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Green gentrification or 'just green enough': Do park location, size and function affect whether a place gentrifies or not?

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Abstract

Recent research shows that the establishment of new parks in historically disinvested neighbourhoods can result in housing price increases and the displacement of low-income people of colour. Some suggest that a 'just green enough' approach, in particular its call for the creation of small parks and nearby affordable housing, can reduce the chances of this phenomenon some call 'green gentrification'. Yet, no study has tested these claims empirically across a sample of diverse cities. Focusing on 10 cities in the United States, we run multilevel logistic regressions to uncover whether the location (distance from downtown), size and function (active transportation) of new parks built in the 2000–2008 and 2008–2015 periods predict whether the census tracts around them gentrified. We find that park function and location are strong predictors of gentrification, whereas park size is not. In particular, new greenway parks with an active transportation component built in the 2008–2015 period triggered gentrification more than other park types, and new parks located closer to downtown tend to foster gentrification more than parks on a city's outskirts. These findings call into question the 'just green enough' claim that small parks foster green gentrification less than larger parks do.

Keywords

environmental gentrification, environmental justice, equity, urban green space, urban parks

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摘要
最近的研究表明，在历史上投资不足的街区建立新公园可能导致房价上涨和低收入有色人种被驱逐。一些人建议采取一种"刚好足够绿色"的方法，也就是呼吁建设小公园和附近的经济适用房，认为这可以减少这种现象的发生，有人称之为"绿色绅士化"。然而，就此等观点，没有一项研究对不同城市的样本进行了实证检验。我们以美国的10个城市为研究对象，进行多层次逻辑回归分析，以揭示是否能根据2000-2008年和2008-2015年期间新建公园的位置（离市中心的距离）、规模和功能（步行或骑行交通）预测其周围人口普查区是否绅士化。我们发现公园的功能和位置是绅士化的强有力的预测因素，而公园的规模则不是。特别是，2008-2015年期间建设的、具有步行或骑行交通组成部分的新绿道公园比其他类型的公园更能引发绅士化，而位于市区附近的新公园比城市郊区的公园更能促进绅士化。这些发现对小公园比大公园更能促进绿色绅士化的说法提出了质疑。

关键词
环境绅士化、环境正义、公平、城市绿地、城市公园

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Introduction

When established in historically marginalised neighbourhoods, investments in sustainable urban infrastructure such as bike paths and urban green spaces can result in rent and property value increases that often displace the low-income residents such projects were intended to benefit (Anguelovski, 2016; Lubitow et al., 2016). This phenomenon has been called *environmental gentrification* (Anguelovski et al., 2018b; Gould and Lewis, 2017; Immergluck and Balan, 2018). As the back-to-the-city movement generates demand for more liveable urban areas, environmental gentrification constitutes one of the major environmental justice issues faced by marginalised urban communities today (Anguelovski, 2016; Hyra, 2015). Among the new environmental amenities found to foster gentrification, urban green spaces such as parks and greenways have received particular attention, and scholars have used the more specific phrase *green gentrification* to describe their impact on socioeconomic and demographic change (Anguelovski et al., 2018b; Gould and Lewis, 2017).

But not all parks are created equal, and not all parks result in green gentrification in the same ways. Decrying the gentrifying impacts of single iconic greenway parks such as New York City's High Line and Atlanta's BeltLine (Immergluck, 2009; Immergluck and Balan, 2018; Loughran, 2014), some researchers advocate for a 'just green enough' approach that encompasses a number of different strategies, including creating smaller parks intended to serve long-term residents, and coupling park development with proactive interventions to preserve and produce affordable housing and jobs (Curran and Hamilton, 2012, 2018; Wolch et al., 2014). Nevertheless, we know that even small neighbourhood parks can foster gentrification when located in desirable central neighbourhoods and surrounded by an attractive housing stock (Anguelovski et al., 2018b). Despite these contradictions, no study has yet modelled how the location, size and function of a new park might interact to shape neighbourhood change, and no investigation has analysed how new parks foster green gentrification across a sample of diverse cities. Specifically, the 'just green enough' claim that new parks that are 'small-scale and in scattered sites' might not result in green gentrification has not been examined in a systematic way (Wolch et al., 2014: 241).

We build on the green gentrification literature by determining what types of parks might predict green gentrification in the first nationwide study of green gentrification in the USA. Focusing on 10 major US cities, we conduct a scaled-up longitudinal analysis to uncover how new parks built between 2000 and 2015 foster gentrification in nearby census tracts. Based on multilevel, mixed effects logistic regressions, we find that, indeed, not all new parks foster gentrification in the surrounding areas and that tracts located within half a mile of a new greenway park built between 2008 and 2015 are substantially more likely to gentrify than others. In addition, we find some evidence that new parks built in this same period and located close to downtown predict gentrification in surrounding tracts more than those that are not. Finally, we do not find any significant associations between park size and gentrification outcomes, which casts some doubt on the particular 'just green enough' claim that small, scattered parks do not foster green gentrification in the same way as larger parks do (see Wolch et al., 2014).

Green gentrification or 'just green enough'

Many post-industrial cities seeking to redefine their economy and image have turned to environmental sustainability as a framework to guide redevelopment (Anguelovski, 2016; Checker, 2011; McKendry, 2018; Quastel, 2009). 'Urban greening' initiatives can include remediating polluted sites, building environmental amenities such as parks and bike lanes and renovating existing parks (Anguelovski, 2016; Connolly, 2018; Eckerd, 2011; Gould and Lewis, 2017; Lubitow et al., 2016; Pearsall, 2013; Quastel, 2009). Urban leaders use these initiatives to improve environmental quality and land values in less desirable urban neighbourhoods, and to consequently attract middle- and upper-class individuals back to the urban core (Hyra, 2015). In many instances, housing price increases resulting from improved environmental conditions and the related influx of new residents and businesses can contribute to displacing long-term residents of historically disenfranchised neighbourhoods, a phenomenon described as *environmental* or *ecological gentrification* (Anguelovski, 2016; Anguelovski et al., 2018a; Checker, 2011; Dooling, 2009). For the long-term residents who remain in place thanks to homeownership or subsidised rental housing, this process can result in a sense of psychological displacement, as many of their social support networks are erased from their neighbourhood (Fullilove, 2016; García and Rúa, 2018; Kern, 2015; Shaw and Hagemans, 2015).

Yet many cities have chosen to move forward with urban sustainability initiatives under the assumption that they benefit all residents equally, when in reality the greatest gains tend to accrue for the most well-off (Checker, 2011; Lubitow et al., 2016; Pearsall and Anguelovski, 2016). Thus, environmental gentrification constitutes an increasingly pressing environmental justice challenge for marginalised communities around the world (Anguelovski, 2016; Checker, 2011; Gould and Lewis, 2017). Equity-minded planners, community organisations and policymakers face a difficult conundrum: as the evidence mounts that environmental amenities can foster environmental gentrification, how can we continue to provide them without displacing the very people they are intended to benefit?

A number of empirical studies in the United States, Spain, South Korea and Germany have shown the extent to which new and/or renovated parks have fostered green gentrification in their surrounding neighbourhoods (Anguelovski et al., 2018b; Connolly, 2018; Gould and Lewis, 2017; Haase et al., 2017; Immergluck, 2009; Kwon et al., 2017). Yet since nearly all of these studies have focused on single, centrally-located, iconic, greenway parks with an ‘active transportation’ function, we know little about the applicability of these studies’ findings to a variety of contexts. Indeed, not all parks are created equal: a small pocket park in Brooklyn’s Sheepshead Bay, New York is unlikely to have the same impact on surrounding property values as, say, the High Line has had in Manhattan (Loughran, 2014).

Two recent studies have modelled green gentrification for multiple parks within the same city and helped shed light on whether park size and location affect gentrification. Anguelovski et al.’s (2018b) study of Barcelona suggests that location matters: new green spaces only contributed to gentrification in areas that *also* had desirable features such as proximity to downtown or the coastline as well as a historic housing stock. Gould and Lewis (2017) analyse four New York City parks and find that three have triggered gentrification in their surrounding neighbourhoods. Among the parks that fostered gentrification, two are very large (above 80 acres), and all three are located close to lively commercial districts with attractive housing stock. Also, the park that did not foster gentrification is much smaller, is located further from white collar job centres and is surrounded by industrial land uses. It is important to note, however, that neither of these studies included park size or location in their statistical models; thus, we developed hypotheses about how location and size can predict green gentrification by interpreting the results of these two studies.

Several other studies of green gentrification have focused on single iconic greenway parks that also have an active transportation function, including the BeltLine in Atlanta (Immergluck, 2009; Immergluck and Balan, 2018), the 606 Trail in Chicago (Rigolon and Németh, 2018a; Smith et al., 2016), the High Line in New York City (Loughran, 2014) and the Gyeongui Line Forest Park in Seoul (Kwon et al., 2017). And all of these found that housing units located in close proximity to new greenway parks have experienced significantly higher appreciation than those located farther from such parks. The consistency of these results suggests that new greenway parks with an active transportation component might trigger green gentrification.

But environmental gentrification is not an inevitable outcome of all urban sustainability initiatives that improve environmental quality in historically disenfranchised neighbourhoods. Using the concept of ‘just green enough’ (JGE), Curran and Hamilton (2012) have argued that brownfield redevelopment in general, and new green spaces in particular, can be implemented without displacing long-term, working-class residents if planning processes are protective of locals’ needs and demands. In particular, Curran and Hamilton (2012: 1027) suggest that greening initiatives should go beyond glamorised visions including ‘park space, waterfront cafes, and luxury LEED-certified buildings’ to also include ‘industrial uses and the working class’. Building on this work, Wolch et al. (2014: 241) claim that JGE approaches should involve the construction of new parks that are ‘small-scale and in scattered sites’ instead of larger green spaces, engaging the community in planning to ensure that new parks fit their needs, and implementing anti-displacement initiatives to preserve and build affordable housing units.

In a recent edited volume, Curran and Hamilton (2018: 6) expand on their original definition to suggest that JGE approaches require ‘equal access to green space, not tourist-oriented parks’ and ‘democratic process, not privatized planning'. In one chapter, Rupprecht and Byrne (2018) argued that the provision of informal green space (e.g. vacant lots and power line corridors) can serve as a JGE strategy that can limit green gentrification. All authors argue that parks must meet residents' demands through meaningful, bottom-up planning, design and management efforts along with strategies to construct and preserve affordable housing for the most vulnerable residents (Curran and Hamilton, 2012, 2018; Rupprecht and Byrne, 2018; Wolch et al., 2014). As such, JGE approaches emphasise the importance of procedural justice – that is, meaningful involvement and equity-oriented policies – and distributional justice – the notion that long-term residents should have improved access to green space and be able to remain in place (Boone et al., 2009).

Although some within the academy and profession have been quick to adopt 'just green enough' as a mantra in redevelopment efforts, these hypotheses have not yet been tested in a systematic study on green gentrification. In particular, no investigation has clearly modelled how the location, size and function of a new park might foster neighbourhood change, and no study has examined green gentrification across a sample of diverse cities. In addition, the specific claim that new parks that are 'small-scale and in scattered sites' might not trigger green gentrification – one of the central tenets of JGE (Wolch et al., 2014: 241) – has not yet been confirmed by empirical studies.

In this article, we advance these nascent green gentrification and JGE streams of literature by asking: (1) Does the *presence* of a new park always foster gentrification in the surrounding areas? (2) Does the *location* of new parks (i.e. distance from downtown) matter for green gentrification? (3) Does the *size* of new parks matter for green gentrification? (4) And do new parks that also serve an active transportation *function* (i.e. a greenway park) foster green gentrification more than others? By answering those questions, we also respond to recent calls to identify the particular characteristics of parks that foster gentrification (Anguelovski et al., 2018a). We hypothesise that larger, centrally located parks that include active transportation trails – parks like Atlanta's BeltLine, Chicago's 606 Trail and New York's High Line – will more strongly contribute to the gentrification of surrounding neighbourhoods than other parks (Immergluck and Balan, 2018; Rigolon and Németh, 2018a).

Methods

We conduct a longitudinal study of parks built between 2000 and 2015 in 10 major US cities. To ensure we are capturing more than a big-city phenomenon in a scaled-up national analysis, we examine the five largest cities (New York, NY, Los Angeles, CA, Chicago, IL, Houston, TX and Philadelphia, PA), as well as five medium-sized cities experiencing major economic growth (Albuquerque, NM, Austin, TX, Denver, CO, Portland, OR and Seattle, WA). This sample includes cities located in all major geographical regions of the United States (East Coast, South, Midwest, Mountain West and West Coast) and with significant variations in population size and ethnoracial composition (see Table 1).

We map gentrification trends at the census tract level for two periods: between 2000 and the 2006–2010 American Community Survey (ACS; for parks built between 2000 and 2008), and between the 2006–2010 ACS and the 2012–2016 ACS (for parks built between 2009 and 2015). We choose 2008 – approximated by the 2006–2010 ACS – as the cut-off point between the two time periods because this was the height of the Great Recession, which severely impacted housing markets (Hyra and Rugh, 2016). In this analysis, we only focus on new parks built

Table 1. Sociodemographic features, GE tracts, gentrified tracts and new parks in the 10 selected cities in 2016.

City	Population	Median household income (US$)	Percent people of colour	Median gross rent (US$)	GE tracts 2000	Gentrified GE tracts 2000–2008	GE tracts 2008	Gentrified GE tracts 2008–2016	New parks 2000–2008 (new greenway parks)	New parks 2008–2015 (new greenway parks)
New York	8,461,961	55,191	67.74	1294	1097	220 (20.1%)	1024	255 (24.9%)	48 (2)	22 (1)
Los Angeles	3,918,872	51,538	71.53	1241	543	71 (13.1%)	541	104 (19.2%)	55 (1)	68 (2)
Chicago	2,714,017	50,434	67.66	987	425	80 (18.8%)	448	65 (14.5%)	29 (3)	35 (2)
Houston	2,240,582	47,010	74.90	898	244	46 (18.9%)	249	29 (11.6%)	23 (0)	15 (3)
Philadelphia	1,559,938	39,770	64.73	943	191	36 (18.8%)	191	37 (19.4%)	4 (0)	5 (1)
Albuquerque	556,859	48,127	59.37	816	62	19 (30.6%)	57	10 (17.5%)	39 (0)	2 (0)
Austin	907,779	60,939	51.11	1106	94	22 (23.4%)	94	22 (23.4%)	16 (3)	13 (0)
Denver	663,303	56,258	46.64	1035	81	30 (37%)	75	20 (26.7%)	55 (6)	8 (1)
Portland	620,589	58,423	28.45	1025	74	23 (31.1%)	71	14 (19.7%)	18 (0)	6 (0)
Seattle	668,849	74,458	34.29	1266	61	16 (26.2%)	57	13 (22.8%)	94 (0)	41 (0)
All cities	22,312,749[a]	54,215[b]	56.64[b]	1061[b]	2872[a]	563[a] (19.6%)	2807[a]	541[a] (20.3%)	381[a] (15[a])	215[a] (10[a])

Notes: For all cities, [a] denotes the sum, [b] denotes the average.
Sources: Sociodemographic data from the 2016 American Community Survey (five-year estimates, 2012–2016); park data from the 10 cities and the Trust for Public Land.

near gentrification-eligible (GE) tracts, which we define as those that have a median household income below the city's median (Anguelovski et al., 2018b; Ding et al., 2016; Timberlake and Johns-Wolfe, 2017). We only focus on GE tracts because 'by definition, in order for tracts to gentrify, they have to be lower-income at the beginning of the period' (Ding et al., 2016: 42).

Data sources and measures

We rely on several data sources to operationalise variables describing parks, sociodemographic characteristics, housing features and other urban amenities (e.g. rail transit, downtowns). Table 2 provides an overview of the variables we use in this study, their data source, their role in our analyses (dependent and predictor variables), their year of measurement and their 'level', where census tract equals Level 1 and city equals Level 2. Although we use census tracts as the units of analysis for this study, we also include data at the city level to describe characteristics of the 10 cities in multilevel, mixed effects models (see statistical analysis section). We use census tracts instead of smaller units of analysis such as census block groups because, for the latter, the American Community Survey provides estimates with very large margins of error (Spielman et al., 2014). We process all these data in ESRI ArcGIS (version 10.5) and run statistical analyses in IBM SPSS (version 25.0).

Dependent variables

We build a dichotomous variable that describes whether a census tract has gentrified or not during each of the two periods. We borrow from the definition of gentrification proposed by Chapple et al. (2017), classifying census tracts as 'gentrified' if they had (1) increases in median household income, (2) increases in the percentage of people with a bachelor's degree, and (3) either a rise in median gross rent or median housing value greater than that of their city in the same period. This definition does not include measures describing race and ethnicity, primarily because several authors have shown evidence of non-white gentrification (Chapple et al., 2017; Timberlake and Johns-Wolfe, 2017).

We use Chapple et al.'s (2017) operationalisation of gentrification among other definitions for three reasons. First, it includes a robust set of measures describing socioeconomic status and housing prices. Second, it is one of the most recent definitions of gentrification and builds on previous conceptualisations (e.g. Bates, 2013; Freeman, 2005). Third, it relies on measures that are available nationwide through the US Census Bureau and is used in a number of recent studies (e.g. Rigolon and Németh, 2019).

Predictor variables

Our variables of interest examine the presence and characteristics of new parks as related to our four research questions. First, we analyse the presence of new park space built in each of the two study periods (2000–2008 and 2008–2016) within half a mile from a census tract's centroid (*new park*; dummy variable).[1] We use half a mile because in the United States this is considered to be the threshold for walking access to parks (Rigolon, 2016), because previous research on green gentrification in the US shows that new parks can impact property values located up to half a mile away (Smith et al., 2016) and because census tracts have relatively large sizes (239 acres, on average, for GE tracts in 2008). We include only developed parks open to the public, excluding community gardens and vacant land designated for future park development. Second, we analyse the acreage of new parks built within half a mile of a census tract (*size of*

Table 2. Variables and data sources.

Dependent variables to define gentrification (binary outcome variable)				
Variable	Description	Data source	Type	Level
Income	Median household income	ACS, LTDB	DV	1, 2
Percent bachelor	Percentage of people aged 25 and above with at least a bachelor's degree	ACS, LTDB	DV	1, 2
Rent	Median gross rent	ACS, LTDB	DV	1, 2
Home value	Median home value for owner-occupied units	ACS, LTDB	DV	1, 2
Predictor variables				
Variable	Description	Data source	Type	Level
Percent Black	Percentage of non-Hispanic Black residents	ACS, LTDB	CV	1
Percent Latino	Percentage of Latino or Hispanic residents	ACS, LTDB	CV	1
Income	Median household income	ACS, LTDB	CV	1, 2
Rent	Median gross rent	ACS, LTDB	CV	1
Percent vacant housing units	Percentage of vacant housing units	ACS, LTDB	CV	1, 2
Population density	Number of residents per acre	ACS, LTDB	CV	1, 2
Percent multifamily	Percentage of multifamily housing units	ACS, LTDB	CV	1
Percent older housing units	Percentage of housing units older than 30 years	ACS, LTDB	CV	1
Variable	Description	Data source	Type	Level
Distance from downtown	Distance from each city's downtown	City data	IV, CV	1
Access to rail transit*	Presence of a rail transit station within half a mile	City data	CV	1
Income change in previous decade	Change in median household income in the previous decade	ACS, LTDB	CV	1
Percent HUD units	Percentage of housing units subsidised by HUD	HUD	CV	1
New park*	Presence of a new park within half a mile	City data	IV	1
Size of new parks	Size of new parks within half a mile	City data, TPL	IV	1
New greenway park*	Presence of a new greenway park with walking/cycling trails within half a mile	City data, TPL	IV	1
New park close to downtown*	Presence of a new park located close to downtown (less than median distance to downtown of gentrification-eligible tracts for each city)	City data, TPL	IV	1
ParkScore	ParkScore index describing the quality of urban park systems	TPL	CV	2

Notes: * denotes a dummy variable. DV: dependent variable. IV: independent variable. CV: control variable/covariate. ACS: American Community Survey. LTDB: Longitudinal Tract Database. HUD: US Department of Housing and Urban Development. TPL: The Trust for Public Land. Level 1: Tract. Level 2: City. All data was collected at the beginning of the two study periods (2000 and 2006–2010 ACS).

new parks). Third, we examine whether new greenway parks – those longer than one mile and with an active transportation purpose – are within half a mile from a census tract centroid (*new greenway park*; dummy variable). We choose a threshold of one mile for greenway parks to single out greenways that connect multiple neighbourhoods and serve as active transportation infrastructure (Rigolon and Németh, 2018a). Fourth, we develop and measure a variable describing park location; for each city, we operationalised 'close to downtown' as any distance shorter than the median distance to downtown of GE tracts (*new park close to downtown*; dummy variable).

Our covariates include a broad range of factors known to foster and limit gentrification (see Table 2). Specifically, for Level 1 (census tracts) we include the percentage of people of colour, housing vacancy, the presence of historic housing buildings, proximity to downtown, access to rail transit stations, the provision of publicly subsidised housing and others (Chapple et al., 2017; Hwang and Sampson, 2014; Rigolon and Németh, 2019; Timberlake and Johns-Wolfe, 2017; Zuk and Chapple, 2016). Covariates for Level 2 (cities) include socioeconomic status (income), the availability of housing (percent vacant housing), urban fabric features (population density) and the quality of urban park systems (ParkScore; see Rigolon et al., 2018). To ensure we are capturing covariates known to prevent or foster gentrification, and not simply to be consequences *of* gentrification, we gather these data at the beginning of the two study periods (2000 and 2008).

Statistical analysis

We run multilevel, mixed effects logistic regressions for the two study periods, modelling gentrification as a dichotomous dependent variable, and use the predictor variables reported in Table 2. We use a multilevel approach due to the nested nature of the data, as all GE census tracts are located within a particular city. In these mixed models, we use random effect intercepts to account for variations among the 10 cities that are not described by the fixed effects (Raudenbush and Bryk, 2002; Sommet and Morselli, 2017). Also, we use 16 fixed effect slopes at Level 1 (census tracts) and four such slopes at Level 2 (city; see Table 3 above). Equation 1 describes our regression formula:

$$\text{Logit}(odds) = B_{00} + B_{10'} * \text{x}1_{ij} + \ldots + B_{N0'} * \text{xN}_{ij} + B_{01'} * \text{X}1_{j} + \ldots + B_{0K'} * \text{XK}_{j} + u_{1j} + \ldots + u_{Nj} + u_{0j} \quad (1)$$

where N is the Level 1 sample size; K is the Level 2 sample size; B_{00} is the fixed intercept; $\text{x}1_{\text{ij}}\ldots\ \text{xN}_{\text{ij}}$ are the Level 1 predictor variables; $B_{10'}\ldots B_{\text{N}0'}$ are the Level 1 fixed slopes; $\text{X}1_{\text{ij}}\ldots\ \text{XK}_{\text{ij}}$ are the Level 2 predictor variables; $B_{01'}\ldots B_{0\text{K}'}$ are the Level 2 fixed slopes; $u_{1\text{j}}\ \ldots u_{\text{Nj}}$ are the residual terms linked with the Level 1 predictors $\text{x}1_{\text{ij}}\ldots\ \text{xN}_{\text{ij}}$, linked to the deviation from the fixed intercept; $u_{0\text{j}}$ is the Level 2 residual; and $\text{var}(u_{0\text{j}})$ is the random intercept variance.

There are several reasons why we used multilevel logistic regressions, rather than other distance-based methods such as geographically-weighted regression that focus only on areas near new parks (e.g. Anguelovski et al., 2018b; Smith et al., 2016). First, multilevel models account for the nested nature of our data. Second, multilevel models require large sample sizes, and averaging the values of demographic and housing variables for geographic units around each new park would have resulted in an excessively small sample size. Third, since we use census tracts as our unit of analysis, comparisons across our gentrification variables describing gentrification for geographies located at various distances from new parks – e.g. 0.1, 0.2, 0.3 miles – would have resulted in much coarser and less meaningful variations in such distances – e.g. 0.5, 1, 1.5 miles. By controlling for a variety of covariates describing demographics, urban fabric and subsidised

Table 3. Odds ratios of the likelihood of gentrification for all GE census tracts in the two periods (main models).

	2000–2008 (n = 2836)		2008–2016 (n = 2779)	
	Model 1 (Level 1)	Model 2 (Levels 1, 2)	Model 1 (Level 1)	Model 2 (Levels 1, 2)
Fixed effects				
Intercept	**0.104*** **	0.419	**0.270***	7.135^
Percent Black	**0.990*** **	**0.989*** **	**0.994** **	**0.993** **
Percent Latino	**0.988*** **	**0.987*** **	**0.990*** **	**0.989*** **
Income	**1.032** **	**1.032** **	**1.023***	**1.022***
Rent	**1.002** **	**1.002** **	1.000	1.000
Percent vacant housing units	**1.052*** **	**1.053*** **	1.004	1.006
Population density	**0.996***	**0.996***	0.998	0.998
Percent multifamily	0.999	0.998	1.000	0.999
Percent older housing units	1.002	1.002	1.002	1.000
Distance from downtown	**0.856*** **	**0.852*** **	**0.884*** **	**0.885** **
Access to rail transit	1.061	1.059	**1.330***	**1.324***
Income change in previous decade	1.007	1.008	**0.970** **	**0.971** **
Percent HUD units	1.002	1.003	0.992^	0.991^
New park	0.720	0.749	0.542^	0.567^
	Model 1 (Level 1)	Model 2 (Levels 1, 2)	Model 1 (Level 1)	Model 2 (Levels 1, 2)
Size of new parks	1.004	1.003	1.003	1.002
New greenway park	0.313	0.299	**3.222***	**3.367** **
New park close to downtown	1.411	1.392	2.045^	1.916^
City – Income		0.989		0.983
City – Percent vacant housing units		0.992		**0.921*** **
City – Population density		1.020		**1.064*** **
City – Park Score		0.983		**0.970*** **
Random effects				
Level 1 intercept	0.000	0.000	0.010	0.000
Level 2 intercept	0.112	0.198	0.118	0.000
Akaike Information Criterion	14,491	14,551	13,654	13,627

Notes: ^$p < 0.10$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

housing, multilevel logistic regressions help us better isolate the impact of new parks.

Before running mixed effect models, we conduct multicollinearity tests for all independent variables and covariates and find that all Variance Inflation Factors (VIFs) are below four, which denotes a lack of multicollinearity (O'Brien, 2007). All other assumptions for multilevel logistic regressions are met.

We run two sets of tests. In the first set, which includes our main models, we use all GE tracts for the two periods (with separate models for 2000–2008 and 2008–2016). In the second, which we consider a sensitivity analysis, we only examine GE tracts within half a mile of a new park to more effectively isolate the potential gentrifying impact of park location, size and function. In this second set of models, we use fewer covariates due to the smaller sample size and only focus on the covariates that were significant in the first set of models. This sensitivity analysis allows us to assess the robustness of our initial results based on changes in the study sample and model details.

For each of the two sets of multilevel logistic regressions, and for each study period, we ran two separate models. The

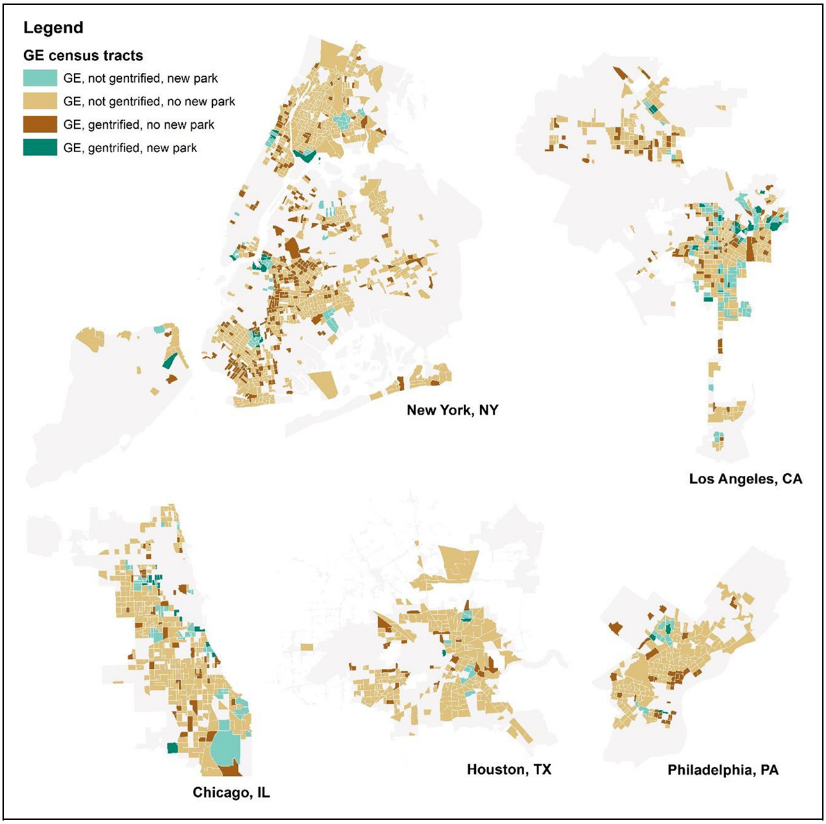

Figure 1. Locations of gentrification-eligible (GE) tracts in 2008 and gentrified tracts between 2008 and 2016 for the five largest cities in the US.

first includes fixed effect slopes for covariates at Level 1 (census tract); the second includes such slopes for covariates at Levels 1 and 2 (census tract and city). This allows us to uncover whether adding city-level variables can improve the model fit, assessed through the Akaike Information Criterion (Anguelovski et al., 2018b).

Findings: Do park location, size and function matter?

Descriptive statistics

Figures 1 and 2 show the location of GE tracts that did and did not gentrify between 2008 and 2016 in the sampled cities (2000–2008 data are not shown but exhibited similar spatial patterns). In the whole sample, 50.6% of all census tracts were GE in 2008, with some variations across cities. For example, 47.6% of tracts were GE in New York City, 54.1% in Los Angeles, 56.3% in Chicago and as few as 43.2% in Seattle (we find similar percentages in 2000). This results in a total of 2872 GE tracts in 2000 and 2807 in 2008. Due to missing data, the main multilevel logistic regression models include 2836 GE tracts in 2000 and 2779 in 2008. For 2008, GE tracts in New York City, Los Angeles and Chicago comprise 36.5%, 19.3% and 16% of the whole

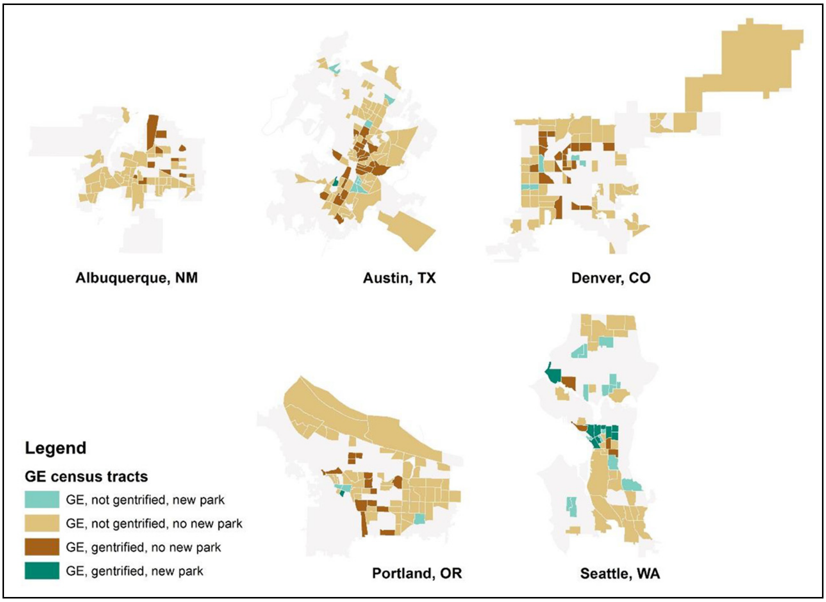

Figure 2. Locations of gentrification-eligible (GE) tracts in 2008 and gentrified tracts between 2008 and 2016 for five medium-sized cities in the US.

sample, respectively. Between 2008 and 2016, 20.3% of GE tracts gentrified, with variations across cities (e.g. 24.9% in New York City, 19.2% in Los Angeles; see Table 1).

More new parks and greenway parks were built in the 2000–2008 period (n = 381 and n = 15) than in the 2008–2016 period (n = 215 and n = 10), perhaps due to significant budget cuts to public park agencies in the US after the 2008 Great Recession (Pitas et al., 2017). The cities that have added more new parks are Los Angeles (both periods), Seattle (both periods) and Denver (2000–2008; see Table 1). The new parks established in the two periods were unevenly distributed within their cities. In the 2000–2008 period, 402 of the 2872 GE tracts were located within half a mile of a new park (14%), and only eight were located within half a mile of a new greenway park built in that time span (0.003%). In the 2008–2016 period, 347 of 2807 GE tracts were within half a mile of a new park (12.4%), and 29 GE tracts were within the same distance of a new greenway park (0.08%). Many well-known greenway parks opened to the public in the second period, including the High Line (New York), the 606 Trail (Chicago) and the Buffalo Bayou Park (Houston).

Multilevel logistic regressions

Multilevel, mixed effects models for all GE tracts in the 2000–2008 period show that none of the variables describing new parks is a significant predictor of gentrification, although many covariates are significantly associated with the likelihood of gentrification (e.g. *percent Black*, *percent Latino*, *distance from downtown*; see Table 3). The Akaike Information Criterion (AIC) is larger in Model 2 (Levels 1 and 2) than in Model 1 (Level 1), which shows that adding Level 2 variables (city-level) to Level 1 variables (tract-level) does not increase the model fit (see Table 3).

Models for all GE tracts in the 2008–2016 period reveal that the presence of a new greenway park within half a mile of a census tract significantly increases the likelihood of gentrification (see Table 3). In Model 1, when controlling for a number of tract-level covariates, being within half a mile of a *new greenway park* increases the odds of gentrification for a census tract by 222% ($p < 0.05$). In Model 2, which controls for four city-level and several tract-level covariates, the presence of a *new greenway park* increases the odds of gentrification for a census tract by 236% ($p < 0.01$). Also, in Model 2, the presence of a *new park close to downtown* increases the odds of gentrification by 91% ($p < 0.10$). Because we use a dummy variable describing a *new park close to downtown*, the dummy variable *new park* thus represents new parks located farther from downtown. As such, *new park* is marginally associated with decreased odds of gentrification (44% decrease in Model 2, $p < 0.10$). These results suggest that new parks increase the odds of gentrification when they are located closer to downtown (less than median distance for GE tracts for each city). Also, the AIC is smaller in Model 2 than in Model 1, which shows that adding Level 2 variables to Level 1 variables improves the model fit (see Table 3).

Odds ratio values for *size of new parks* are slightly larger than 1 in all models for the two periods, but none are statistically significant. The fixed-effect Level 2 variable describing the quality of urban park systems (*ParkScore*) is significant for the 2008–2016 period, suggesting that GE census tracts in cities with better park systems (e.g. Portland, OR, New York, NY) are less likely to gentrify than those in cities with worse park systems (e.g. Houston, TX, Los Angeles, CA). Specifically, an increase of one point (on a 0–100 scale) in *ParkScore* reduces the odds of gentrification for GE tracts by 3% ($p < 0.01$). Finally, random-effect Level 2 intercepts are not significant in any of the models, suggesting that intercepts do not vary substantially by city.

Results of the sensitivity analysis focusing on GE tracts within half a mile of a new park (Table 4) tend to confirm those of the main models (Table 3). Specifically, the presence of a *new greenway park* increases the odds of gentrification for a census tract by 145% in the 2008–2016 period ($p < 0.05$) but not in the 2000–2008 period. Also, *size of new parks* is not a significant predictor of gentrification. For *distance from downtown*, which in these models is a significant predictor of gentrification in both study periods ($p < 0.01$), for every one-mile increase in distance, the odds of gentrification for GE tracts with access to a new park decrease by 20% (2000–2008) and by 18% (2008–2016).

Overall, our findings show that new greenway parks have a significant impact on gentrification in the 2008–2016 period. Specifically, five of the seven greenway parks located near GE tracts were linked to the gentrification of a majority of their surrounding tracts, including projects in Chicago (e.g. the 606 Trail), New York (e.g. the High Line) and Houston (e.g. Buffalo Bayou Park; data not shown). In addition, Figures 1 and 2 confirm that new parks located in proximity to a city's downtown might foster gentrification more than those located at the city's periphery. Indeed, in the 2008–2016 period, several census tracts with access to new parks and located near downtowns did gentrify, particularly in Los Angeles, CA, and Seattle, WA, and to a lesser extent in New York, NY. In Los Angeles, many of the new parks near downtown that have fostered gentrification are located along or near the Los Angeles River, a once-forgotten stormwater management channel that is undergoing major revitalisation efforts (García and Mok, 2017).

Table 4. Odds ratios of the likelihood of gentrification for GE census tracts within half a mile of a new park (sensitivity analysis).

2000–2008 (n = 400)		2008–2016 (n = 347)	
Variables	Odds ratios	Variables	Odds ratios
Fixed effects		*Fixed effects*	
Intercept	0.408	Intercept	0.280^
Percent Black	0.992	Percent Black	0.997
Percent Latino	**0.985***	Percent Latino	0.992
Income	1.049^	Income	1.034^
Rent	1.000	Access to rail transit	1.291
Percent vacant housing units	1.048	Income change in previous decade	0.968
Population density	0.991^		
Distance from downtown	**0.802****	Distance from downtown	**0.824****
Size of new parks	1.001	Size of new parks	1.004
New greenway park	0.251	New greenway park	**2.454***
		City – Population density	0.999
Random effects		*Random effects*	
Level 1 intercept	0.000	Level 1 intercept	0.094
Level 2 intercept	0.462	Level 2 intercept	0.000
Akaike Information Criterion	2264	*Akaike Information Criterion*	1742

Notes: ^$p < 0.10$, *$p < 0.05$, **$p < 0.01$.

Conclusion

This article advances previous empirical research on green gentrification by demonstrating that the function and location of new parks can help explain whether the neighbourhoods around them will gentrify. Based on a scaled-up analysis of 10 major US cities, we find clear evidence that, from 2008–2016, new greenway parks with an active transportation function fostered gentrification more than other parks. These results confirm the findings of studies focusing on individual greenways in the US (Immergluck, 2009; Rigolon and Németh, 2018a; Smith et al., 2016) and South Korea (Kwon et al., 2017). We also find that new parks located in closer proximity to downtowns trigger gentrification more than parks located on the cities' outskirts, all else being equal. We do not find support for the hypothesis that larger parks are stronger drivers of gentrification than smaller parks. These results confirm previous findings on the impact of park location in Brooklyn and Barcelona, but contradict other findings related to park size in the same cities (Anguelovski et al., 2018b; Gould and Lewis, 2017).

Overall, our findings challenge one of the strategies of the 'just green enough' (JGE) approach that is specific to urban green spaces (see Wolch et al., 2014). In particular, we do not find empirical support for Wolch et al.'s (2014) claim that small, scattered parks do not trigger green gentrification while larger parks do. When located in close proximity to downtowns, we find that new parks tend to trigger gentrification *regardless* of their size and function. On the other hand, our findings do support the JGE claim that iconic greenway parks can have major impacts on gentrification (Curran and Hamilton, 2018; Wolch et al., 2014). Although our model includes the provision of federally subsidised affordable housing (*percent HUD units*), we did not consider the impact of local initiatives that might have been implemented to preserve and produce affordable housing and jobs, due to a lack of national databases modelling those variables. Because such local initiatives are another critical tenet of the JGE approach (Curran and Hamilton, 2018; Wolch et al., 2014), future studies focusing on individual cities could develop databases to model those initiatives.

Our findings also show that new greenway parks and parks located close to downtowns fostered gentrification between 2008 and 2016, but not so much between 2000 and 2008. In addition to variations in the samples of GE tracts between 2000 and 2008, a few factors can explain these differences. First, only eight gentrification-eligible census tracts were located within half a mile of a new greenway park built between 2000 and 2008. For that reason, there were only minimal variations in the *new greenway park* variable for this period, which helps explain its lack of significance. Second, the first phases of New York's High Line and Atlanta's BeltLine opened in 2009 and 2008, respectively; after their opening, developers and cities around the country saw their massive impact on property values (Immergluck and Balan, 2018; Loughran, 2014), which likely inspired the development of similar projects elsewhere. In other words, this 'post-High Line effect' might have triggered a knowledge transfer between developers and urban planners in a variety of growing cities who regularly 'import innovatory policy developed elsewhere in the belief that it will be similarly successful in a different context' (Stone, 1999: 52). Third, US cities were experiencing a real estate bubble in the years leading up to 2008, which has accelerated gentrification across several inner-city ethnoracial minority neighbourhoods (Hyra and Rugh, 2016). These widespread gentrification patterns linked to the housing bubble may have limited the impact of parks on gentrification. This suggests that planners must account for broader economic forces and markets questions when making decisions about parks and other environmental infrastructure (see also Rigolon and Németh, 2018b).

The limitations of our study suggest avenues for future research. First, using smaller units of analyses than census tracts (e.g. parcels or buildings) might provide more nuanced findings on the impact of new parks on housing prices (see Immergluck and Balan, 2018). Second, future work at the parcel level could investigate how park location, size and function affect housing prices in individual cities. Third, although our study contributes to the JGE discourse by using a scaled-up approach across several cities, future studies focusing on individual cities could combine our analysis of park location, size and function with local data on affordable housing, community organising and working-class jobs. Fourth, we provided explanations for the differences in the findings between the two study periods, but such differences warrant further research on when green gentrification occurs, including on how housing market factors interact with new park openings (see Anguelovski et al., 2018a). Fifth, our study portrays gentrification as a phenomenon signalled by increases in socioeconomic status and housing prices. But neighbourhood change also has major impacts on sense of place and feelings of rootedness for longtime residents, particularly when new parks and public spaces might be designed to attract wealthier newcomers (Fullilove, 2016; García and Rúa, 2018; Kern, 2015). Future research should build on recent work on attitudes towards new greenways such as Atlanta's BeltLine (Palardy et al., 2018), to unpack how marginalised longterm residents perceive and use new parks in gentrifying neighbourhoods.

The results of our study have key implications for urban planning and policy in global cities. Those implications are particularly timely because, as cities around the world are implementing urban greening programmes to promote human health and address climate change, they need to adequately account for the gentrification-related inequities that often accompany greening (Anguelovski et al., 2018a). First, because we find consistent evidence that new greenway parks built in the 2008–2016 period significantly increased the likelihood of green gentrification, future planning efforts to build similar greenways should effectively engage affordable housing non-profits and dedicate specific funds for housing (Immergluck and Balan, 2018; Rigolon and Németh, 2018a). Second, planners and activist researchers should build on existing gentrification 'early warning systems' (Chapple and Zuk, 2016: 109) and incorporate the potential impacts of the location and function of new parks into such models. These tools could provide local non-profits with much-needed resources to assess whether new parks might trigger green gentrification. Finally, as we find that large parks do not foster gentrification more than small parks, planners and policymakers should strive to address deep-rooted inequities in accessible park acreage by adding substantial amounts of new green space in park-poor, low-income communities of colour, while also providing and protecting nearby affordable housing (Rigolon, 2016; Wolch et al., 2014). Looking ahead, we hope that our findings will stimulate additional research and policy actions to ensure that urban greening initiatives around the world will truly benefit historically marginalised communities.

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Notes

1. Ideally, we would have used individualised periods for each park to account for the time lapse between when each new park was built and the end of the study period. But because of our study's multi-city scale and the lack of tract-level American Community Survey data from 2000–2008, this option was unviable. Also, we know very little about how long it takes for an area to gentrify after a nearby park is constructed; in some cases, neighbourhoods can even gentrify in advance of a park's construction (Smith et al., 2016).

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