Wachter and Gillen, 2006). Furthermore, business opportunities exist in terms of green job creation and infrastructure development in and around vacant lots. Schilling and Logan (2008) suggest that lots that meet specific ecological requirements could feasibly be used for biofuel production, municipal CO_2 sequestration plants, or small-scale for-profit agriculture.

There have also been recent efforts to better understand the social dimensions of biodiversity (e.g., Sharma and Ruud, 2003; Paloniemi and Tikka, 2008; Riechers et al., 2016). Cultural ecosystem services, as defined by the Millennium Ecosystem Assessment (2003), acknowledges cultural benefits of biodiversity such as spiritual attachments, recreation experiences, and aesthetic values. Broadly speaking, exposure to nature and real or perceived biodiversity may provide many benefits to people, including improved psychological well-being, physical health, and cognitive function (Brown and Grant, 2005; Maller et al., 2006; Fuller et al., 2007; Shin et al., 2010), although Keniger et al. (2013) recognize the cultural implications and Western biases of the literature on this matter. While there are some discrepancies about the relationship between biodiversity and human well-being (Dallimer et al., 2012; Schwartz et al., 2014), Keniger et al. (2013) explicitly examine the evidence and conclude that there are three types of benefits to humans from increased access to nature. These benefits represent a gradient of presence and purpose: indirect benefits, incidental benefits, and intentional benefits. Indirect benefits are gained without physically being present in nature (e.g. window views of a park), while incidental and intentional benefits arise from being in a more natural setting, whether it be passive (incidental, e.g. plantings near the bus stop) or motivated by the nature itself (intentional, e.g. gardening). Social scientists have also examined the impacts of restoration and environmental activity on local residents. Németh and Langhorst (2014) suggest that increasing temporary usage of vacant land demonstrates that people are taking interest in these sites, which increases positivity and catalyzes community engagement around a common goal. This phenomenon is referred to as "activating" in the urban planning literature (Raco, 2007). Garvin et al. (2012) make an explicit case for the benefits of greening vacant lots on psychological feelings of safety in an environment. Additionally, increased vegetation and tree density in cities correlated strongly with significant reductions in total crime and violent crime in the dense urban center of Baltimore (Maryland, USA) (Kuo and Sullivan, 2001). Philadelphia (Pennsylvania, USA) also saw significant decreases in crime following general clean-up and "greening" in vacant lots (Branas et al., 2011).

Although the interactions between ecology, economy, and society are not thoroughly understood, there is potential for delineating the benefits of restoration in light of overlap between these three domains (Fig. 1), and utilizing this framework to inform policy and decision processes (Daniel et al., 2012). The extensive benefits of biodiversity, coupled with alarming rates of climate change, global extinction, and—in some areas—human population growth, make a compelling case for maximizing and restoring habitat in urban areas.

2.2. Ecological, economic, and social challenges to restoring vacant lots

Vacancy is a largely transient state; ownership or development of a property may change when conditions are economically or socially viable (Kremer et al., 2013; Németh and Langhorst, 2014). Because of this transiency, use of vacant lots should be approached as a temporary rather than long-term solution (Németh and Langhorst, 2014). There are several interdisciplinary challenges with this framework. Time, ownership, and money all limit the possibilities for undertaking a restoration project, and challenges with maintenance, bureaucracy, and shifting social climates may persist even after a project is underway (Bullock et al., 2011). Here, we elaborate on the ecological, economic, and social challenges that arise throughout or as a result of a restoration process.

First, restoration takes time. Natural succession is highly implicated in vacant lot vegetation structure, and lots that have been vacant longer have a plant community that is more representative of the historic native community (Albrecht et al., 2011; Bonthoux et al., 2014). Early successional wastelands in Munich (Germany) often had a high proportion of invasive species and naturalized weeds (Albrecht et al., 2011). Furthermore, periodic anthropogenic disturbances such as mowing can interrupt successional patterns by destroying more fragile native plants while spreading seeds of weeds with higher fecundity and longer reproductive seasons (Török et al., 2012). The time required to achieve desired ecosystem functionality is also highly dependent on the type of community being restored (Wilson et al., 2011). For example, forest systems take longer to establish functionality (Dobson et al., 1997), and are more permanent, rendering the space actually or perceptually unavailable for development. Grassland restoration may be most effective in vacant lots because biodiversity increases fairly rapidly (Fischer et al., 2013a), sites can easily be developed in the event of change in ownership or development (Németh and Langhorst, 2014), and low-input techniques are available (Packard and Mutel, 2005). However, even after identifying a target plant community, multiple factors influence community composition over time. Fischer et al. (2013b) suggested that tall perennials with large seeds are most likely to become established in an urban grassland restoration. However, Renton et al. (2014) suggested that restoring habitat connectivity in highly fragmented landscapes significantly increased the likelihood that annuals—and to some extent trees—would persist in the landscape after 270 years of increasing climate change. In this simulation model, perennials were extirpated quickly. These examples demonstrate a difference in persistence based on functional traits, and merit site- and goal-specific evaluation.

Another challenge with temporary land use is that groups that restore or garden these spaces often do not own the land. The land may be expensive or bureaucratically unavailable (Németh and Langhorst, 2014), making it difficult to justify expending time, money, and labor on a project that may be disputed or disrupted at any time. Several organizations are starting to find ways around this. For example, in Chicago, Illinois (USA), NeighborSpace helps procure land ownership and gives legal counsel to communities looking to convert vacant land to park space or community gardens (Ben Helphand: President, personal communication, neighbor-space.org). In Baltimore, Maryland (USA), the Parks & People Foundation offers an Adopt a Vacant Lot program to support community gardening and investment (parksandpeople.org). While these programs do not directly restore high-quality habitat, they represent a community mindset geared towards green space reclamation and restoration.

There are several other social and ecological challenges involved in vacant lot restoration (Harrison and Davies, 2002; Bonthoux et al., 2014). Weed restrictions can be overbearing and enforcement often extends beyond noxious weeds. Even individuals who intentionally plant native plants in their front yards or along parkways are sometimes forced to remove anything that neighbors complain is unsightly (Schindler, 2014). This lack of knowledge and appreciation for native biodiversity among the public presents a challenge. Land managers must weigh the benefits of restoration with the risks of potentially harboring pests, contributing to sources of allergenic pollen, and having restoration efforts misconstrued as weed growth. These aesthetic concerns become a big challenge especially when vacant lots are allowed to grow wild (unmowed). Furthermore, as vacant lots are generally perceived negatively (Accordino and Johnson, 2000; Goldstein et al., 2001) and are related to depressed real estate values (Németh and Langhorst, 2014), local communities may be hesitant to invest in ecological projects on vacant land without substantial evidence of economic and social benefits.

A disconnect between local residents and restoration efforts in their communities is a major reason why restoration projects in vacant lots fail (Pediaditi et al., 2010). People who reside in areas with lots of vacant space may have little connection with the natural world (Hollander, 2004), possibly because they are unlikely to be responsible for land/yard management or they may be disenfranchised from high-quality green space. Conversely, it is also important to be aware that there exists a socioeconomic paradox in the aftermath of restoring vacant lots. The phenomenon of ecological gentrification (Dooling, 2009) has been proposed by several authors under many other names ("eco-gentrification," Patrick, 2011; "environmental gentrification," Checker, 2011; "green gentrification," Gould and Lewis, 2012). Investing heavily in restoring or increasing green space in the form of parks, green roofs, etc. has a profound effect on the property values surrounding the restored sites, which can, in extreme cases, drive low-income residents from their homes (Wolch et al., 2014).To effectively integrate high-

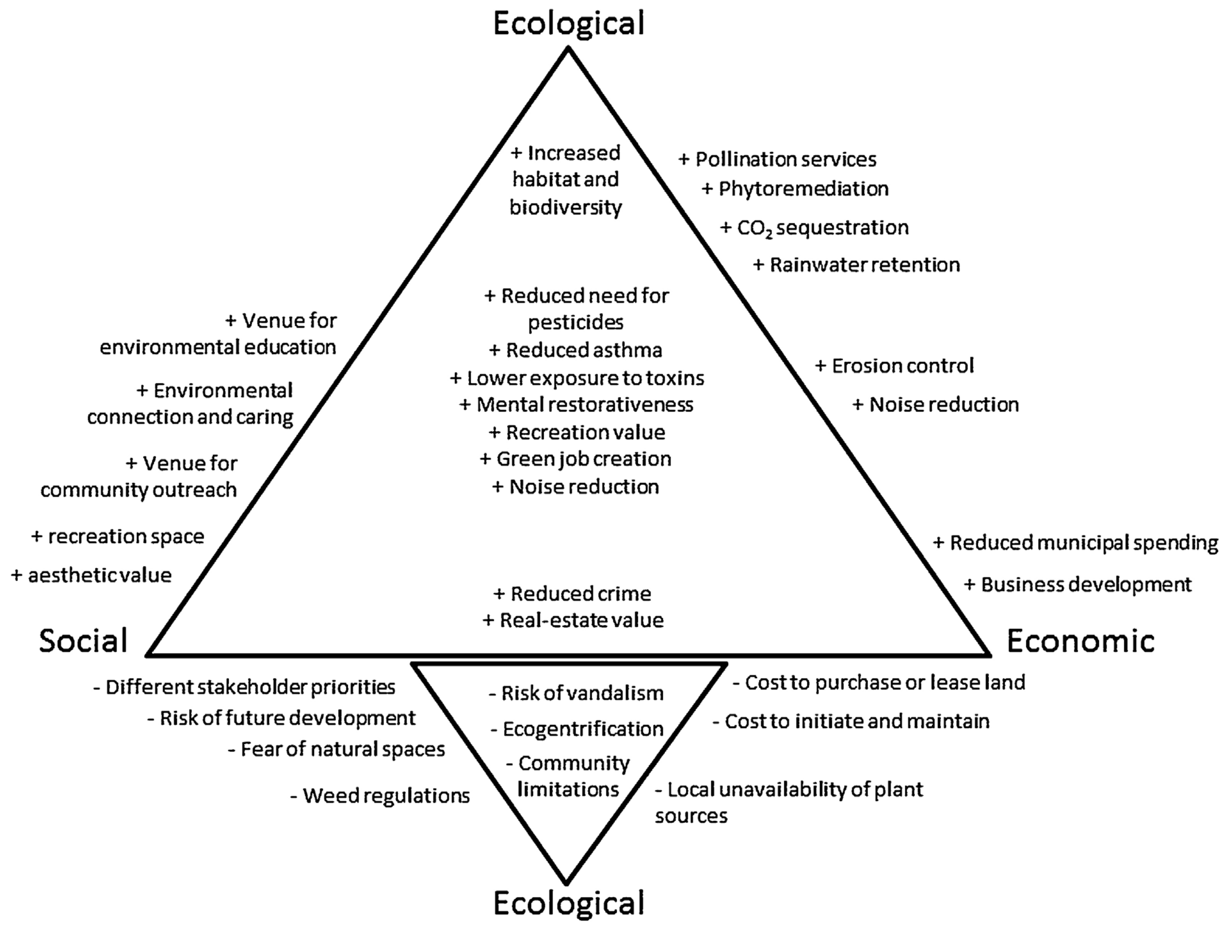

Fig. 1. Potential benefits (top triangle, +signs) and challenges (bottom triangle, −signs) of undertaking restoration projects in vacant lots across an interdisciplinary gradient.

quality green spaces into a community without placing an undue economic burden on low-income residents, planners, shareholders, and residents need to be invested in the project and cognizant of social challenges. Pediaditi et al. (2010) and Nassauer (1995) have identified elements of novel landscapes that help spark humans to care about it. These "cues to care" involve design elements such as strong delineations between native plants and mowed spaces or built terraces and raised beds that illustrate a compromise between the cost of installing and maintaining these features, encouraging social involvement, and maximizing ecological function (Nassauer, 1995). In essence, they exemplify the challenges of finding solutions that fall within a win-win–win paradigm for all stakeholders (Fig. 1, Foley et al., 2005).

2.3. *Evaluating success of restoration programs*

Restoration outcomes can be evaluated from a combination of ecological, economic, and social perspectives, although little work to-date has studied long-term outcomes of vacant lot restoration. Ecologically, measuring restoration success is a source of much debate (Pediaditi et al., 2010; Wortley et al., 2013). In natural areas, restoration often is not considered successful unless the community is self-sustaining over time (Hobbs and Norton 1996). According to this definition, if human input is required to keep the system healthy, an ecosystem has not been fully restored. However, in urban areas, economic and social factors might counteract ecological measures of success, and human inputs are unavoidable due to the highly disturbed and human-dominated nature of the landscape (Ramalho and Hobbs, 2012). Higgs (1997) argued instead for a more holistic approach to defining restoration success by including historical, social, cultural, political, aesthetic, and moral components. By including these distinct but complementary viewpoints, restoration projects are more likely to acknowledge and meet the needs of diverse stakeholders while maintaining a foundation in ecological process.

Doick et al. (2009) illustrated the complexity of measuring success of vacant lot restoration. In their analysis of six case studies in the United Kingdom, the authors found a severe disconnect between the original project goals and the actual outcomes of greening vacant spaces. Ecological shortcomings were frequently unrecognized by laypeople. They suggested that a lack of ecological monitoring following the projects resulted in areas that looked healthy but may not provide the desired ecosystem services. This problem arises because we lack the empirical understanding needed to set realistic restoration goals (Doick et al., 2009). Lovell and Johnston (2009) and Felson and Pickett (2005) also make a compelling case for increasing socio-ecological monitoring and experimentation in anthropogenic landscapes. These studies address the need for thinking about function, aesthetics, and sustainability in a restoration project and strongly advocate for interdisciplinary work to minimize challenges and shortcomings across social, ecological, and economic regimes.

2.4. *Recommendations for practice*

Our literature review suggests that restoring biodiversity in vacant spaces is a complex, interdisciplinary process and treating it as such can significantly improve outcomes (Pediaditi et al., 2010).

Here, we use information from the literature to make specific recommendations for practitioners on four different aspects of vacant lot restoration: (1) site selection, (2) the approach to restoration, (3) specific plantings, and (4) project follow-up and monitoring.

The beginning of a restoration project lies in selecting a site, which can be challenging due to limited land availability cities (Doick et al., 2009; McPherson et al., 2013; Németh and Langhorst, 2014). Selecting a site that contributes to (or at least doesn't impede) overall social and ecological goals is important. Sanches and Pellegrino (2016) suggests that restoration sites be selected carefully using a multidisciplinary approach, considering factors such as adjacency to other green space, potential for stormwater retention, and accessibility by urban residents (among other factors). Municipal land managers would also be advised to consider the social and ecological benefits and challenges of a single large or several small (SLOSS) sites for restoration, as some areas of cities have expansive vacant areas that may achieve higher diversity than smaller lots surrounded by buildings (Godefroid and Koedam, 2007; Kattwinkel et al., 2011). However, these same contiguous areas may be located within low-income neighborhoods, presenting a paradox. On one hand, the location may limit the social benefits of the green space because the socioeconomic profile of a neighborhood determines whether the space is visited (Peschardt et al., 2012). On the other hand, low-income neighborhoods would benefit most from the indirect or incidental benefits of green space (e.g., improved air quality, phytoremediation) (Keniger et al., 2013). If large areas are unavailable or unusable, lots that act as stepping stones between larger parks or preserves and are adjacent to restored or green area may be equally beneficial. These connected spaces allow species movement across the landscape, and may help prevent local extirpations and long-term extinctions (Magle et al., 2010; Renton et al., 2014).

While the physical process of restoration cannot begin without land, determining the restoration approach is another critical component of success. Different restoration approaches can run the gamut of cost, scale, and timeframe, and many professional and lay organizations exist to carry out projects. When thinking specifically about restoration in urban residential areas, large-scale projects undertaken by professional contractors are not necessarily the best option, as extensive financial inputs might be perceived as undue risk. Low-input restoration methods can be considered as possible alternatives depending on budgetary constraints and desired outcomes. Furthermore, large vacant spaces in the inner city may be better suited to restoration using a "just green enough" model, which suggests undertaking small restoration projects over time to avoid the risks of ecogentrification (Dooling, 2009; Curran and Hamilton, 2012).

Another important aspect of restoration involves the plantings. Appropriate plantings for successful restorations in vacant lots might include robust perennial species, specifically those that can grow in contaminated soils and effectively remediate these conditions (Reddy and Chirakkara, 2013; Köppler et al., 2014). While some researchers strongly support using only native plants in restorations, Hobbs et al. (2006) suggest that focusing on returning highly altered sites to historic conditions is always impractical and usually impossible. Instead, identifying the desired ecosystem functions and engineering a hybrid community with those goals in mind may be more realistic and effective. Some examples of these goals include increasing diversity of the soil microbial community (Bach et al., 2012), increasing water uptake in areas prone to flooding (Walsh, 2000), preventing erosion (Li et al., 2014), or reducing noise pollution from highways or train tracks (Van Renterghem, 2014). By initially focusing efforts on a small number of species with specific characteristics, progress and sustainability will be easier to monitor (Funk et al., 2008), leading to a greater likelihood of success (Pediaditi et al., 2010).

Finally, monitoring outcomes and assessing goal fulfillment is an often-neglected component of restoration projects. A meta-analysis by Pediaditi et al. (2010) found that brownfield greening projects can result in wasted time, money, and failure to accomplish goals, often due to poor engineering or inadequate follow-up. Building long-term monitoring into the project's budgets could remedy these problems. Furthermore, including the community in the process and encouraging their involvement in outcome monitoring can be a useful way to foster social connections and relevance (Anderson et al., 2014). For a restoration project to have long-lasting positive outcomes, community engagement and investment cannot play second fiddle to other goals set forth by professionals.

2.5. Recommendations for research

Vacant lots are becoming incorporated into the urban ecological paradigm in European cities. As such, we have a small body of literature on restoration in cities where space is limited by centuries of development (e.g. Foster et al., 2003; Doick et al., 2009; Fischer et al., 2013a,b). However, North America has not fully embraced vacant lots as a land resource for restoration projects, and as such, the literature does not exist to effectively support planning or management in those systems. The lack of research leaves doors wide open to study field-specific and interdisciplinary processes in vacant lots. Here, we put forth initial suggestions for researchers who are interested in building our knowledge base from ecological, social, and economic perspectives.

Ecologically, understanding how vacant lots serve as habitat can help us understand and develop conservation paradigms for shrinking cities (Kremer et al., 2013). Investigating whether unrestored vacant lots harbor rare or endangered plants or animals, and what site characteristics contribute to this phenomenon, would be an important step in this work (Bonthoux et al., 2014). In a broader context, it would be useful to know whether lots in certain locations serve different functions. For example, some lots may be ideally located to serve as habitat corridors or stepping-stones. Other lots might be well-suited to provide water retention based on topographical and precipitation patterns (Zelner et al., 2016). Many smaller-scale ecological questions remain as well, such as identifying annual patterns of allergenic pollen production from these spaces and evaluating the pollinator community that utilizes flowering weeds. In short, planning effective strategies for vacant lot restoration depends on knowing how their ecological function is affected by both site-specific factors and their juxtaposition in the landscape.

In terms of social aspects of restoration, it would be interesting and valuable to investigate the trade-offs between ecological and social benefits. This could allow exploration of concrete strategies that maximize both. There are also numerous applied questions that are strictly social. It would be especially valuable to deepen our understanding of the ways in which people of various backgrounds and ethnicities connect to their local environments and ultimately get involved in restoration projects, while paying particular attention to low-income residents and minorities (Hoffman et al., 2012). Expanding Nassauer's (1995) cues to care would be a good starting point for evaluating what features cause vacant lots to be perceived as blight on the neighborhood versus a green-space resource. We expect that there may be some non-linear paths to accepting and caring for a space that require long-term study to best inform future urban restoration.

Following up on all these questions with assessment of economic costs and gains would also help us to understand the feasibility of these investments. For instance, what management actions would reduce municipal spending or save home owners money (e.g., by reducing basement flooding)? It is also worth investigating how property values surrounding restored vacant lots change in comparison with property values surrounding unrestored lots. In short, based on the literature reviewed and the shortage of truly interdisciplinary work on the topic of restoration in vacant lots, we advocate for research on practices that maximize ecological and social benefits while minimizing economic costs.

3. Conclusions

Vacant lots represent a large ecological and social resource in urban centers, yet they are often regarded as unsightly, unsafe, and unusable. Restoring suitable habitat in these sites can increase ecosystem services, habitat connectivity, and social well-being, but there are several caveats. Planning and follow-up need to include a broad range of expertise, and ecological and social needs must be rectified within specific, attainable goals. Moving forward with some of the recommendations for practice and research presented here, it is possible that we could dramatically increase the habitat available for native wildlife in cities and reduce deleterious effects of city dwelling for human residents, despite increasing urbanization pressures worldwide (UNDESA, 2014).

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