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Measuring landscape change, lot by lot: Greening activity in response to a vacant land reuse program

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ABSTRACT

Urban vacancy is a persistent problem in many cities across the U.S. and globally. Vacant land greening helps improve neighborhood conditions and initiatives that transfer vacant lots to neighborhood residents can return benefits to where they are most needed. We examined one such initiative, the Chicago Large Lot Program, which allows property owners in high-vacancy areas to purchase 1–2 city-owned vacant lots on their block for $1 each. We developed a fine-scale landscape change analysis based on a visual assessment of aerial and street-level imagery. Our assessment, which included 20 different aspects of land/tree cover and condition/care, was applied to 424 lots purchased in two areas of the city one year before and after purchase. Among the significant changes we observed was an 8% increase of lots with gardens, and while there was a 16% reduction of lots with mature trees, it was accompanied by a similar increase in the proportion of mature trees in "good condition." Also, nearly a third of the lots showed signs of appropriation for use and/or stewardship prior to purchase, a process known as "blotting." We found that transfer of ownership to residents through the Large Lot Program was followed by improved condition and care regardless of prior blotting, but the non-blotted lots had bigger improvements in condition and care after purchase than the blotted lots. Changes associated with vacant land greening have both social and ecological implications, and we discuss our findings with respect to urban greening strategies and future research.

1. Introduction

Urban vacancy is a pressing issue in many cities worldwide (Nassauer & Raskin, 2014). Vacancy can affect whole cities or certain neighborhoods, and though the forces that give rise to vacancy often vary for different cities, its effects are most commonly and directly felt by those residents who remain in place. This is especially the case in residential areas with longstanding vacancy problems, where homes are vacated, then abandoned, then demolished in a devolution of a once-dense urban fabric (Johnson, Hollander, & Hallulli, 2014). This scenario is familiar to Shymaine Wright, who has lived in Chicago's Englewood community for more than 50 years and witnessed its change as two-thirds of the neighborhood's population has left:

> *You got that house, and you got three other houses on the block, when at one time there were 25 houses on the block. That says it's no longer a community. You got three houses to a block? That's not a community (Shymaine Wright, quoted in the* Chicago Tribune, 2018*).*

The emptiness described by Wright is a major physical manifestation of urban vacancy, yet lower density may not be the biggest factor contributing to the lost sense of community she has experienced. In other contexts, particularly in suburban and exurban communities, abundant green space and expansive yards are viewed by residents as adding to their quality of life (e.g., Vogt & Marans, 2004). Rather, vandalism, dumping, and other signs of physical disorder that follow vacancy in urban neighborhoods are often cited as key predictors of crime and the loss of social cohesion (Sampson & Raudenbush, 2004). Conversely, if these signs of abandonment and neglect are replaced by those of occupancy and care, repurposed vacant land within formerly dense urban neighborhoods can be an asset that strengthens community cohesion and sense of place (Alaimo, Reischl, & Allen, 2010; Gobster, Stewart, Rigolon, van Riper, & Williams, 2018; Stewart, Gobster, Rigolon, & van Riper, Williams, 2019).

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Vacant land greening is not a substitute for restoring the vibrant communities of earlier times but can be an important step toward rebuilding community and mitigating green space deficiencies in older neighborhoods (Gobster et al., 2018; Stewart et al., 2019). This idea drives vacant land reuse programs in several cities in the U.S. and elsewhere (Crauderueff, Margolis, & Tanikawa, 2012). Among these, programs that sell vacant lots to nearby residents at reduced cost hold particular appeal, as those who have remained in the neighborhood are most likely to benefit from and be committed to its improvement (Burchfield, 2009). To date, however, few studies have assessed how such programs affect change on the landscape and accomplish broader personal, social, and ecological goals.

In this study, we examined changes made to vacant residential lots through the City of Chicago's Large Lot Program (City of Chicago, 2014a). At an applied level, our work presents an approach to inform planners about the type and degree of changes being made to lots, to evaluate progress and program success. At a scholarly level, the work adds a temporal dimension to the literature on urban vacancy and greening, which has tended to examine social and ecological patterns at a single point in time (Anderson & Minor, 2017). The study also provides a fine-scale understanding of landscape change, a phenomenon that is usually assessed at broad metropolitan or landscape scales (e.g., Gobster, Stewart, & Bengston, 2004) and thus has largely neglected changes at the neighborhood level that is most salient to people's everyday quality of life (Sullivan, 2001). Finally, the work extends methods of visual landscape quality assessment (Gobster, Ribe, & Palmer, 2019) by adapting recent approaches from sociology, public health (e.g., Bader et al., 2015), and urban ecology (e.g., Taylor & Lovell, 2012) to understand the greening of vacant lots through landscape condition and care.

2. Background

2.1. Urban vacancy and greening strategies

Despite the dominant global trend toward increased urbanization, many cities around the world are shrinking in population (Dewar & Thomas, 2012). For decades, economic decline, especially the loss of heavy industry, has been a major driver of vacancy in older cities of the U.K., Europe, U.S., and elsewhere (Dewar & Thomas, 2012). Aging population and politically induced migration are two more recent sociodemographic drivers of vacancy in some cities of Japan and Eastern Europe (Doringer, Uchiyama, Penker, & Kohsaka, 2019). Most recently, the Great Recession of 2008 furthered vacancy problems in many older "Rustbelt" cities of the Northeastern and Midwestern U.S. and created new ones in "Sunbelt" cities of the south and west (Hollander, 2011; Schilling & Logan, 2008).

The impacts of vacancy have been severe for cities such as Detroit, which lost 63% of its population between 1950 and 2015, resulting in approximately 120,000 vacant lots and another 110,000 vacant housing units (Detroit Future City, 2017; U.S. Census Bureau, n.d.). With its greater economic diversity, Chicago has seen a smaller overall impact, with a 25% population loss between 1950 and 2015, resulting in 33,000 vacant lots, one-third of which are city owned, along with 34,000 vacant housing units (City of Chicago, n.d.; Gallun & Maidenberg, 2013; Podmolik, 2015; U.S. Census Bureau, n.d). Unlike Detroit, however, vacancy in Chicago is unequally distributed across the city, and longstanding patterns of racial segregation have concentrated vacancy in the largely African-American communities on the city's south and west sides (Table 1; Moore, 2016).

Population loss and de-densification of this magnitude have created significant challenges for urban planners, and some have responded by implementing vacant land greening programs (Németh & Langhorst, 2014). Former use, vacancy status (vacant structure, abandoned structure, vacant land), ownership type, and spatial distribution of vacant land are among the factors considered by planners in

Table 1
Demographic and land use statistics for study areas and the City of Chicago.*

	Greater Englewood**	East Garfield Park	City of Chicago
Demographics (2015)			
Total population	94,508	20,656	2,717,534
Households	32,300	6,923	1,035,436
% population change 1950–2015	−67.4%	−70.5%	−24.9%
% population change 2000–2015	−25.4%	−1.1%	−6.2%
% African American	91.9%	91.3%	30.9%
Median Income	$23,596	$21,482	$48,522
% below poverty rate	40.8%	42.8%	21.7%
Housing and Land Use (2013)			
Occupied housing units	32,300	6,923	1,035,436
% owner occupied	30.0%	22.8%	44.3%
% vacant units	28.5%	17.7%	13.2%
Total land area (km^2)	25.42	5.01	598.73
% area open space	13.2%	14.8%	7.1%
Open space km^2/10,000 residents	0.36	0.36	0.16
% area vacant land	15.7%	13.7%	5.1%

* Chicago Metropolitan Agency for Planning (2017).
** Includes Englewood, West Englewood, Woodland and Washington Park Community Areas. Does not include fractional areas of New City, Fuller Park, and Greater Grand Crossing Community Areas that are also included within the Greater Englewood planning area as defined in the Green Healthy Neighborhoods Plan (City of Chicago, 2014a,b).

understanding vacancy within a city and determining whether greening is a viable short- or long-term strategy (Németh & Langhorst, 2014). When successfully implemented, greening strategies help stabilize population loss and improve social and ecological values (e.g., Anderson & Minor, 2017).

Our work focuses on vacant residential land that has reverted to public ownership due to property tax delinquency and been cleared of buildings. Although there are various types of vacant land, residential properties often account for the bulk of vacant parcels in high-vacancy cities (Newman, Bowman, Lee, & Kim, 2016). Usually occurring as noncontiguous patches of small lots, this land does not lend itself to conventional public green space development, but it may be desirable for adoption and stewardship by those living nearby for yards and gardens, parking spaces, or other uses (Kremer, Hamstead, & McPhearson, 2013). Such demands are evident in cities with high amounts of vacant residential land, even in the absence of formal programs. In a process known as "blotting," nearby residents informally appropriate and maintain vacant lots for personal use (Armborst, D'Oca, & Theodire, 2008). Yet without legal ownership, blotters may be unwilling to invest in major improvements because of the risk that the lot will be reclaimed.

A range of formal greening strategies for publicly-owned vacant residential properties have been proposed and implemented. The first and most basic strategy is exemplified by programs in Philadelphia and Cleveland, where city governments work in conjunction with civic groups to demolish abandoned buildings and "clean and green" vacant lots while maintaining city ownership (Heckert & Kondo, 2018). In an extension of the "broken windows" theory (Sampson & Raudenbush, 2004), these programs aim to minimize the visual signs of neglect that invite crime and antisocial behaviors. Such programs, however, require substantial and continued financial input by municipalities and partner groups.

A second strategy involves programs whereby local community groups lease or adopt city-owned vacant lots for an approved purpose (Crauderueff et al., 2012). For example, Baltimore's Growing Green Initiative comprises eight greening options including green parking lots, urban agriculture, and stormwater management (City of Baltimore,

Table 2
Summary of hypotheses, variables, and analytical tests.

Hypothesis		Variables	Analysis
1	Lots purchased under the Large Lot Program will see significant improvements in condition and care	Grouping: before vs. after purchase DVs*: All variables in Table 3	Related-samples tests (McNemar, Marginal Homogeneity, Wilcoxon Signed Rank)
2	The process of cleaning and greening under new ownership will result in a more manicured landscape	Grouping: before vs. after purchase DVs: Land-tree cover variables in Table 3	Related-sample tests (McNemar, Marginal Homogeneity, Wilcoxon Signed Rank)
3.1	Blotted lots will show a higher level of condition and care prior to purchase than non-blotted lots	Grouping: blotted vs. non-blotted DV: Condition/care index	Independent samples Mann-Whitney *U* test
3.2	The act of purchase will result in significant further improvements to the blotted lots	Grouping: before vs. after purchase DV: Condition/care index	Related-samples Wilcoxon Signed Rank test (for blotted lots)
3.3	Non-blotted lots will have a bigger improvement in condition and care after purchase than the blotted lots	Grouping: before vs. after purchase DV: Condition/care index	Related-sample Wilcoxon Signed Rank test; compare effect size between blotted and non-blotted lots

* DV: Dependent variable.

2012). While helping reduce blight and municipal maintenance costs as well as building community, the impact of such programs may be limited by the temporary nature of the agreements, need for oversight, and willingness of groups to adopt lots.

A third strategy, and the one used by the Chicago Large Lot Program, is to transfer vacant property to private ownership. Many cities and counties in the U.S. with high vacancy rates have established land banks or other sales programs that align with this strategy (Tappendorf & Denzin, 2011). The specific conditions of these programs vary: Some "side yard" programs limit purchase to residents adjacent to a vacant property, while others are open to anyone, usually for a higher price (Ganning & Tighe, 2015). These programs can alleviate municipal maintenance burdens, return property to the tax rolls, and put land to productive use as private or shared green space, or for built uses ranging from parking to new housing when market demand increases. Conversely, high purchase costs may be a deterrent to transfer, limiting purchase to nearby property owners may be seen as overly restrictive, and opening sales to anyone may invite speculators to simply hold land without improvement until it can be resold for profit (Ganning & Tighe, 2015).

3. Research questions and hypotheses

Our research builds upon the vacant land greening literature in three ways. First, we sought to identify and measure green and built changes in land cover condition and care of vacant lots transferred from public to private ownership as part of the Chicago Large Lot Program. Within this context, we define condition in terms of degree of maintenance, and lots that are in good condition have trimmed vegetation and well-maintained built features that convey order and neatness. Good maintenance has been found to be a strong predictor of preferences for public green spaces (Gobster, 2002), residential yards (Larson, Casagrande, Harlan, & Yabiku, 2009), and greened vacant lots (Morckel, 2015). Care connotes more than neatness and order; it involves engagement with the landscape and not only connects people with the land as owners and stewards but also has an expressive component that communicates this intent to others (Nassauer, 1995). Thus, the primary question driving our research was to examine the extent to which large lot condition and care would change as a result of private ownership. Improvements in lot condition and care would provide evidence of the success of the Large Lot Program, and we expected to see significant improvements in selected measures of condition and care after the transfer of vacant lots to private ownership (hypothesis 1).

While condition and care are key ways in which people perceive landscape beauty and express stewardship goals, improvements made in lot maintenance for social reasons also have ecological implications (e.g., Anderson & Minor, 2017). In this respect, a secondary question of our work was to understand how patterns of vegetation cover and condition might change as a result of program participation. For this question, we hypothesized that the process of cleaning and greening vacant residential lots through new private ownership would result in a more manicured landscape, one that is preferred primarily for aesthetic and social functions (hypothesis 2). This type of greening might differ from that conducted by environmental groups, which would likely emphasize functions related to ecosystem services (Kim, Miller, & Nowak, 2018; Kremer et al., 2013). Evidence to support hypothesis 2 would include increased areas and improved condition of pavement, gardens, and turf, and reductions in woody vegetation as undesired trees and shrubs are removed by new owners. While our work does not directly assess the ecological effects of such changes, these measures provide insights into the current discourse on the social and ecological dynamics of urban vacancy, which we discuss later in the paper.

Finally, given the paucity of research on blotting, we sought to identify its extent within our study areas and to better understand how it affected changes made by residents after purchase. If residents were already benefiting from vacant lots without cost, would ownership simply protect current use and maintain the status quo? Alternatively, could the security of ownership lead residents to invest in improvements beyond what they would do as a blotter? We expected this latter reason to be the case and hypothesized that, although blotted lots would show a higher level of condition and care prior to purchase than non-blotted lots (hypothesis 3.1), the act of purchase would result in significant further improvements to the blotted lots (hypothesis 3.2). Additionally, because non-blotted lots by definition receive minimal if any care prior to purchase, we expected that non-blotted lots would see a bigger change in condition and care after purchase than blotted lots (hypothesis 3.3).

4. Methods

4.1. Research design

We tested these hypotheses in the context of changes made to lots purchased under the Chicago Large Lot Program. The hypotheses are summarized in Table 2 along with their relevant variables and statistical tests. We used a before-and-after research design that relied on fixed-samples panel data without a control group (Chambliss & Schutt, 2019), and our units of analysis were the individual large lot parcels assessed at two points in time. For most hypotheses, the values of individual dependent variables or aggregations were compared before and after purchase, which was treated as a grouping variable in related-samples statistical tests. An exception to this approach was for hypothesis 3.1, where the blotting of lots was used as a grouping variable in an independent samples statistical test. The transfer of lot ownership from the city to the resident was viewed as a policy intervention, and our dataset was purposely developed to assess the visual conditions of the lot pre- and post-purchase. In aggregate, any changes in lot conditions could be framed as an effect of the policy.

4.2. Large Lot Program and study areas

The Large Lot Program grew out of a Green Healthy Neighborhoods plan initiated in 2011 by the Chicago Department of Planning and Development in collaboration with local community groups (City of Chicago, 2014b). Focused on the Greater Englewood area on the city's south side, the 20-year plan reconceives the area's more than 11,000 public and private vacant properties as assets to revitalization and population stabilization. As a part of this plan, the Large Lot Program seeks to repurpose the many city-owned vacant lots scattered within residential blocks. The program invites residents who own property on a block to purchase one or two lots on or that block or an adjacent block for $1 each, stipulating that they maintain the property, fence the lot if it is not directly side-adjacent to their owned property, and pay the current property taxes. After meeting these conditions for five years, they are free to sell. While large lot owners are permitted to build housing or garages upon the lots, in the initial years of the program it was expected that most would use the lots as private green space or shared spaces such as community gardens (Channick, 2016). Restricting purchase to current property owners assumes that owners have a greater stake in the future of their neighborhood and thus in maintaining the lot, but also helps ensure that benefits gained from purchase are returned to local residents.

The Large Lot Program was adopted by the city in early 2014, with the first round of lot offerings in April in the Greater Englewood area and a second round in July in the East Garfield Park community area on the city's near west side (Fig. 1). Both areas have high proportions of African-American residents, high rates of poverty, and large amounts of vacant land (Table 1). While public green space is greater than the city average, much of it lies within a few large regional parks at the edges of the study areas and the Large Lot Program aims to provide close-to-home green space opportunities.

Qualified property owners were encouraged to apply for the lots on the program's website (https://largelots.org/) through news stories and community outreach activities. Successful applicants closed on purchases in late 2014 and received quit claim deeds in early 2015. In Greater Englewood, 209 qualified applicants purchased 275 out of 4062 available lots (7%). In East Garfield Park, 112 qualified applicants purchased 149 out of 418 available lots (36%). Together, there were a total of 321 owners and 424 lots.

In spring 2015, our research team met with representatives from the city and local community organizations who developed the Large Lot Program to discuss an evaluation study. From this discussion and review of the literature, our team drafted a study plan and secured federal funding to support work for this visual assessment and a related social assessment (Gobster et al., 2018; Stewart et al., 2019) to understand the motivations and needs of new lot owners.

4.3. Assessment approach

The approach used in this study to measure the condition and care of vacant lots derives in part from research on the visual assessment of landscapes. Visual assessments relate landscape features or qualities to key aspects of human perception such as attractiveness and safety (Gobster et al., 2019). Biophysical landscape features are commonly employed because of their management relevance and are measured via ground-level assessments made on-site or from photographs, and aerial assessments of satellite imagery and mapped resource data (Zube, Sell, & Taylor, 1982). The validity of using photographs to represent actual landscapes is well established as are protocols to assess the reliability of indicators (Daniel & Vining, 1983).

There has been a surge of interest in recent years of applying visual assessment tools in a neighborhood context, from urban sociologists examining physical and social disorder (e.g., Sampson & Raudenbush, 2004), to public health researchers understanding supportiveness for physical activity (Griew et al., 2013), to urban ecologists assessing green space quality (Gidlow, Ellis, & Bostock, 2012). Much of this recent research has been fueled by increasingly available aerial and ground-level imagery through sources such as Google Earth and Google Street View, which can complement or replace costly and time-consuming field-based audits. The high resolution of this imagery lends itself to the measurement of fine-scaled features in the environment, from graffiti on buildings (e.g., Bader et al., 2015) to types of gardens (e.g., Taylor & Lovell, 2012). Although remote sensing technologies have long been used in metropolitan-scale landscape change assessments, surprisingly few studies to date have taken advantage of time-series aerial and ground-level imagery to examine fine-scale landscape changes (Ilic, Sawada, & Zarzelli, 2019; Naik, Kominers, Raskar, Glaeser, & Hidalgo, 2017).

4.4. Data sources

We used multiple data sources including property information from the City of Chicago, the Large Lot Program's website, and county tax portal (Cook County, n.d.) to locate large lot property boundaries and other attributes; Google Earth aerial and Google Street View and Bing Streetside ground (street) level imagery from which land use and landscape features were coded; and field photography to supplement street-level imagery. To assess large lot "before" conditions, we had Google Street View coverage for 80% of the large lots taken during June-October 2014, just before lot purchases. For the remainder of lots we used lower resolution Bing Streetside images dating from May 2014 or earlier Street View images. Google Earth aerial imagery was taken between October 2014 and April 2015, prior to purchase or the start of the spring gardening season. To complete the change assessment of "after" purchase lot conditions, we took our own street-level photography in October 2015 after the first full growing season since ownership (in some cases supplementing it with available Google Street View imagery from July-October 2015) and used Google Earth aerial photography from May-June 2016, the closest matching post-purchase date available.

4.5. Variable measurement

4.5.1. Condition-care and aerial measures

Our measurement protocol most closely followed the work of Dewar, Nassauer, and Dueweke (2013), who developed a set of "cues to care" indicators for assessing vacant land and structures as part of their Detroit Sustainability Indicators Integrated Assessment. They developed measures for vegetative elements such as flowers, well-maintained turf, and trimmed trees that express stewardship; built features such as patio chairs, children's play equipment, and barbeque grills that show signs of occupancy and social use; and dumping, vandalism, and junked cars that convey neglect and physical disorder. We adapted a subset of 14 of their indicators and operationally defined them to cover the range of conditions present in our study areas (Table 3). Further detail of our methods is available in Gobster et al. (2018); Stewart et al. (2019).

Each before and after street-level image was coded by a trained research assistant for presence/absence, number, or condition for each of the indicators. A subset of 100 randomly selected large lots was re-coded by the same assistant six months later to assess the test-retest reliability of the measures. Kappa values ranged from $r = 0.481$ to 0.906 (Table 3), indicating moderate to excellent agreement, with the average Kappa of $r = 0.672$ across the measures considered acceptable for similar types of analyses (e.g., Griew et al., 2013). We also included

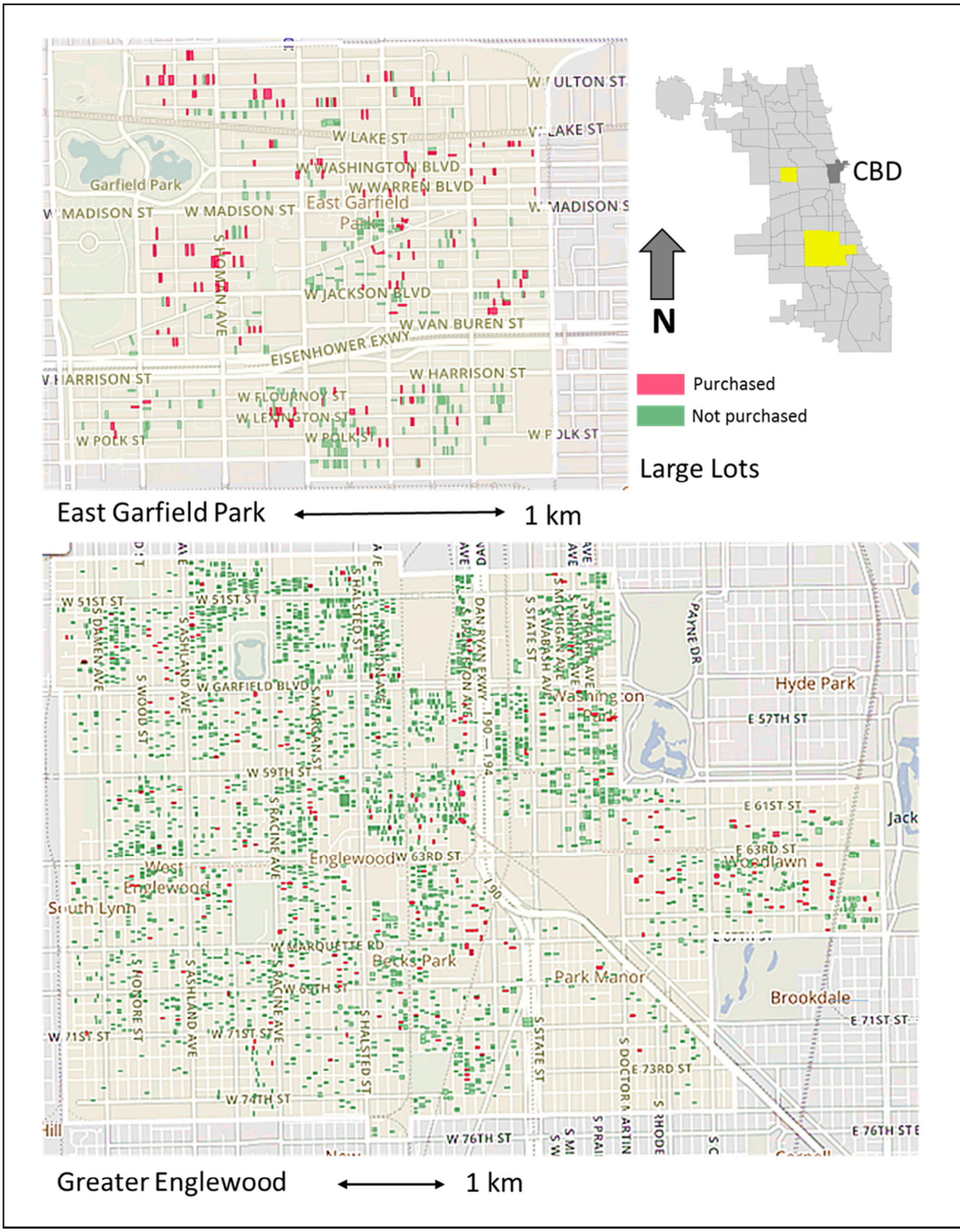

Fig. 1. Large Lot study areas and location within the City of Chicago.

a set of six aerial measures to quantify the extent of changes made to land cover (e.g., bare ground, turf) and tree canopy cover at the lot level before and after purchase. We measured these areas with the Polygon tool in the Ruler feature of Google Earth Pro. In cases where shadows or canopy cover obscured ground areas, the images were cross-checked with Street View or field photographs or by alternate aerial imagery to help maximize accuracy, or were otherwise coded as missing data. Reliability tests were not conducted on the aerial measures because previous tests using similar ordinal-level measures showed acceptable reliability (average r = 0.713).

4.5.2. Condition-care index

To assess the overall effects of changes made to lots as a result of participation in the Large Lot Program, we transformed selected measures related to lot condition and care into dichotomous variables reflecting positive conditions (e.g., pavement in good condition = 1;

Table 3
Condition-care and land/tree cover variables, measurement, and reliability.

Street level	Measurement	Kappa[a]
Pavement condition	0 = none, 1 = poor, 2 = moderate, 3 = good	0.616
Turf condition	0 = none, 1 = poor, 2 = moderate, 3 = good	0.531
Garden type(s)	0 = none, 1 = small patch, 2 = moderate/extensive – ornamental, 3 = moderate/extensive – vegetable or mixed veg/ornamental	0.906
Structure condition	0 = none, 1 = poor, 2 = moderate, 3 = good	na*
Shrubs and small trees (presence)	0 = absent, 1 = present	0.660
Shrubs and small trees (condition)	0 = none, 1 = poor, 2 = moderate, 3 = good	0.637
Mature trees (presence)	0 = absent, 1 = present	0.726
Mature trees (condition)	0 = none, 1 = poor, 2 = moderate, 3 = good	0.691
Fencing (presence/condition)	0 = none, 1 = bollards, 2 = poor, 3 = good	0.905
Yard ornamentation (amount)	0 = none, 1 = minimal, 2 = moderate/extensive	0.586
Social/recreational use (amount)	0 = none, 1 = minimal, 2 = moderate/extensive	0.654
Vehicles (number/condition)	0 = none, 1 = 1–2 usable cars, 2 = 3 + usable cars, 3 = usable boats/trailers, 4 = abandoned or unusable vehicle(s)	0.666
Dumping (not vehicles)	0 = none, 1 = minimal, 2 = moderate/extensive	0.481
Vandalism and graffiti	0 = none, 1 = minimal, 2 = moderate/extensive	na
Aerial (%)		
Bare ground cover	0–100% continuous	na
Pavement cover		
Turf cover		
Garden cover		
Structure cover		
Tree canopy cover		

[a] Cohen's kappa used for dichotomous variables; otherwise linear-weighted kappa is reported.
* na = not assessed.

Table 4
Values of land/tree cover and condition-care variables before and after purchase.

Aerial (avg. % of lot)	Before (mean %)	After (mean%)	Z	n	Ranks	Asymp. sig. (2-tailed)	*r*
Bare ground cover	9.3	7.0	−4.883[a]	420	5% P, 16% N, 79% T	0.000	0.169
Pavement cover	3.0	3.7	−1.856[b]	422	5% P, 4% N, 91% T	0.064	0.064
Turf cover	84.0	84.8	−2.044[b]	423	17% P, 10% N, 73% T	0.041	0.070
Garden cover	3.2	3.8	−4.102[b]	423	8% P, 3% N, 89% T	0.000	0.141
Structure cover	0.3	0.3	−1.095[b]	422	0% P, 0% N, 100% T	0.273	0.038
Tree canopy cover	22.6	23.3	−2.912[b]	422	17% P, 9% N, 74% T	0.004	0.100
Street level (binary recoded[c])	**Before (%)**	**After (%)**	**Chi-Square[d]**	**n**		**Asymp. sig. (2-tailed)[e]**	
Pavement in good condition*	4.2	7.1	3.559	395		0.059	
Turf in good condition	66.3	67.7	0.031	391		0.859	
Any garden type present*	10.5	18.8	16.000	390		0.000	
Structure in good condition	0.9	3.8	NA	396		0.013	
Any shrubs or small trees present	38.9	38.0	0.033	395		0.857	
Shrubs or small trees in good condition*	8.3	11.9	3.674	395		0.055	
Any mature trees present	50.9	34.5	44.907	397		0.000	
Mature trees in good condition*	5.7	21.2	50.704	397		0.000	
Fencing in good condition*	30.0	48.2	52.900	396		0.000	
Any yard ornamentation present*	6.6	10.6	7.314	396		0.007	
Any social/recreational uses present*	5.4	13.5	23.077	394		0.000	
Any vehicles present	26.2	18.2	12.663	396		0.000	
Any dumping (not vehicles) present	5.9	3.8	1.531	396		0.216	
Any vandalism and graffiti present	0.0%	0.0	NA	NA		NA	

[a] Based on positive ranks; [b] Based on negative ranks; [c]McNemar Test; [d]Continuity corrected. [e]Exact sig test (binomial distribution used).
NA = Not applicable.
P = Positive rank (increase), N = Negative rank (decrease), T = tie.
* Item included in the 7-item condition/care index of large lots.

else = 0), then aggregated them into a "condition-care index" (see starred items in Table 4). The 7-item index showed acceptable internal consistency (Cronbach's alpha = 0.753, before purchase; 0.698, after purchase; Santos, 1999).

4.5.3. Blotting

The phenomenon of blotting is not yet well-described in the literature, and guidance for its measurement is vague. In the earliest publication describing blotting, Armborst and colleagues (2008) examined property records to document how Detroit residents purchased lots adjacent to their homes, but they also found that a considerable number of properties were simply appropriated. While their definition of blotting is fairly open-ended, a full page "Detroit blot sampler" illustrates 30 different blotted properties, fenced and unfenced, where improvements from mowing, to parking, to extensive landscaping have been made to maintain the property and facilitate use. Building on that work, Dewar and colleagues (2013, p. 4) identified blotted parcels as those "marked by cues of care that include mowed grass, maintained flower beds, maintained edges, other uses such as for parking cars, storage, and residential expansion." While they do not determine ownership, they assume the lot is being cared for by the adjacent homeowner and specify that the blotted parcel must be fenced or hedged but open to the adjacent parcel for access.

For our study, because all the large lots were owned by the city prior to purchase, we could reliably assume that any blotted lot had been appropriated. Given the relatively high level of condition and care of some unfenced lots in our sample, the fencing/hedging criterion specified by Dewar and colleagues (2013) seemed overly restrictive for determining blotting. Yet because the city will mow vacant properties upon request, mowing alone should not qualify a lot as blotted. Therefore, we developed operational definitions for coding fenced and unfenced blots: 1) front of lot with fence in good condition plus mown turf; other signs of care or occupancy optional; or 2) lot unfenced or with fence in less than good condition, mown turf plus one or more other signs of care or occupancy. Other signs of care or occupancy included parked cars or other vehicles that did not look abandoned, pavement in good condition, gardens, yard ornaments, and social and recreational features. Applying these criteria, we developed a binary variable and coded lots as blotted or non-blotted using the 2014 Google Street View imagery. Although the assessment of blotting was made independently of the assessment of the variables in the condition-care index, they shared some of the same attributes and a point-biserial analysis showed a moderate correlation ($r = 0.571$ before, $r = 0.410$ after, $p < .001$).

4.6. Analysis

An overview of the statistical tests we used for each hypothesis is presented in Table 2. We performed all tests using IBM SPSS 25, and all test assumptions were met. To assess the effects of program participation on changes made to large lots (hypotheses 1 and 2), we used the observed values of individual variables as originally measured (Table 3) before and after purchase in related-samples tests of significance appropriate to their measurement level. These included the McNemar test (Table 4) for dichotomous data (e.g., presence of mature trees), Marginal Homogeneity test for multi-categorical data (e.g., garden type), and related-samples Wilcoxon signed-rank test for continuous data (e.g., percentage turf cover). We used the Wilcoxon non-parametric test (Tables 4 and 5) rather than a paired-samples *t*-test because a Shapiro-Wilk test of normality showed that the continuous variables were not normally distributed. Further, with the large amount of zero values, it was impossible to normalize their distribution through common transformations. The Wilcoxon test transforms scores of repeated observations into ranks (positive, negative, and ties) and compares such ranks across a sample (Pallant, 2011).

To examine whether program participation influenced condition and care in blotted lots (hypothesis 3), we conducted three sets of tests. First, we ran Mann-Whitney U tests (for independent samples) to assess whether the blotted sub-sample of lots had a higher condition-care index than the non-blotted sub-sample, both before and after lot purchase (hypothesis 3.1). Second, we ran the related-samples Wilcoxon signed-rank test for the condition-care index using the entire sample. This test helped us examine whether there were any overall changes in condition and care that occurred after purchase. Third, we split the sample between blotted and non-blotted in 2014 and performed another Wilcoxon test in the two split sub-samples (Table 5). We then compared the effect sizes of within paired sample differences – calculated as $r = Z/\text{sqrt}(n)$ (Pallant, 2011) – for the entire sample, blotted sub-sample, and non-blotted sub-sample to examine the role of owning blotted lots on their condition-care level (hypotheses 3.2 and 3.3).

5. Results

5.1. Lot-level change: condition and care

Table 4 reports the percentages of the 20 lot-level measures before and after purchase. To simplify presentation, the results for the street-level measures are shown with frequency data in binary format as described above; data and significance tests for all category levels are shown in Appendix S1.

The aerial measures showed a statistically significant reduction in area of bare ground, with an effect size of $r = 0.16$. Further, there were significant increases in areas of turf, garden, and tree canopy cover after purchase, while changes in pavement and structure cover were not statistically significant (see Table 4). Although the percentage change was small when averaged across the 424 lots, change to individual lots was at times very noticeable. For example, while there was an overall reduction in bare ground of 2.3%, 5% of lots ($n = 20$) had reductions in bare ground of 25%-91%. These included bare soil parking lots that had been paved or graveled, rehabilitated construction sites, and lots that had been used as alley-to-street shortcuts that were now fenced and reclaimed as yard space. Likewise, 4% of lots saw 25–83% increases in turf cover and 10 lots had an increase in garden space between 10%–29% (see examples in Appendix S2).

Although the aerial measures provided a useful quantitative assessment of land cover change, the more visible changes noted above were more effectively captured by the street-level measures of condition and care. As presented in Table 4, the majority of measures showed statistically significant improvements in condition and care: there were increases in the percent of lots with gardens, yard ornaments, and social/recreational features; reductions in vehicles parked on the lots; and improvements in the condition of structures, mature trees, and fencing. There was little or no evidence of dumping and vandalism, and together with the small increase in condition of turf, no significant changes were found. Taken as a whole, changes in the values of the aerial and street-level measures suggest support for hypothesis 1 that participation in the Large Lot Program results in significant improvements in lot condition and care, factors integral to gauging the success of the program.

5.2. Vegetation change

Looking specifically at the vegetation variables, we found mixed support for hypothesis 2 about the ecological implications of changes in vegetation management as a function of program participation. Turf

Table 5
Lot level care (7-item condition care index) as a function of time and blotting prior to the purchase.

Between independent samples[b] (blotted/non-blotted)	n	Ranks	Z	Asymp. sig. (2-tailed)	*r*
Before purchase	419	–	−0.13.307	0.000	0.650
After purchase	391	–	−9.025	0.000	0.4564
Within paired samples[a] *(Before/after purchase)*	**n**	**Ranks**	**Z**	**Asymp. sig. (2-tailed)**	***r***
All lots	387	43% P, 8% N, 49% T	−8.919	0.000	0.3205
Blotted lots	121	45% P, 15% N, 40% T	−3.489	0.000	0.2242
Non-blotted lots	266	42% P, 9% N, 49% T	−8.543	0.000	0.3703

P = Positive rank (increase), N = Negative rank (decrease), T = tie.
[a] Wilcoxon signed-rank Test.
[b] Mann-Whitney U Test.

condition did not see any significant change, and while there was a statistically significant increase in turf cover, the effect size was small. Looking at garden types, there were increases in both ornamental and vegetable gardens (Appendix S1). An expected finding was the decrease in mature trees present on the large lots after purchase. A closer look at the condition data for mature trees (Appendix S1) shows major reductions in the proportion of lots with trees in poor and moderate condition, resulting in a shift in lots with no mature trees as well as those in good condition. Inspection of individual before and after photos where removals occurred shows these trees tended to be weedy or misshapen, growing along property lines and fences, or dead or in poor health (Appendix S1). With respect to tree cover, the aerial measure of tree canopy also included trees not on the large lot (e.g., parkway strip along the street, adjacent lots) but where the canopy reached over it. This may explain why tree canopy registered a small increase even while trees were being removed within the large lots. As a separate but related issue, our tree canopy area variable may also have been influenced by seasonal difference in the time they were taken (October 2014 and April 2015 before purchase versus May-June 2016 after purchase). While care was taken in measuring crown areas, a greater proportion of trees in "leaf-on" condition in post-purchase imagery could have resulted in an increase in reported cover.

5.3. Blotting

Our blotting analysis revealed that nearly a third of large lots (31%) showed signs of appropriation for use and/or stewardship prior to purchase. Visual inspection of a means plot (Fig. 2) showed higher values of the 7-item condition-care index for blotted lots compared to non-blotted ones before purchase, along with increases in condition-care in both types of lots after purchase. As presented in Table 5, Mann-Whitney U tests showed that the differences between the level of condition-care of blotted and non-blotted lots were statistically significant both before ($Z = -13.307$, $p < .001$) and after purchase ($Z = -9.025$, $p < .001$), supporting hypothesis 3.1. Further, the Wilcoxon tests showed that the increases in condition-care after purchase were significant for the overall sample and for both the blotted and non-blotted sub-samples. The increase in the condition-care index had a higher effect size in non-blotted lots ($r = 0.37$, medium effect size) than in blotted lots ($r = 0.22$, small effect size), in support of hypothesis 3.3. But the act of purchase also revealed a further increase in condition-care of blotted lots beyond what had happened prior to purchase, in support of hypothesis 3.2.

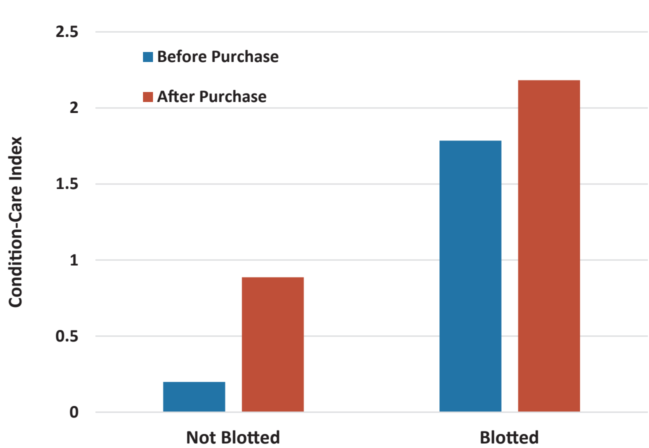

Fig. 2. Plot of marginal means of lot level care as a function of time and prior blotting. Note: Condition-care index ranges from 0 to 7.

6. Discussion

6.1. Vacant land greening strategies and landscape change

Our findings point to the success of the Large Lot Program in improving the condition and care of vacant land through the individual actions of large lot owners. Because our research design did not include a control group of vacant lots outside the program, we cannot assert a causal link between program enrollment and observed changes. But the short time span under which changes occurred, the number of different changes made to lots that we observed, and the lack of other public or private initiatives aimed at lots during this period reduce the likelihood of a spurious association between the program's implementation and improvement in large lots condition and care (Craig, Katikireddi, Leyland, & Popham, 2017).

We found considerable support for hypothesis 1, showing significant changes in 12 of 20 different indicators of condition and care, from reductions in the area of bare ground and increases in the area of garden cover to improvements in the condition of trees and fencing and increases in the presence of yard ornaments and social/recreation features reflecting cues to care. These indicators and their values are consistent with the literature on urban greening and residential landscape preferences (e.g., Bradley, Lelekacs, Asher, & Sherk, 2014; Larsen & Harlan, 2006), but our application of them adds important temporal and policy dimensions missing from most of this literature to date.

Our visual assessment approach, combined with readily available aerial and street-level time series imagery, provides a useful set of methods and tools for conducting fine-scale analyses of landscape change. While the multiple measures used in this and other studies are labor intensive to assess, relatively small-scale assessments such as ours are feasible with a trained staff and minimal resources. For municipalities without a research and planning staff this could happen in partnership with experts at academic institutions or state/federal agencies. For larger study areas, a streamlined measurement procedure may be warranted, perhaps combined with a random sampling of lots. Although we found few studies in the literature measuring change at the lot or block level, recently published studies look promising, especially in combination with the auto-coding of landscape features to allow larger-scale assessments (Ilic et al., 2019; Naik et al., 2017).

Our lot-level measures of condition and care also show promise for evaluating vacant land policy interventions such as the Large Lot Program. Many cities in the U.S. and globally have developed vacant land re-use strategies (e.g., Németh & Langhorst, 2014), but there is little evidence reported on the success of their programs beyond how many lots were enrolled (Ganning & Tighe, 2015). Our individual measures and aggregate condition-care index, when assessed before and after a policy intervention, provide useful metrics to planners and policy makers for evaluating the types and extent of changes. Our analysis mainly focused on the "greening" aspect of vacant land reuse, and our short-term evaluation of change suggested that new owners were implementing some of the goals of the Large Lot Program by maintaining and enhancing green space, with little change in structure cover. Whether this pattern persists is a question for future research. For the Large Lot Program and similar vacant land reuse programs with broader goals of stabilizing population and returning wealth to communities, it is fully expected that improvements to the built environment will happen. As it does, studies like this should reflect those changes and adopt appropriate indicators for their assessment.

6.2. Integrating social and ecological goals

Two prominent streams of research in the vacant land greening literature include social research aimed at improving and revitalizing human communities, and ecological research aimed at increasing ecosystem services such as biodiversity and storm water retention (Anderson & Minor, 2017). Although there are important exceptions (e.g., Nassauer, Van Wieren, Wang, & Kahn, 2008), much of this work operates in parallel with little integration, and findings and recommendations sometimes run at odds with each other.

In our work, good condition and care were defined by regularly mown turf and new or well-maintained pavement without cracks or rubble, and our findings partially supported hypothesis 2 in showing a substantial reduction in mature trees and small but non-significant increases in the area and condition of pavement. While our study did not measure changes in ecological conditions, our findings imply that these socially-driven improvements may not align with ecological goals. On the other hand, the observed increase in both ornamental and vegetable gardens could provide important ecosystem services (e.g., for pollinators) depending on what is planted. Beyond our study, the close association between greening and “cleaning,” or the manicuring of vacant lots, not only reflects the perceptions of those who commonly undertake stewardship of these properties, but is a larger reflection of residential landscaping norms (e.g., Nassauer, Wang, & Dayrell, 2009; Uren, Dzidic, & Bishop, 2015).

At the policy and program level, vacant land greening strategies should aim at accomplishing multiple goals (Anderson & Minor, 2017; Rega-Brodsky, Nilon, & Warren, 2018). Well-established principles such as Nassauer’s cues to care (e.g., Nassauer, 1995; Nassauer & Raskin, 2014) can help align “messy” ecologically beneficial features within “orderly frames” that have broad social appeal and acceptance. In our study, the reordering of large lots by removing poorly shaped or misplaced trees seems like a logical first step for anyone managing a small parcel for multiple goals. Once the desired layout is established, plantings can be reintroduced to provide a combination of beauty, food, habitat, rainfall absorption and other social and ecological goals. To achieve a combination of these goals, support programs run by municipalities and nonprofits are instrumental in providing ideas, resources and learning opportunities for new lot owners. In the context of the Large Lot Program, a recent urban agriculture initiative of the City of Chicago polled 2017 large lot purchasers about their interest in growing food and other uses of their property and the results appear promising: 54% asked for information about resources and support for planting trees and shrubs for landscaping, 39% for plants that attract songbirds and pollinators, and 42% for rain barrels to capture water for use in the garden (Newman-Brooks, 2018).

6.3. Blotting and the effects of ownership

We found significant support for hypothesis 3 (all sub-hypotheses), and in this respect, our study contributes to the emerging literature on blotting. Based upon the patterns observed within our study area, our operational definition also helps clarify those used by Armborst et al. (2008) and Dewar et al. (2013), providing additional guidance to planners and researchers seeking to measure blotting. Blotting asserts a claim to property, and like the concept of adverse possession (Németh & Langhorst, 2014), visible signs of appropriation such as the parking of vehicles on a lot must necessarily also show some form of continued stewardship such as mowing to maintain use and distinguish it from other actions such as dumping or abandonment. This makes care a component of blotting. With respect to our study, yard art and other recognized cues to care (Dewar et al., 2013) contributed to the moderate correlation found between our blotting and condition-care measures.

While the appropriation and stewardship components of blotting provide personal and social benefits, our study also suggests that blotting may limit the extent to which individuals are willing to make improvements to property they do not legally own. Ownership changes this relationship, and in the case of large lot purchases, we saw an increase in the post-purchase values of the condition-care index for both blotted and non-blotted lots. For this reason, among the various greening strategies discussed earlier in the paper, programs based on private ownership hold particular promise in advancing land stewardship beyond the level of basic maintenance. These greater expressions of stewardship play catalytic roles in neighborhood and community revitalization efforts that are the end goals of most vacant land reuse policies (Nassauer & Raskin, 2014).

7. Conclusions

Our study provides evidence that a municipal policy that encourages residents to repurpose vacant lots contributes to neighborhoods with improved signs of condition and care. Focusing on the Chicago Large Lot Program, this study also supports the idea that to achieve improvements in vacant lot condition and care, ownership matters. Our findings also suggest that the implementation of vacant land greening programs may result in tradeoffs between social and ecological goals in short-term, but related research also shows that proactive support initiatives (e.g., outreach and assistance) can help such programs achieve a broader range of both social and ecological benefits (Anderson & Minor, 2017; Nassauer & Raskin, 2014). Together, this visual assessment and our companion social assessment (Gobster et al., 2018; Stewart et al., 2019) show how, lot by lot, new large lot owners are helping to beautify and revitalize their communities with a reconfigured vision. This vision, while it relies on individual actions, is tied together by an increased sense of community and attachment to place (Gobster et al., 2018; Stewart et al., 2019). These findings hold significant promise for planners, policymakers, and advocates who seek to help long disenfranchised communities address the pervasive issue of urban vacancy by implementing resident-led greening actions.

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Author statement

PHG and WPS designed and led the overall research effort. PHG designed and led data collection for the visual assessment. AR and SH led data analysis. All authors contributed to the writing of this manuscript.

Appendices. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.landurbplan.2019.103729.

References

Alaimo, K., Reischl, T. M., & Allen, J. O. (2010). Community gardening, neighborhood meetings, and social capital. *Journal of Community Psychology, 38*, 497–514. https://doi.org/10.1002/jcop.20378.

Anderson, E. C., & Minor, E. S. (2017). Vacant lots: An underexplored resource for ecological and social benefits in cities. *Urban Forestry and Urban Greening, 21*, 146–152. https://doi.org/10.1016/j.ufug.2016.11.015.

Armborst, T., D'Oca, D., & Theodire, G. (2008). Improve your lot!. In K. Pallagst (Ed.). *Cities growing smaller* (pp. 45–46). Cleveland, OH: Cleveland: Urban Design Collaborative, Kent State University.

Bader, M. D. M., Mooney, S. J., Lee, Y. J., Sheehan, D., Neckerman, K. M., Rundle, A. G., & Teitler, J. O. (2015). Development and deployment of the Computer Assisted Neighborhood Visual Assessment System (CANVAS) to measure health-related neighborhood conditions. *Health and Place, 31*, 163–172. https://doi.org/10.1016/j.healthplace.2014.10.012.

Bradley, L. K., Lelekacs, J. M., Asher, C. T., & Sherk, J. T. (2014). Design matters in community gardens. *Journal of Extension, 52*(1), 1TOT9.

Burchfield, K. B. (2009). Attachment as a source of informal social control in urban neighborhoods. *Journal of Criminal Justice, 37*, 45–54. https://doi.org/10.1016/j.jcrimjus.2008.12.007.

Chambliss, D. F., & Schutt, R. K. (2019). *Making sense of the social world: Methods of investigation* (6th ed.). Thousand Oaks, CA: Sage.

Channick, R. (2016, November 29). Chicago's $1 lots program expanding: City to sell another 4,000 vacant parcels on South, West sides. Chicago Tribune. http://digitaledition.chicagotribune.com/tribune/article_popover.aspx?guid=5b11db21-f44c-489d-8c66-e86f550c9a62.

Chicago Metropolitan Agency for Planning (2017). Community data snapshots. https://www.cmap.illinois.gov/data/community-snapshots.

Chicago Tribune (2018, June 12). Lot by lot, reviving Chicago's many Englewoods (Editorial). Chicago Tribune. https://www.chicagotribune.com/opinion/editorials/ct-edit-englewood-dollar-vacant-lots-20180607-story.html.

City of Baltimore (2012). *City of Baltimore green pattern book: Using vacant land to create greener neighborhoods.* Baltimore, MD: City of Baltimore Office of Sustainability.

City of Chicago (2014a). *Large Lot Program.* Chicago: City of Chicago Department of Planning and Development https://www.cityofchicago.org/content/dam/city/depts/dol/rulesandregs/DPDLARGELOTSPROGRAM.pdf.

City of Chicago (2014b). *Green healthy neighborhoods.* Chicago: City of Chicago Department of Planning and Development https://www.chicago.gov/city/en/depts/dcd/supp_info/green-healthy-neighborhoods.html.

City of Chicago (n.d.). City-owned land inventory. https://data.cityofchicago.org/Community-Economic-Development/City-Owned-Land-Inventory/aksk-kvfp.

Cook County, Illinois (n.d.). Cook County property tax portal. http://www.cookcountypropertyinfo.com/.

Craig, P., Katikireddi, S. V., Leyland, A., & Popham, F. (2017). Natural experiments: An overview of methods, approaches, and contributions to public health intervention research. *Annual Review of Public Health, 38*, 39–56. https://doi.org/10.1146/annurev-publhealth-031816-044327.

Crauderueff, R., Margolis, S., & Tanikawa, S. (2012). *Greening vacant lots: Planning and implementation strategies.* New York, NY: The Nature Conservancy.

Daniel, T. C., & Vining, J. I. (1983). Methodological issues in the assessment of landscape quality. In I. Altman, & J. F. Wohlwill (Vol. Eds.), *Human behavior and environment: vol. 6*, (pp. 39–84). New York: Plenum.

Detroit Future City (2017). *139 square miles.* Detroit, MI: Inland Press https://detroitfuturecity.com/wp-content/uploads/2017/07/DFC_139-SQ-Mile_Report.pdf.

Dewar, M., Nassauer, J., & Dueweke, E. (2013). Cues to care database-codebook. Unpublished codebook for Detroit Sustainability Indicators Integrated Assessment. Ann Arbor: University of Michigan Graham Environmental Sustainability Institute.

Dewar, M., & Thomas, J. M. (Eds.). (2012). *The city after abandonment.* Philadelphia, PA: University of Pennsylvania Press.

Doringer, S., Uchiyama, Y., Penker, M., & Kohsaka, R. (2019). A meta-analysis of shrinking cities in Europe and Japan. Towards an integrative research agenda. *Journal of European Planning Studies*. https://doi.org/10.1080/09654313.2019.1604635 (online preprint).

Gallun, A., & Maidenberg, M. (2013). November 9). Will the foreclosure crisis kill Chicago? *Crain's Chicago Business*.

Ganning, J. P., & Tighe, J. R. (2015). Assessing the feasibility of side yard programs as a solution to land vacancy in U.S. shrinking cities. *Urban Affairs Review, 51*(5), 708–725. https://doi.org/10.1177/1078087414555435.

Gidlow, C. J., Ellis, N. J., & Bostock, S. (2012). Development of the neighbourhood green space tool (NGST). *Landscape and Urban Planning, 106*, 347–358. https://doi.org/10.1016/j.landurbplan.2012.04.007.

Gobster, P. H. (2002). Managing urban parks for a racially and ethnically diverse clientele. *Leisure Sciences, 24*, 143–159. https://doi.org/10.1080/01490400252900121.

Gobster, P. H., Stewart, W. P., Rigolon, A., van Riper, C. J., and Williams, D. A. 2018. Visual resource stewardship at the neighborhood scale: Methods for assessing a vacant lot reuse program. In Gobster, P. H., and Smardon, R. C. (Eds.) Proceedings of the Visual Resource Stewardship Conference, November 7-9, 2017, Argonne National Laboratory, Lemont, IL. St. Paul, MN: USDA Forest Service General Technical Report NRS-P-183. https://doi.org/10.2737/NRS-GTR-P-183-VCS-4.

Gobster, P. H., Ribe, R. G., & Palmer, J. F. (2019). Themes and trends in visual assessment research: Introduction to the *Landscape and Urban Planning* special collection on the visual assessment of landscapes. *Landscape and Urban Planning, 191*, 103635. https://doi.org/10.1016/j.landurbplan.2019.103635.

Gobster, P. H., Stewart, S. I., & Bengston, D. N. (2004). The social aspects of landscape change: Protecting open space under the pressure of development. *Landscape and Urban Planning, 69*, 149–151. https://doi.org/10.1016/j.landurbplan.2003.09.003.

Griew, P., Hillsdon, M., Foster, C., Coombes, E., Jones, A., & Wilkinson, P. (2013). Developing and testing a street audit tool using Google Street View to measure environmental supportiveness for physical activity. *International Journal of Behavioral Nutrition and Physical Activity, 10*(103), 1–7. http://www.ijbnpa.org/content/10/1/103.

Heckert, M., & Kondo, M. (2018). Can "cleaned and greened" lots take on the role of public greenspace? *Journal of Planning Education and Research, 38*, 211–221. https://doi.org/10.1177/0739456X16688766.

Hollander, J. B. (2011). *Sunburnt cities: The Great Recession, depopulation and urban planning in the American Sunbelt.* London: Routledge https://doi.org/10.4324/9780203834381.

Ilic, L., Sawada, M., & Zarzelli, A. (2019). Deep mapping gentrification in a large Canadian city using deep learning and Google Street View. *PLoS One, 14*(3), https://doi.org/10.1371/journal.pone.0212814.

Johnson, M. P., Hollander, J., & Hallulli, A. (2014). Maintain, demolish, re-purpose: Policy design for vacant land management using decision models. *Cities, 40*, 151–162. https://doi.org/10.1016/j.cities.2013.05.005.

Kim, G., Miller, P. A., & Nowak, D. J. (2018). Urban vacant land typology: A tool for managing urban vacant land. *Sustainable Cities and Society, 36*, 144–156. https://doi.org/10.1016/j.scs.2017.09.014.

Kremer, P., Hamstead, Z. A., & McPhearson, T. (2013). A social–ecological assessment of vacant lots in New York City. *Landscape and Urban Planning, 120*, 218–233. https://doi.org/10.1016/j.landurbplan.2013.05.003.

Larsen, L., & Harlan, S. L. (2006). Desert dreamscapes: Residential landscape preference and behavior. *Landscape and Urban Planning, 78*, 85–100. https://doi.org/10.1016/j.landurbplan.2005.06.002.

Larson, K. L., Casagrande, D., Harlan, S. L., & Yabiku, S. T. (2009). Residents' yard choices and rationales in a desert city: Social priorities, ecological impacts, and decision tradeoffs. *Environmental Management, 44*, 921–937. https://doi.org/10.1007/s00267-009-9353-1.

Moore, N. Y. (2016). *The south side: A portrait of Chicago and American segregation.* New York: St. Martin's Press.

Morckel, V. (2015). Community gardens or vacant lots? Rethinking the attractiveness and seasonality of green land uses in distressed neighborhoods. *Urban Forestry & Urban Greening, 14*, 714–721. https://doi.org/10.1016/j.ufug.2015.07.001.

Naik, N., Kominers, S. D., Raskar, R., Glaeser, E. L., & Hidalgo, C. A. (2017). Computer vision uncovers predictors of physical urban change. *Proceedings of the National Academy of Sciences, 114*, 7571–7576. https://doi.org/10.1073/pnas.1619003114.

Nassauer, J. I. (1995). Messy ecosystems, orderly frames. *Landscape Journal, 14*(2), 161–170. https://doi.org/10.3368/lj.14.2.161.

Nassauer, J. I., & Raskin, J. (2014). Urban vacancy and land use legacies: A frontier for urban ecological research, design, and planning. *Landscape and Urban Planning, 125*, 245–253. https://doi.org/10.1016/j.landurbplan.2013.10.008.

Nassauer, J. I., Van Wieren, R., Wang, Z., & Kahn, D. (2008). *Vacant land as a natural asset: Enduring land values created by care and ownership.* Flint, MI: Genesee Institute.

Nassauer, J. I., Wang, Z., & Dayrell, E. (2009). What will the neighbors think? Cultural norms and ecological design. *Landscape and Urban Planning, 92*(3–4), 282–292. https://doi.org/10.1016/j.landurbplan.2009.05.010.

Németh, J., & Langhorst, J. (2014). Rethinking urban transformation: Temporary uses for vacant land. *Cities, 40*, 143–150. https://doi.org/10.1016/j.cities.2013.04.007.

Newman, G. D., Bowman, A. O'M., Lee, R. J., & Kim, B. (2016). A current inventory of vacant urban land in America. *Journal of Urban Design, 21*, 302–319. https://doi.org/10.1080/13574809.2016.1167589.

Newman-Brooks, M. (2018). Your lot, your garden! Unpublished exit survey data of 2017 Large Lot purchasers. Chicago: City of Chicago Department of Planning and Development.

Pallant, J. (2011). *SPSS survival manual: A step by step guide to data analysis using SPSS* (4th ed.). Maidenhead, England: Open University Press.

Podmolik, M. E. (2015). Land bank will take 'calculated risk' in 26 areas. Chicago Tribune. https://www.chicagotribune.com/business/ct-land-bank-focus-0507-biz-20150507-story.html.

Rega-Brodsky, C. C., Nilon, C. H., & Warren, P. S. (2018). Balancing urban biodiversity needs and resident preferences for vacant lot management. *Sustainability, 10*, 1679. https://doi.org/10.3390/su10051679.

Sampson, R. J., & Raudenbush, S. W. (2004). Seeing disorder: Neighborhood stigma and the social construction of "broken windows". *Social Psychology Quarterly, 67*(4), 319–342. https://doi.org/10.1177/019027250406700401.

Santos, J. R. A. (1999). Cronbach's alpha: A tool for assessing the reliability of scales. *Journal of Extension, 37*, 88–92.

Schilling, J., & Logan, J. (2008). Greening the Rust Belt: A green infrastructure model for right sizing America's shrinking cities. *Journal of the American Planning Association, 74*, 451–466. https://doi.org/10.1080/01944360802354956.

Stewart, W. P., Gobster, P. H., Rigolon, A., Strauser, J. R., Williams, D. A., & van Riper, C. J. (2019). Resident-led beautification of vacant lots that connects place to community. *Landscape and Urban Planning, 185*, 200–209. https://doi.org/10.1016/j.landurbplan.2019.02.011.

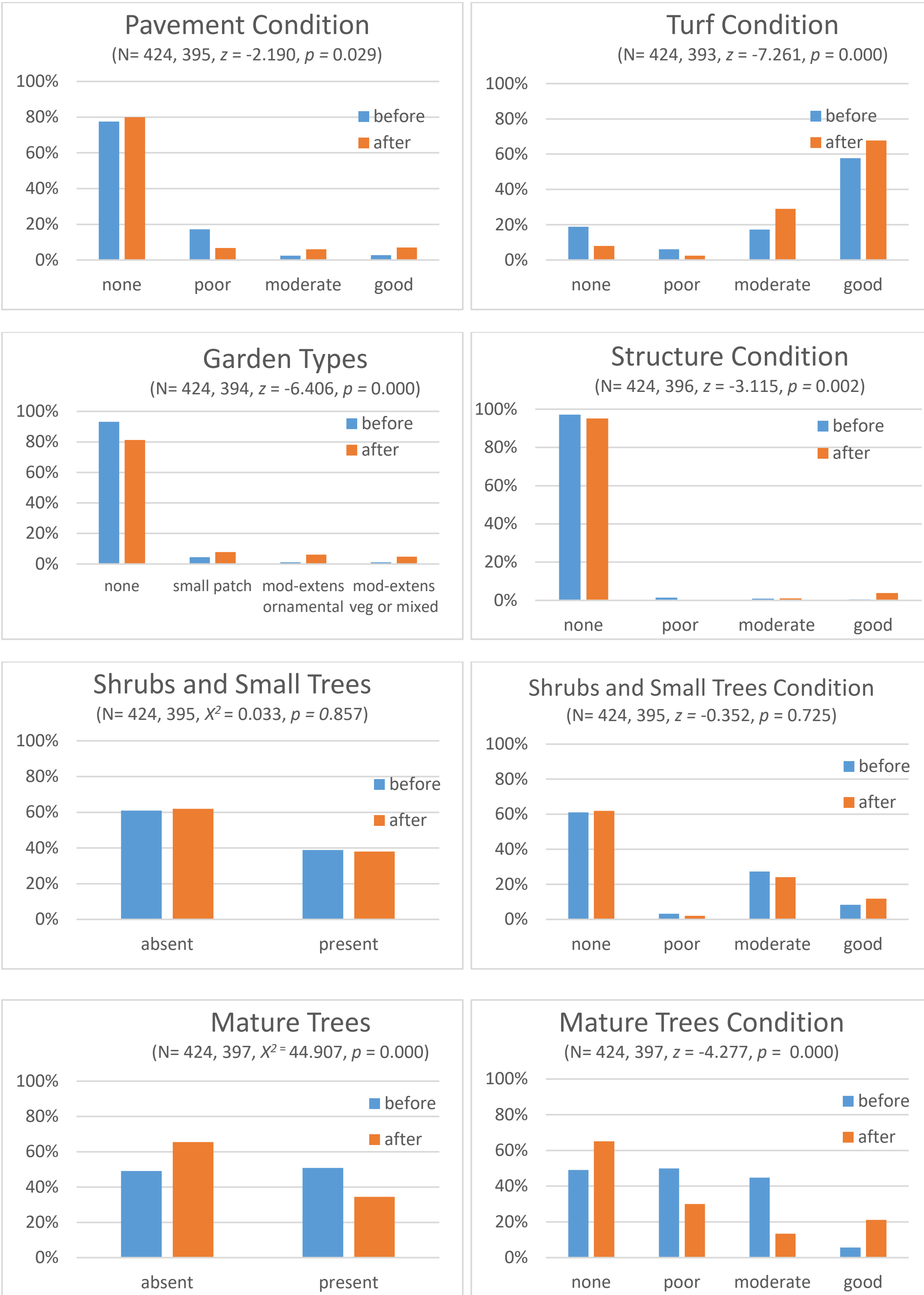
Sullivan, W. C. (2001). Does the neighborhood landscape matter? *Landscape Journal, 20*, 198–201. https://doi.org/10.3368/lj.20.2.198.

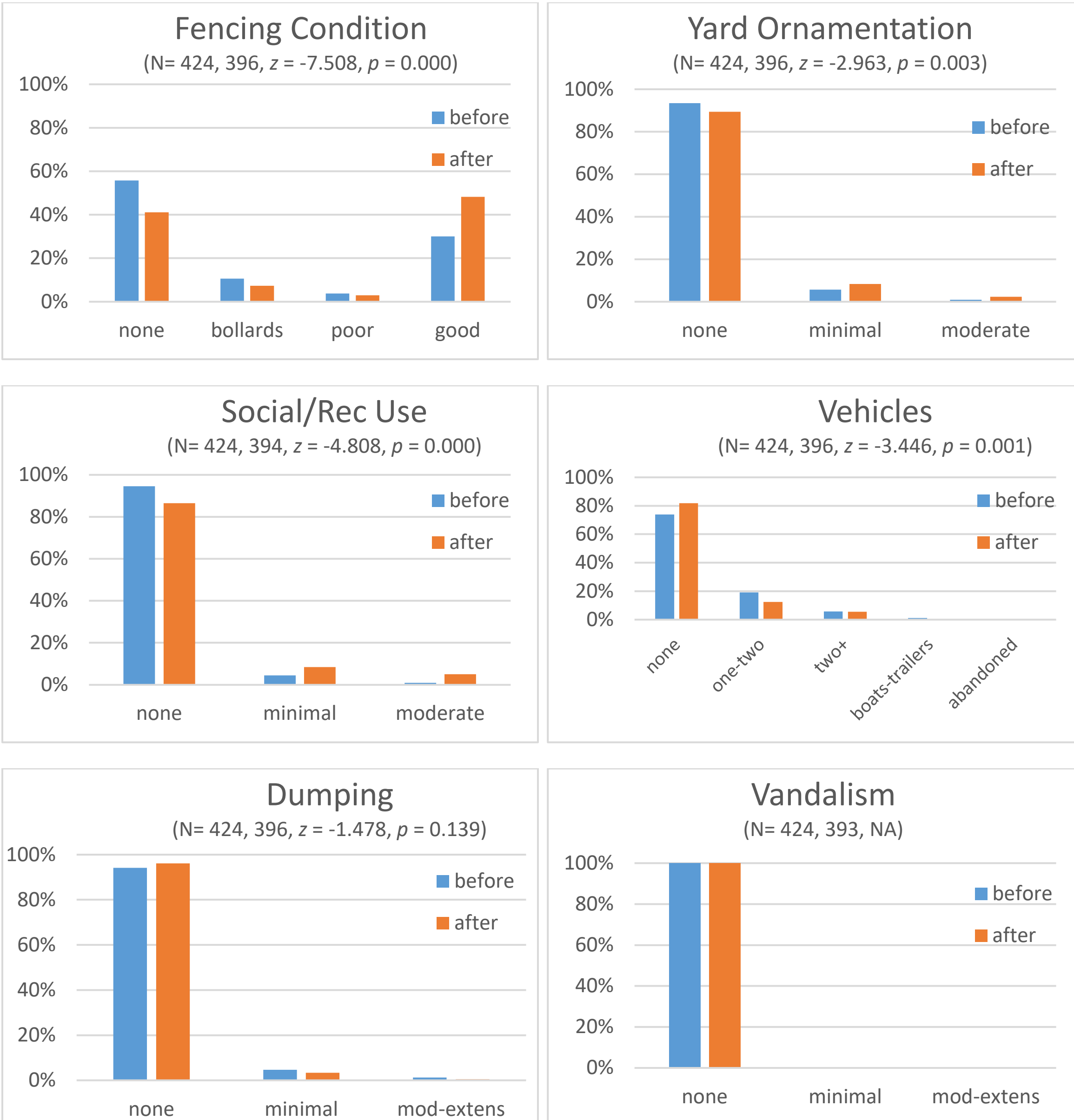
Tappendorf, J. A., & Denzin, B. O. (2011). Turning vacant properties into community assets through land banking. *Urban Lawyer, 43*, 801–812.

Taylor, J. R., & Lovell, S. T. (2012). Mapping public and private spaces of urban agriculture in Chicago through the analysis of high-resolution aerial images in Google Earth. *Landscape and Urban Planning, 108*, 57–70. https://doi.org/10.1016/j.landurbplan.2012.08.001.

U.S. Census Bureau (n.d.) American Fact Finder. https://factfinder.census.gov.
Uren, H. V., Dzidic, P. L., & Bishop, B. J. (2015). Exploring social and cultural norms to promote ecologically sensitive residential garden design. *Landscape and Urban Planning, 137*, 76–84. https://doi.org/10.1016/j.landurbplan.2014.12.008.
Vogt, C. A., & Marans, R. W. (2004). Natural resources and open space in the residential decision process: A study of recent movers to fringe counties in southeast Michigan. *Landscape and Urban Planning, 69*, 255–269. https://doi.org/10.1016/j.landurbplan.2003.07.006.
Zube, E. H., Sell, J. L., & Taylor, J. G. (1982). Landscape perception: Research, application and theory. *Landscape Planning, 9*, 1–33. https://doi.org/10.1016/0304-3924(82)90009-0.

Appendix S1. Frequency data and significance tests for lot level condition-care measures[1].





[1]McNemar related-samples test used to test significance for dichotomous (absence/presence) variables; otherwise the McNemar-Bowker test significance is reported. NA = not applicable

Appendix 2

Large Lot Sampler

This photo collection depicts the visual conditions of selected Large Lots in the year before and after purchase to highlight various changes made by owners:

- Mature trees removed
- Shrubs and small trees removed
- Shrubs and small trees planted
- Turf improvements
- Bare ground revegetated
- Parking improvements
- Gardens added
- Yard ornaments added
- Social and recreational uses added

Mature Trees Removed

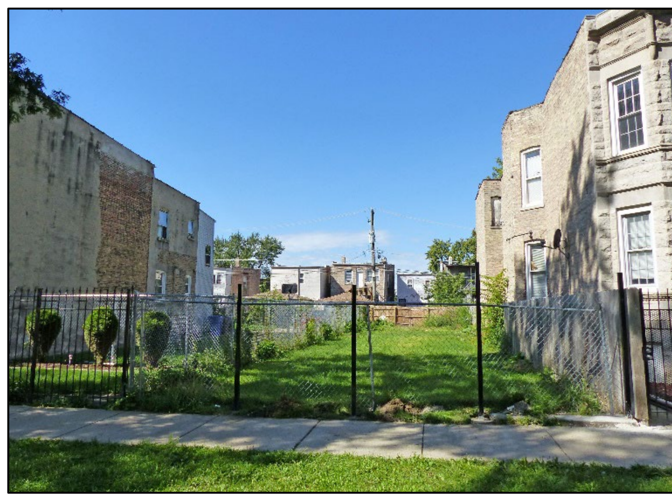
Before

After

1a. Google Street View October 2014

1b. US Forest Service photo September 2015

2a. Google Street View October 2014 BLOTTED



2b. US Forest Service photo September 2015

3a. Google Street View October 2014

3b. Google Street View July 2015

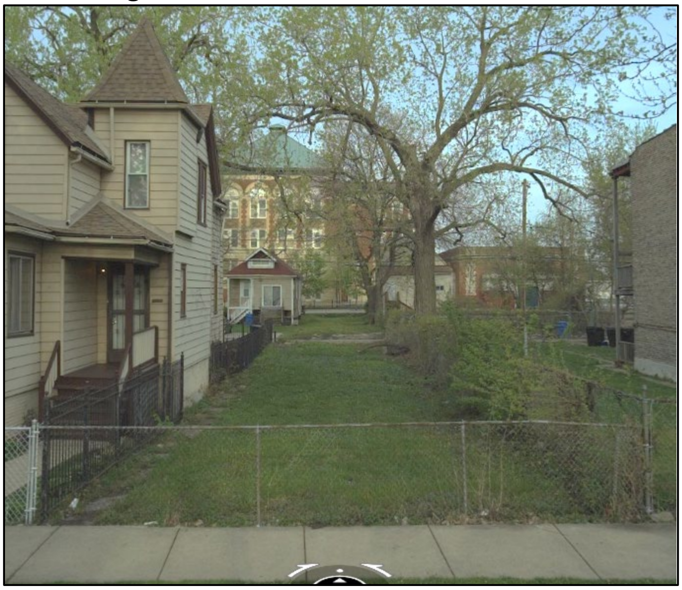
Shrubs and Small Trees Removed

Before

After

4a. Google Street View June 2014

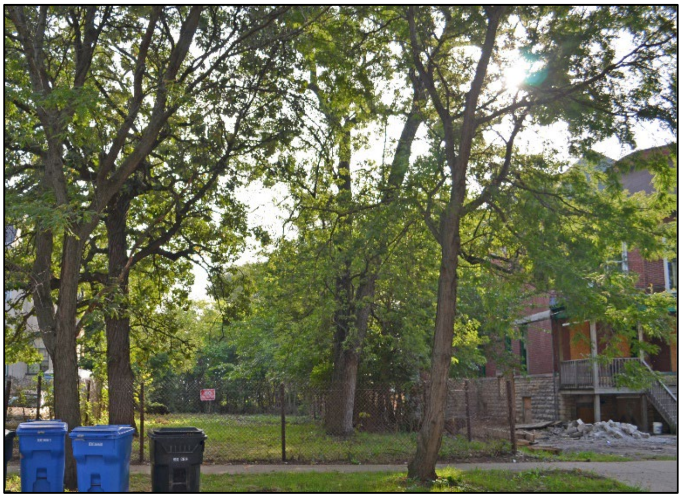
4b. US Forest Service photo September 2015



5a. Bing Streetside May 2014 BLOTTED

5b. US Forest Service photo September 2015

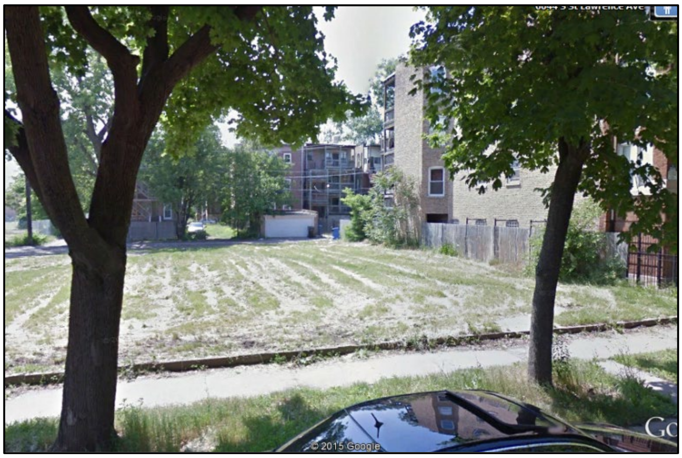
6a. Google Street View October 2014



6b. US Forest Service photo September 2015

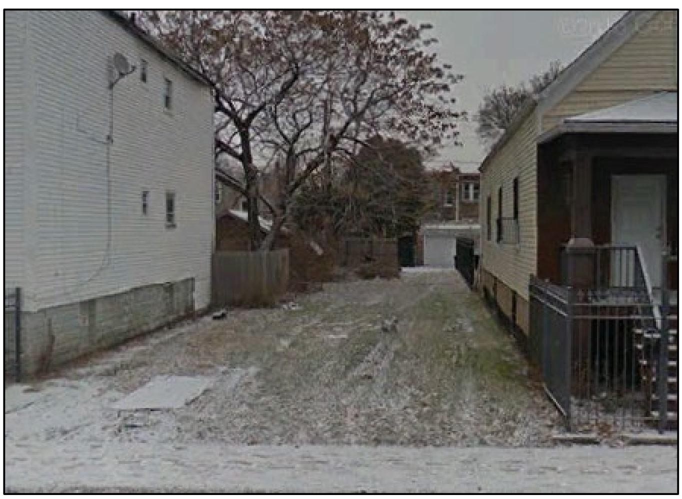
Shrubs and Small Trees Planted

Before | After



7a. Google Street View June 2014

7b. US Forest Service photo September 2015



8a. Google Street View December 2014

8b. US Forest Service photo September 2015

9a. Bing Streetside May 2014 BLOTTED

9b. US Forest Service photo October 2015

Turf Improvements

Before

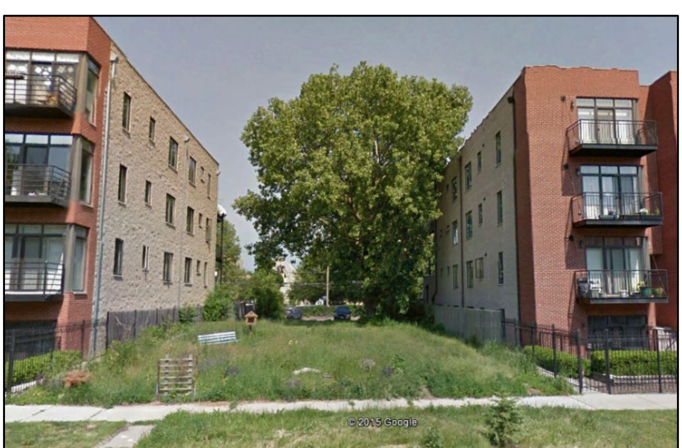
After

10a. Google Street View June 2014

10b. US Forest Service photo September 2015

11a. Google Street View June 2014

11b. US Forest Service photo September 2015



12a. Google Street View May 2014 BLOTTED

12b. US Forest Service photo September 2015

Bare Ground Revegetated

Before

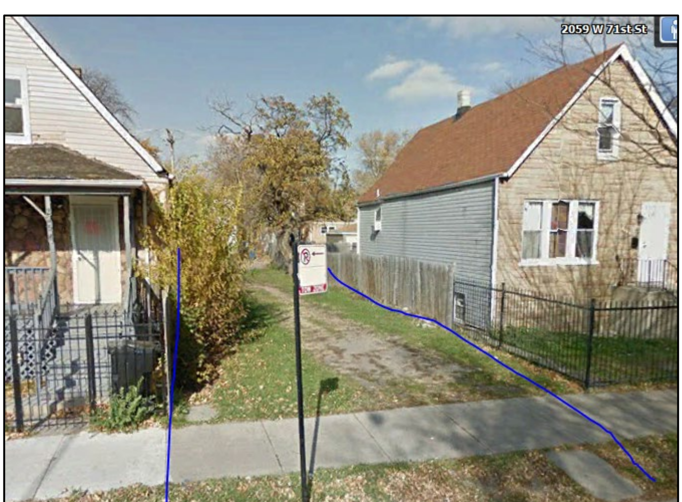
After

13a. Bing Streetside May 2014 BLOTTED

13b. US Forest Service photo October 2015

14a. Google Street View October 2014

14b. US Forest Service photo September 2015



15a. Google Street View November 2014

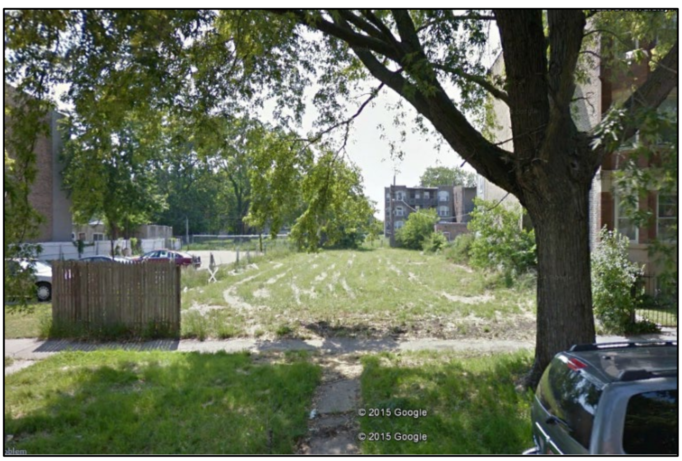
15b. US Forest Service photo September 2015

Parking Improvements

Before | After

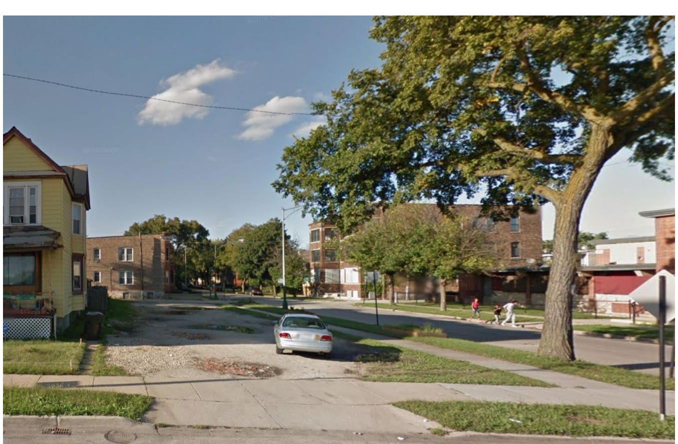
16a. Google Street View October 2014

16b. US Forest Service photo September 2015



17a. Google Street View June 2014

17b. US Forest Service photo September 2015



18a. Google Street View September 2014 BLOTTED

18b. Google Street View October 2015

Gardens Added

Before

After

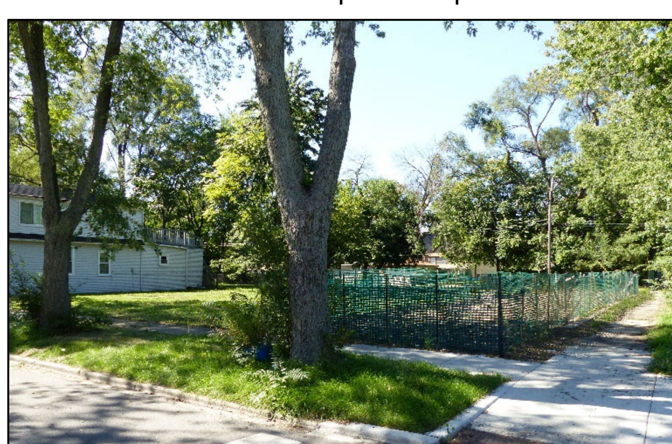
19a. Google Street View November 2014 BLOTTED

19b. US Forest Service photo September 2015

20a. Google Street View December 2014

20b. US Forest Service photo September 2015

21a. Google Street View October 2014



21b. US Forest Service photo September 2015

Yard Ornaments Added

Before

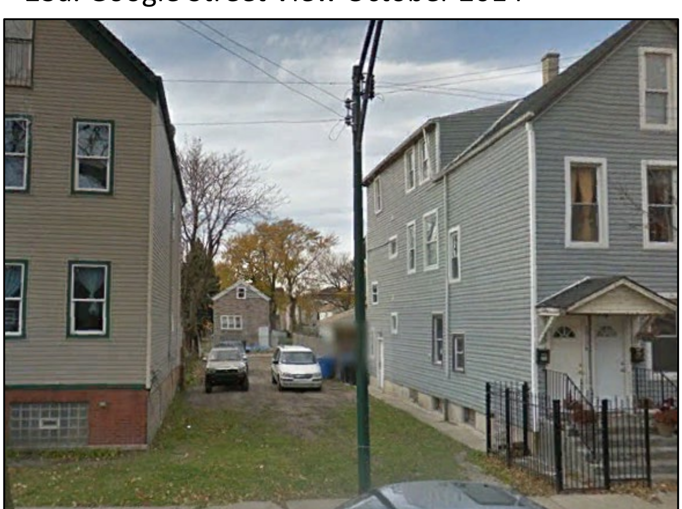
After

22a. Google Street View October 2014

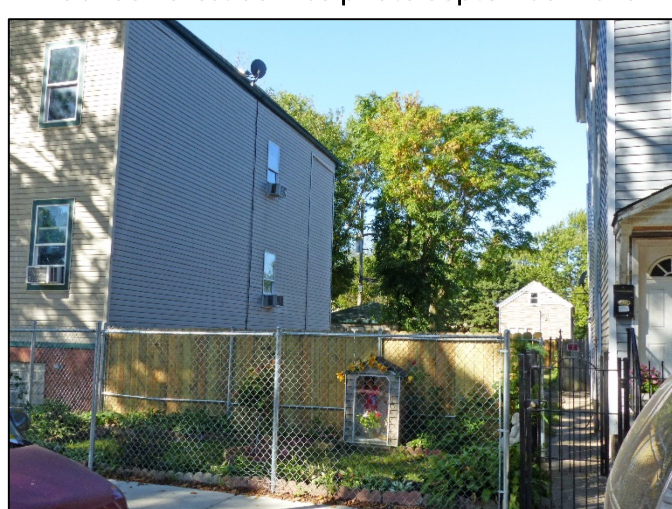
22b. US Forest Service photo September 2015

23a. Google Street View October 2014

23b. US Forest Service photo September 2015



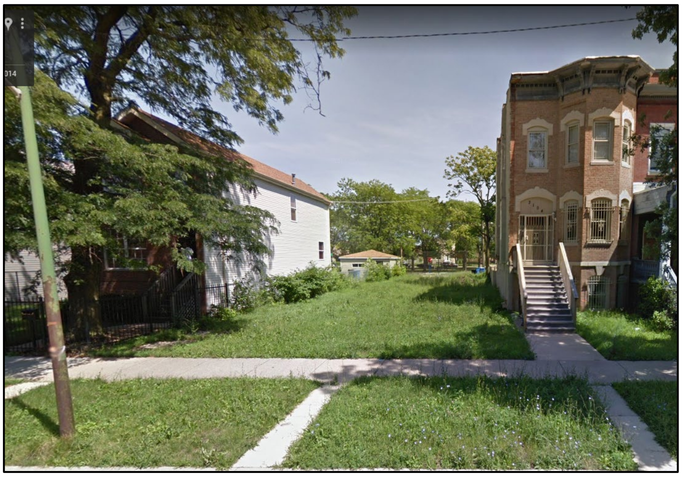
24a. Google Street View November 2014 BLOTTED



24b. US Forest Service photo September 2015

Social-Recreational Uses Added

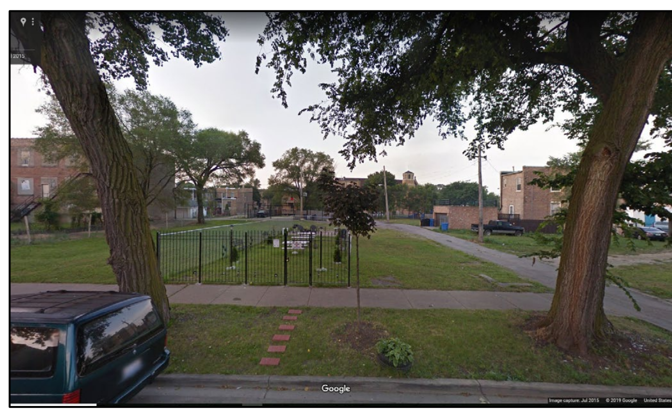
Before | **After**



25a. Google Street View July 2014

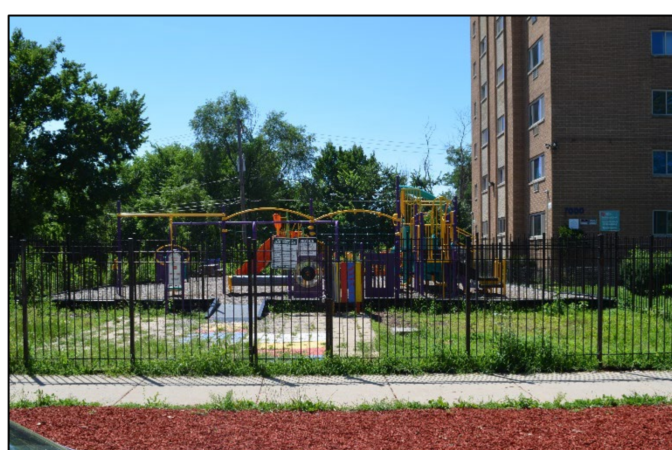
25b. US Forest Service photo October 2015

26a. Google Street View September 2014



26b. Google Street View July 2015

27a. Bing Streetside May 2014 BLOTTED



27b. US Forest Service photo September 2015