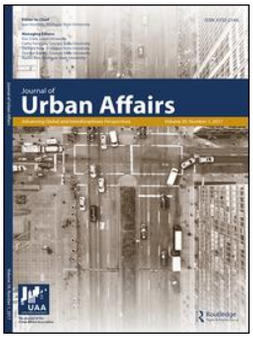

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St. Louis's "urban prairie": Vacant land and the potential for revitalization

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ABSTRACT

As part of a larger project to understand the relative health and disorder of St. Louis's neighborhoods, this article presents estimates of the number of vacant parcels in the city. These estimates, which are considerably higher than previously published ones, are heavily concentrated in the city's disinvested and segregated north side. We term this heavy concentration of vacancy *urban prairie*. After accounting for other factors as well as possible sources of statistical error, we identify both long-term population loss since 1970 and the proportion of African American residents as significant covariates associated with the amount of urban prairie land per neighborhood. These high levels of concentrated vacancy lead us to critique the city's existing approaches as being too limited in scope and to suggest a range of possibilities for revitalizing portions of northern St. Louis while allowing prairie land to continue to exist in others.

> It is a quiet, cloudless spring morning on the 1800-block of Laflin Street. There is a slight breeze and the grasses that cover the vacant lots wave gently. Voices from a nearby high school occasionally drift over the block. Otherwise, the only consistent sound is of red-winged blackbirds and common grackles—both blackbirds—singing and a nearby woodpecker engaging in its eponymous work. On the east side of the block, there is one boarded-up building barely visible in a stand of trees. On the west side of the street, a set of stairs leads to the stark remains of a collapsed building, barely visible in the weeds. A second collapsed building sits nearby. Otherwise, trees and grasses cover the lots on this block of Laflin Street. Trash and abandoned tires are piled at several points in the street and on what remains of the sidewalk on the west side of the street. The block to the east, which shares an alley with these lots, has four apparently occupied homes that abut the shared alley. The block to the east has a half-dozen boarded-up vacant and collapsing structures along with two occupied homes on the shared alley. The alleys themselves are dotted with collapsing garages. During a half an hour, only one car drives up Laflin Street. The mini van's back window is missing and has been replaced with several translucent trash bags. —C. Prener's fieldnotes (Spring 2017)

The 1800 block of Laflin Street, in the JeffVanderLou neighborhood of northern St. Louis, is emblematic of the city's segregation, poverty, and physical decline (see Figure 1). The census tract that this block sits in was over 96% African American in 2015, and just over half the population was living below the poverty line. Physically, the neighborhood is striking as well. The vacant lots that dominate the street along with boarded-up buildings are pictured in Figure 1. This block, and the surrounding neighborhoods, bear the physical scars of the dramatic population decline that St. Louis, Missouri, has experienced.

Like a number of shrinking cities in the United States, the city of St. Louis has been beset by population decline since the middle of the 20th century (Gordon, 2009, 2013). For a city that was the fourth largest in the nation when it proudly hosted the 1904 World's Fair, the visceral dismemberment of the city's neighborhoods has been particularly conspicuous. Indeed, one does not have to go

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Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/ujua.

Figure 1. Vacant lots on the west side of the 1800 block of Laflin St.

far from the city's pockets of vibrancy to see the physical consequences of shrinkage (Gordon, 2013). Boarded-up buildings appear in even some of the most developed neighborhoods, and the most notorious parts of St. Louis have widespread blight. In northern St. Louis, entire blocks like the 1800 block of Laflin Street have been largely abandoned and allowed to physically decompose into overgrown lots with little current population.

In the vein of a number of recent studies (see Silverman, Yin, & Patterson, 2013), we argue that the shrinking cities phenomenon may be demographic in origin but that it has very real physical manifestations. Vacancy itself has been widely documented in the literature, but here we make several important contributions. First, unlike most studies (see Yin & Silverman, 2015, for a notable departure), we do not rely on U.S. Census measures of vacancy. Instead, we construct a novel data set that combines eight key indicators to develop parcel-level estimates of vacancy. We then use spatial statistics to demonstrate the demographic correlates of shrinking cities as well as the way in which the physical consequences of shrinkage are notably concentrated in specific parts of St. Louis. Many of these blocks have exceptionally high vacancy rates, and we expand the concept of *urban prairie* to describe this spatial concentration of vacancy. Finally, we argue that our data speak to the need for much greater intervention than the current policy solutions allow for given their overwhelming focus on publicly owned properties.

Background

Shrinking cities and vacancy

Though specific criteria as to what classifies a city as shrinking differ, most definitions have one thing in common: sustained population loss as the result of structural crisis (Bernt, 2015; Martinez-Fernandez, Audirac, Fol, & Cunningham-Sabot, 2012; Pallagst, Fleschurz, & Said, 2017; Rieniets, 2009). Their existence in the United States is generally attributed to macrolevel economic forces that have led to the deindustrialization of former Rust Belt manufacturing centers (Martinez-Fernandez et al., 2012; Pallagst et al., 2017; Rieniets, 2009). Though the causes of urban shrinkage are important, sustained population loss poses real social and administrative challenges for a city's leadership. A declining tax base

and decreased population density hinders the ability to maintain and distribute public services (Rybczynski & Linneman, 1999). Population loss may not be equally distributed throughout a city's boundaries, causing some neighborhoods to experience more neglect than neighborhoods that are demographically stable or growing (Hollander, 2010; Tighe & Ganning, 2015).

A physical consequence of urban shrinkage is the proliferation of urban blight or the decline of the existing built environment. As Sousa and Pinho (2015, p. 12) write, "[Urban shrinkage] is often confusing, because whereas, for instance, population growth naturally leads to urban growth, population decrease does not immediately lead to urban shrinkage." As such, numerous studies have investigated the physical form in which sustained population loss manifests. This includes abandoned buildings and vacant plots with a bleak outlook for revitalization (Accordino & Johnson, 2000; Hollander, 2010; Hollander & Németh, 2011; Rybczynski & Linneman, 1999; Silverman et al., 2013; Sousa & Pinho, 2015). High vacancy rates are associated with a variety of social problems, including crime (Branas, Rubin, & Guo, 2012; Cui & Walsh, 2015; Spelman, 1993) and poverty (Immergluck, 2016; Silverman et al., 2013). Properties neighboring vacant homes have lower selling prices (Han, 2014; Whitaker & Fitzpatrick, 2013), suggesting that vacancy brings down the overall attractiveness of a neighborhood, leading to further decline.

Many cities struggle with vacancy-related problems, but Silverman et al. (2013) argue that the type of vacancy found in shrinking cities is distinct. Coining the term *zombie properties*, the authors suggest that abandonment in shrinking cities is fundamentally different than that in cities without systemic population loss because, often despite the best efforts of community organizations and the city government, zombie properties are not destined to be revitalized. Nonetheless, an array of tactics have been employed in attempts to address concentrated urban blight. Hackworth (2014) gives an overview of these tactics, describing cities that have predominantly relied on market forces, as well as those that have implemented interventionist programs such as land banks. The problem, however, is one that neither the market nor more governance-oriented efforts can solve in isolation. Hegemonic urban planning practices have relied on an assumption that decline is a sign of a city in poor health, but because urban shrinkage is a structural phenomenon, scholars have argued that the existing growth-oriented paradigm is not a realistic or valid approach for cities dealing with systemic population loss (Bernt, 2009; Martinez-Fernandez et al., 2012; Pallagst et al., 2017; Shetty & Reid, 2013; Weaver & Holtkamp, 2015). Subsequently, the concept of *smart decline* or *right-sizing* has emerged as an alternative strategy (Bontje, 2005; Haase, 2008; Hollander, 2011; Hollander & Németh, 2011; Hummel, 2015; Schilling & Logan, 2008).

A smart decline framework proposes that when a city is no longer in its growth stage, it must adapt and embrace decline. Given the fiscal constraints of a shrinking tax base, shrinking cities must think about how to best foster demographic stability and promote a high quality of life for the remaining population. Demolition, one smart decline strategy, can be particularly controversial because individuals who live in neighborhoods scheduled to be demolished may still have an emotional attachment to their homes (Mallach, 2011). Nonetheless, demolition is an integral component of right-sizing and therefore has received attention in the shrinking cities genre. Demolitions have in large part been reactive to blight rather than used to proactively clear land for some planned future use (Mallach, 2011; Yin & Silverman, 2015).

A more proactive approach to demolition might work in conjunction with the practices of land banking and urban greening. Land banking occurs when a city organization takes ownership of land, either for repurposing it or simply to take it off the market and suppress supply (Hackworth, 2014; Hummel, 2015). Repurposing of land might take the form of urban greening; Haase (2008) and Schilling and Logan (2008) have suggested that right-sizing is an ideal opportunity for implementing green infrastructure programs. Though scholars like Paddeu (2017) argue that a just implementation of green programs is far more complex than much of the shrinking cities literature suggests, the potential for a radically different urban landscape exists within the confines of shrinking cities.

The urban prairie

The term *urban prairie* is a colloquialism that originates in Detroit (Binelli, 2013) and has been used to describe areas of that shrinking city that have seen widespread abandonment. Its use in both the popular press and academic literature has been limited in most cases to a shorthand term for describing in a qualitative sense the physical manifestations of the unplanned retreat from certain neighborhoods: vacant buildings, crumbling infrastructure, and overgrown lots (Binelli, 2013; Dooling & Simon, 2012; Gallagher, 2010). Prairie lands provide both a strong visual indicator of disorder, for example, and may challenge a city's ability to provide services in the most sparsely populated areas. Writing for *National Geographic*, Gamache and colleagues (2015) mapped these characteristics in Detroit and defined *urban prairie* as a spectrum ranging from traditional neighborhoods to largely vacated neighborhoods. There has been little application of the term outside of Detroit, though a 2012 public radio story about St. Louis, Missouri, did invoke the term to describe the city's blighted north side (Byrnes, 2012).

St. Louis

St. Louis, with tens of thousands of vacant properties, would seem ripe for such description. Like many shrinking cities, its trajectory can be seen as a multidimensional combination of macroeconomic forces and local sociopolitical conditions (Bernt, 2015). Beginning in the early 20th century, racial segregation and division were hardened into laws known as deed covenants that prohibited the sale of properties to African Americans. Pervasive redlining and deindustrialization in the postwar period exacerbated these trends, leading to population increases in the suburbs and concurrent declines in the city (Gordon, 2009; Maimaitijiang, Ghulam, Sandoval, & Maimaitiyiming, 2015). From its postwar high population of 856,796 in 1950, the city has lost nearly two thirds of its population. In 2016, St. Louis's population was 311,404, just 36% of what it was in 1950. By the late 1970s, the *New York Times* concluded that "by almost any objective or subjective standard, St. Louis is still the premier example of urban abandonment in America" (Reinhold, 1978s, p. E5).

Perhaps no site in St. Louis encapsulates this trend more than Pruitt-Igoe (see Figure 2). Originally conceived of after World War II as part of urban renewal efforts, the segregated housing complex opened in 1954 but quickly began deteriorating physically and socially as a result of poor maintenance, shoddy construction, and neglect by the city. Beginning in 1971, the buildings were demolished, and the site sits unused today; it is now a dense urban forest of mature trees and heavy undergrowth (Bristol, 1991). Pruitt-Igoe's current state, in the heart of what is known as "North City," is not an aberration but rather a prime example of the vacancy that has beset large swaths of the city. Northern St. Louis, which is largely African American (see Figure 2), is often identified as the epicenter of the city's abandonment, with vacancy rates perhaps approaching 28% (Tighe & Ganning, 2015).

Evan as some neighborhoods in the city's central corridor have successfully redeveloped more recently (Monti & Burghoff, 2012; Swanstrom, Webber, & Metzger, 2015), North City has remained largely marginalized. Like Pruitt-Igoe, this marginality is the result of both long-standing episodes of racial antagonism, policies that reinforced segregation historically (Gordon, 2009), and little policy intervention to undo its lasting legacy (Farley, 2005). More recent events like the St. Louis Public Schools' collapse and subsequent loss of accreditation (Strauss, 2017) and the continued expansion of the suburban footprint around the city (Gordon, 2013) have only deepened the complex web of factors confronting the city.

One of the most visible indicators to residents and visitors alike is the city's density of vacant properties. For all of their visibility, however, the actual number of public and private vacant properties remains an open question. The city's conscious managerial approach (as opposed to more market-friendly approaches; see Hackworth, 2014) to land ownership through its two land banks, the Land Reutilization Authority (LRA) and the Land Clearance for Redevelopment

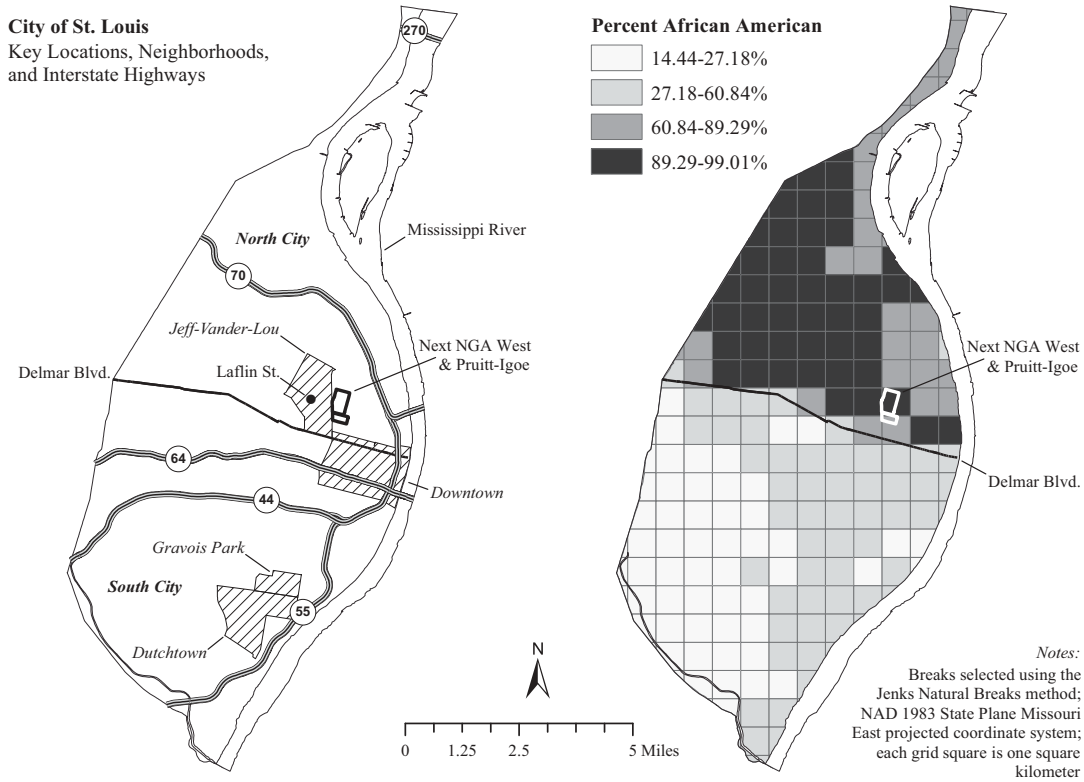

Figure 2. City of St. Louis reference map and distribution of African American residents.

Authority (LCRA), has left it in possession of approximately 12,000 vacant properties. There is reason to believe that these represent less than half of the vacant properties in the city, however. At least one 2017 media report put the vacant property count at 25,000 (KMOX, 2017), though that estimate's methodology was not reported. This number is substantially similar to the unpublished data set used by Tighe and Ganning (2015), which was likely produced sometime in 2009 or 2010 as part of a graduate student's capstone project, which, like the data itself, is not publicly available. The city has tried to produce its own estimates with the help of AmeriCorps. The outcome speaks to the depth of abandonment in the city: AmeriCorps was unable to complete its work within a year and the project has been put on hold (Miller, Lockrem, & Wittstruck, 2017).

The city government has initiated a number of programs that attempt to repurpose the land that is held in particular by LRA, the oldest land bank in the country (Miller et al., 2017). Through the Mow to Own program, residents who live adjacent to a vacant, city-owned lot may apply to maintain and eventually purchase the property for a nominal fee (Miller et al., 2017). Similarly, the LRA's Garden Lease Program is a mechanism for residents and neighborhood associations to temporarily lease vacant property for $1 per year, incentivizing the creation of vegetable and flower gardens (Miller et al., 2017). Under a consent decree with the U.S. Department of Justice, the Metropolitan Sewer District in St. Louis has partnered with the city to demolish hundreds of vacant homes as part of a bid to manage storm runoff (Barker & Moskop, 2017). These programs, however, apply only to publicly held vacant properties.

Given the lack of transparency in the estimates of vacancy in the city, the goal of this article is to discern the extent of vacant buildings and lots in the city of St. Louis in a way that attempts to capture as many parcels as possible. Drawing from multiple data sources, we produce conservative and liberal estimates of how many vacant properties exist within the city boundaries. Using these

data, we locate vacancy hotspots and coldspots and identify some of the social factors associated with high concentrations of vacant properties. With a smart decline framework in mind, we conclude by offering policy solutions that are a departure from current programs, such as Mow to Own and the Garden Lease Program, that incentivize more purposeful resident-driven revitalization.

Data and methods

As part of a larger project aimed at understanding levels of development and disorder within St. Louis's neighborhoods, we constructed a novel data set of information about each parcel in the city. Following O'Brien, Sampson, and Winship (2015), we relied on publicly available bulk administrative databases to obtain these indicators of vacancy. These sources, which do have drawbacks, are described in detail below and are followed by other sources of demographic data and our analysis approach.

Vacant parcel data

The vacant parcels data were constructed by the authors from a number of publicly available data sources (see Table 1 for a summary). As discussed above, the city does not maintain a single public list of vacant parcels. Rather, indicators of vacancy are spread out over a range of databases that were obtained from the city's open data website. Our final data set of vacant parcels was constructed using eight separate indicators derived from seven different city databases.

The first three indicators were what we will refer to here as "primary" indicators. These were obtained on January 15, 2017, and are treated as cross-sectional data that are valid for that date. The indicators were drawn from the city's parcel ownership and tax database, which was used to identify parcels owned by the LRA and the LCRA (the two public land banking agencies described above). We also drew data from a binary indicator included in the parcel ownership database that identified

Table 1. Vacancy data sources.

Indicator	Source[a]	Description
(1) Vacant lot[b]	(A) Property ownership database	Represents the city's assessment of the property as a vacant lot
(2) Land Reutilization Authority (LRA) property[b]	(A) Property ownership database and (B) LRA sales data	Combines data on property ownership with the LRA's own sales list to identify properties held in the city's land bank
(3) Land Clearance for Redevelopment Authority (LCRA) property[b]	(A) Property ownership database	Identifies properties held by the city's development agency
(4) Property condemned[c,d]	(C) Condemnation database, (D) Building inspection database, and (F) Building permit database	Identifies properties that have been condemned and that have not had a subsequent inspection
(5) Vacant building survey completed[c,d]	(D) Building inspection database and (F) Building permit database	Represents vacant properties that have been party of the city's yearly survey of vacant buildings
(6) Vacant building inspection completed[c,d]	(D) Building inspection database and (F) Building permit database	Identifies vacant buildings subject to ad hoc inspections
(7) Citizens' Service Bureau calls for property[d,e]	(E) Citizens' Service Bureau calls database and (F) Building permit database	Represents properties that have had calls made to the Citizens' Service Bureau (St. Louis's 3-1-1 system) regarding either vacant lot or vacant building conditions
(8) Demolition permit completed[c,d]	(F) Building permit database	Identifies properties that have had demolition permits completed on a major residential or commercial structure

Note. [a]All data obtained from the city of St. Louis's Open Data website.
[b]Represent status as of January 15, 2017.
[c]Based on longitudinal data covering the period between January 1, 1992, and January 15, 2017.
[d]All indicators in the second set (4 through 8) were scrubbed to eliminate properties that had building permits completed after the dates associated with all positive indicators.
[e]Based on longitudinal data covering the period between January 1, 2009, and January 15, 2017.

vacant lots. The second source of data included lists of current vacant lots and vacant buildings available for purchase from the LRA. These were combined with property ownership data to create a single master list of LRA parcels throughout the city. All three of these indicators were taken at face value as evidence of vacancy, and any parcel that had one or more positive indicators from this group was coded as vacant.

The remaining five indicators were what we refer to as "secondary" indicators. These were drawn from a mix of data sources, all of which were longitudinal in nature. The database with the narrowest range of dates, the building permits data, began in 1992. Unless otherwise noted, all other data sources were filtered so that observations before January 1, 1992, were removed. These data were also obtained on January 15, 2017, and therefore did not have observations after that point. All of the longitudinal data were collapsed so that we had observations for individual addresses rather than individual permits, inspections, or calls for service, for which an address might have multiples. They were also cleaned so that observations that were specific to single units within apartment buildings were removed because these may not have contributed to disorder observable from the street level. Observations for an entire apartment building or a complex of buildings were, however, retained.

The fourth indicator, condemned properties, was drawn from a specific list of condemned properties in the city. This data set included both currently condemned structures as well as buildings that had been condemned in the past. For that reason, condemnation data was paired with data from a fourth source, the city's building inspections database. Building inspections are required by city code before condemned properties can be inhabited again, and the list of condemned properties was compared against inspections to identify and remove any condemned buildings that had been subsequently inspected with compliance noted.

The fifth and sixth indicators were also drawn from the building inspection database. The fifth indicator represented buildings inspected as part of yearly vacant building surveys conducted by the city. For the valid range, which covered 1992 through 2016, an average of 5,660 buildings were surveyed each year by the city. Any property that was surveyed one or more times was included in this indicator. The sixth indicator also represented inspections of vacant buildings, except that those were done on an ad hoc basis rather than as part of the building survey program.

The seventh indicator was drawn from Citizens Service Bureau (CSB) data. The CSB is St. Louis's equivalent of a 3-1-1 system, a non-emergency service that allows individuals to report issues with both public and private property such as signal lights out, animal infestations, potholes, and issues with vacant properties and lots. This data set contained calls for service from 2008 through February 2017 and was therefore edited to remove any observations after January 15, 2017, to achieve parity with the other indicators. The data set was also filtered to extract only calls for service for a particular set of problem codes related to vacant lots or vacant buildings.[1] The eighth and final indicator was completed demolition permits for main commercial and residential structures. Like the condemnation data, observations for apartment units were filtered out of the data set.

All of the secondary indicators had an additional level of filtering applied to them using building permits, with the inspection or permit date being compared against a data set of completed building permits. When properties that had vacancy indicators but subsequently were subject to construction were identified, they were removed from the vacancy data set. Properties were also checked against a list of parks and other large open spaces, which were sometimes listed as vacant lots by the city, and any overlapping parcels were removed from the final data set.

The final data set of vacant parcels was used to make two estimates, a low estimate and a high estimate of vacated properties (see Tables 2 and 3). Given the varying quality of St. Louis's data, we felt that circumspection was warranted with our analyses. The low estimate was a more conservative estimate that included any parcel that had a positive primary indicator or at least two separate positive secondary indicators. The high estimate was a less conservative estimate that had a positive primary indicator or at least one positive secondary indicator. These data sets were created using the RStudio application (RStudio Team, 2015) for the statistical computing language R (R Core Team, 2017) and have been archived by the authors on a dedicated website.[2]

Table 2. Block- and grid-level descriptive statistics.

Variable	Range	Mean	*SD*
Block level			
Proportion of block vacant, low estimate	0–1.00	0.256	0.304
Proportion of block vacant, high estimate	0–1.00	0.378	0.332
Grid level			
Vacant area, low estimate (km^2)	0–0.478	0.123	0.123
Vacant area, high estimate (km^2)	0–0.659	0.181	0.156
Proportion below poverty line, 2015[b]	0.046–0.648	0.287	0.140
Proportion African American, 2015[b]	0.014–0.990	0.549	0.344
Median rent (dollars), 2015[b]	490.000–1,080.000	746.081	74.532
Median age of residential structure, 2015[b]	42.750–76.000	69.181	7.057
Proportional population change, 1970–2015[a]	−0.814 to 0.434	−0.416	0.203

Note. [a]1970 value interpolated from the Brown Longitudinal Census Tract Database; 2015 value interpolated from the 2015 American Community Survey 5-year census tract estimates.
[b]Interpolated from 2015 American Community Survey 5-year census tract estimates.

Table 3. Parcel-level descriptive statistics.

	Low estimate		High estimate	
Variable and values	Frequency	%	Frequency	%
Parcel ownership				
Private ownership	19,092	58.870	34,569	71.999
City LRA and LCRA ownership	11,704	36.089	11,704	24.377
Other city agencies[a]	911	2.809	992	2.066
Other public entities[b]	724	2.232	748	1.558
Total	32,431	100.00	48,013	100.00
Parcel zoning				
Residential	24,728	76.248	38,040	79.229
Commercial	5,870	18.100	7,832	16.312
Other	1,668	5.143	1,952	4.066
Unknown	165	0.509	189	0.394
Total	32,431	100.00	48,013	100.00

Note. [a]This category includes the city of St. Louis as well as a number of its departments, including the public schools, the Housing Authority, and the Water Division.
[b]This category includes the state of Missouri, the Bi-State Development Corporation (which operates public transit in the metropolitan area), and the United States government.

Demographic data

Data on vacancy were paired with demographic data with the intention of understanding the social forces associated with the abandonment of properties in St. Louis. Demographic data were drawn from two sources, the 2015 American Community Survey (ACS) 5-year estimates and the Longitudinal Tract Database (see Logan, Stults, & Xu, 2016; Logan, Xu, & Stults, 2014). The Longitudinal Tract Database was produced by Brown University's Spatial Structures in the Social Sciences Center, and they provide a means for matching data measured at 1970, 1980, 1990, or 2000 census tract boundaries to the most recent 2010 boundaries. These data were combined to create a measure of population change for each census tract in St. Louis from 1970 to 2015. In addition, the 2015 ACS was used to obtain estimates for the number of African American residents, the number of individuals living below the poverty line, and the median age of housing.[3] Descriptive statistics for these measures can be found in Table 2.

Mapping and analyses

Initial maps and spatial analyses were conducted using ArcGIS 10.3.1 (ESRI, 2014). The vacant parcel list was joined to a full list of city parcels. This was used to calculate square meters covered by vacant parcels, which was then aggregated to each city block and divided by the block's total area. The result

was a value between 0 and 1 representing the proportion of each blocks area that was vacant (see Table 2). These data were analyzed using the Getis-Ord Gi* (Getis & Ord, 1992) statistic to identify clusters of lower than average values (coldspots) and higher than average values (hotspots).

The parcel map was also unioned with a fishnet of 1-km^2 grids. These provided a spatially stable unit of analysis that, though divorced from lived neighborhood boundaries, gave us a predictable number of neighbors. This feature of the data is statistically preferable to irregularly shaped polygons for spatial statistics (Maimaitijiang et al., 2015).[4] Unioning the parcel data with the grid data produced subdivided parcels that straddled two or more grid squares. Individual parcels or portions of parcels were then aggregated to the grid square to produce a measure of the total volume of vacant land in square kilometers (see Table 2). These same grid squares were used to interpolate the demographic data from 2010 census tract boundaries. Demographic characteristics were estimated for each grid square based on census tract(s) they intersected, proportional to the size of the intersections.

Once the grid squares were matched with both the primary dependent variable (vacant square kilometers) as well as demographic control variables, regression estimates were produced using GeoDaSpace 1.0 (Anselin & Rey, 2014), a statistical application for estimating spatial regression models. Initial ordinary least squares (OLS) models were fit to identify aspatial patterns in our data. The presence of heteroskedasticity, which is a common feature in aggregated spatial data (Baltagi, 2001), was confirmed using both visual plots and Breusch-Pagan tests. White standard errors were used to produce more conservative standard errors and p values for these OLS models. Given the presence of heteroskedastic errors as well as spatial clustering in both the dependent variable (see Figure 3) and the OLS residuals (see Table 2), we used a general method of moments (GMM) spatial error model to account for both the spatial autocorrelation and heteroskedasticity in our data (Anselin & Rey, 2014).[5] Testing revealed that these models were robust to alternate specifications with different combinations of variables measuring historical data.

Results

Vacant property in St. Louis

As we noted above, our data set of vacant properties contains two estimates for the number of vacant parcels (those that are either vacant lots or have vacant buildings). The estimates range from n = 33,073 parcels in the low estimate to n = 48,836 parcels in the high estimate out of a total of 128,644 parcels. These estimates are substantially higher than other studies, but comparisons are difficult because these studies did not publish any methodology and because they took place before the full effects of the 2008 recession and the resulting housing crisis had set in. Our more holistic approach to identifying vacancy and the detrimental effects of the recession in St. Louis could each plausibly explain these differences in the estimates.

Two trends are visible in our tabulations of vacant parcels in Table 3. The first is that the city of St. Louis's land banks own a sizeable minority of the parcels (approximately 36% in the low estimate and 24% in the high estimate). This finding has ramifications for both the current policy solutions, which are strictly aimed at these publicly owned properties. These properties are also heavily residential, with the residentially zoned properties making up approximately 76% of properties in the low estimate and 79% in the high estimate. These findings reflect the impact of St. Louis's demographic shrinkage and highlight the need for a housing-centric approach to stabilizing communities in the city.

Vacancy and St. Louis's urban prairie

When these estimates are mapped (see Figure 4), both the low and high estimates show a pronounced increase in vacancy on the north side of the city. The southern beginning of the uptick

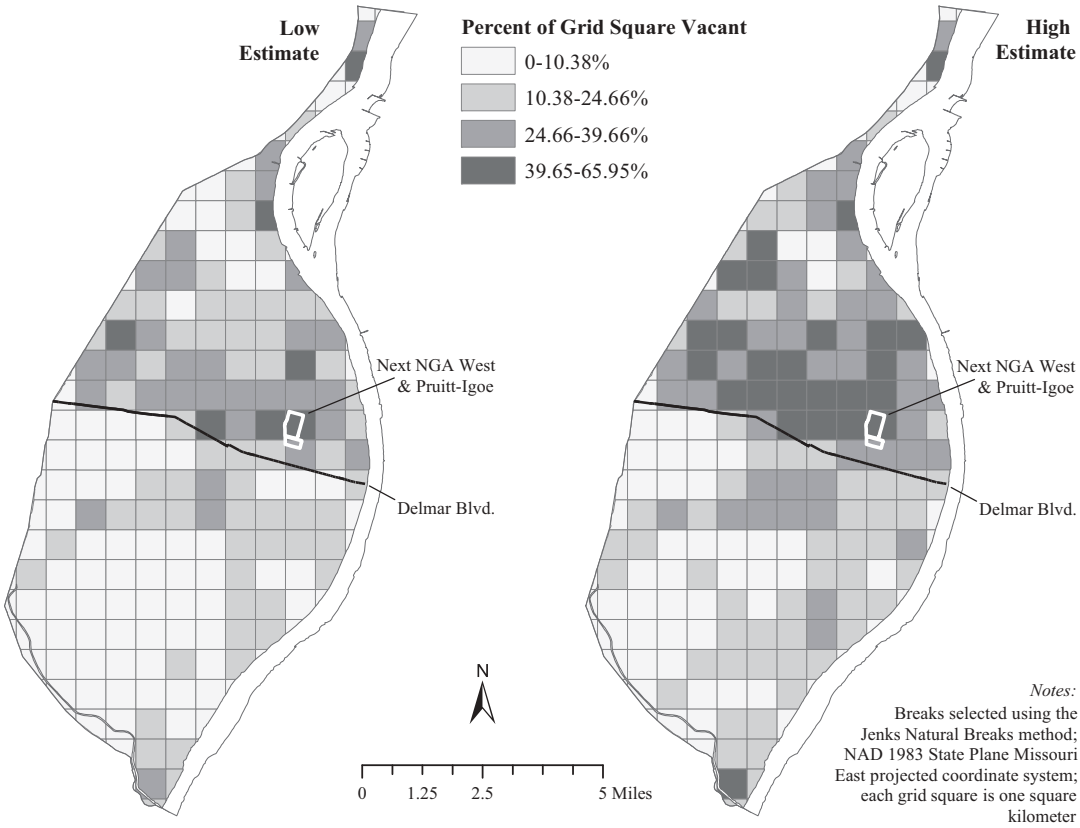

Figure 3. Number of square kilometers per grid square estimated to be vacant.

roughly follows what locals know as the "Delmar Divide" (Gordon, 2013), the path that Delmar Boulevard cuts across St. Louis from its western border with St. Louis County to the downtown core of the city. Delmar serves as a de facto border between heavily African American northern St. Louis (see Figure 2 for a map of African American residential patterns) and the wealthier, more diverse remainder of the city. North of Delmar, vacancy increases dramatically with little respite.

South of Delmar, there are several notable patterns in both maps. There is a relatively narrow band of vacancy that remains distinct from the widespread abandonment in North City but stretches from the southwest corner of St. Louis across to the southern edges of the Downtown neighborhood (see Figure 2 for Downtown's location). There are also several clusters of concentrated vacancy in the southeast area of the city around the neighborhoods of Gravois Park and Dutchtown (see Figure 2 again for the locations of these neighborhoods). Finally, both maps show concentrated vacancy at the very southern tip of the city. These patterns, particularly those in the southeast parts of St. Louis, are more pronounced in the high estimate than in the low estimate. What is notable, however, is that the basic contours of the geography of vacancy remain stable regardless of the definition.

Figure 5 shows both the hot- and coldspots for the two competing estimates of vacancy, calculated using the Getis-Ord Gi* statistics described above. Like the maps above showing the percentage of vacant lots throughout the city, both the low and high estimates appear to be substantively similar. The major departure between the two estimates comes in the Gravois Park area along the southeast side of the city. The statistically significant hotspot in the high data does not appear in the low spot.

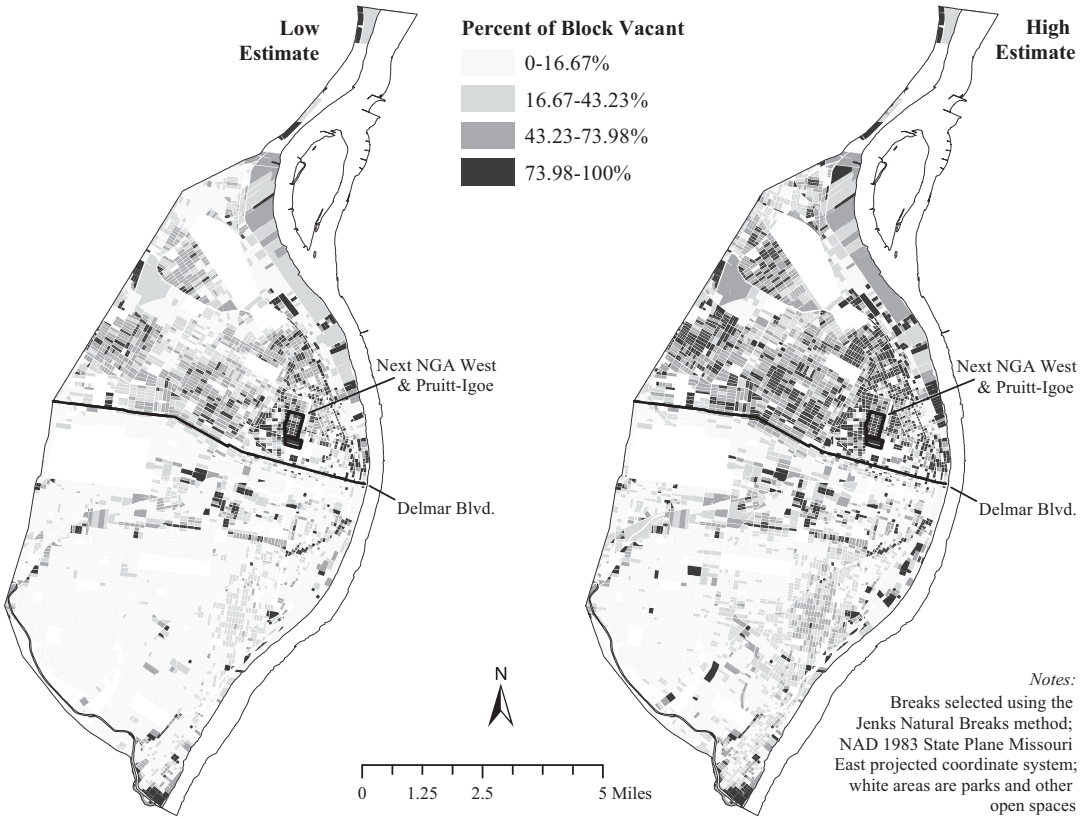

Figure 4. Proportion of each block's land area estimated to be vacant.

Both Figures 4 and 5 visualize the idea of urban prairie. Indeed, the core thrust of these data is not just that St. Louis has a sizeable quantity of vacant land but that it is concentrated in particular regions within the city. By using spatial statistics, we are able to demonstrate the degree of clustering in a robust manner that extends what has been a largely qualitative description of disorder. These maps highlight the zones within St. Louis where nature is indeed reasserting itself and where one can find entire blocks like the 1800 block of Laflin Street described at the beginning. These are prairie-like both literally, in the sense that they are often dominated by overgrown lots, and figuratively, in the sense that they are depopulated but not unpopulated swaths of the city. We suggest here that urban prairies are in fact spatially rooted elements of a city's physical and social geography and that clustering of prairie areas should be a constituent element of their definition.

Demographic factors associated with urban prairie

To understand what demographic factors may be associated with higher densities of urban prairie, we fit both OLS and GMM regression models using a dependent variable that aggregated vacant parcels up to 1-km grid squares (see Figure 3). The regression findings (see Table 4) underscore several important points. The first is that, concurrent with past studies (e.g., Silverman et al., 2013), poverty rates and median age of structure are initially significant in both of the OLS models (1a and 2a). However, models 1b and 2b illustrate that population change from 1970 to 2015 accounts for the effects of poverty and structure age on vacancy. The proportion of African American residents, however, remains associated with the amount of

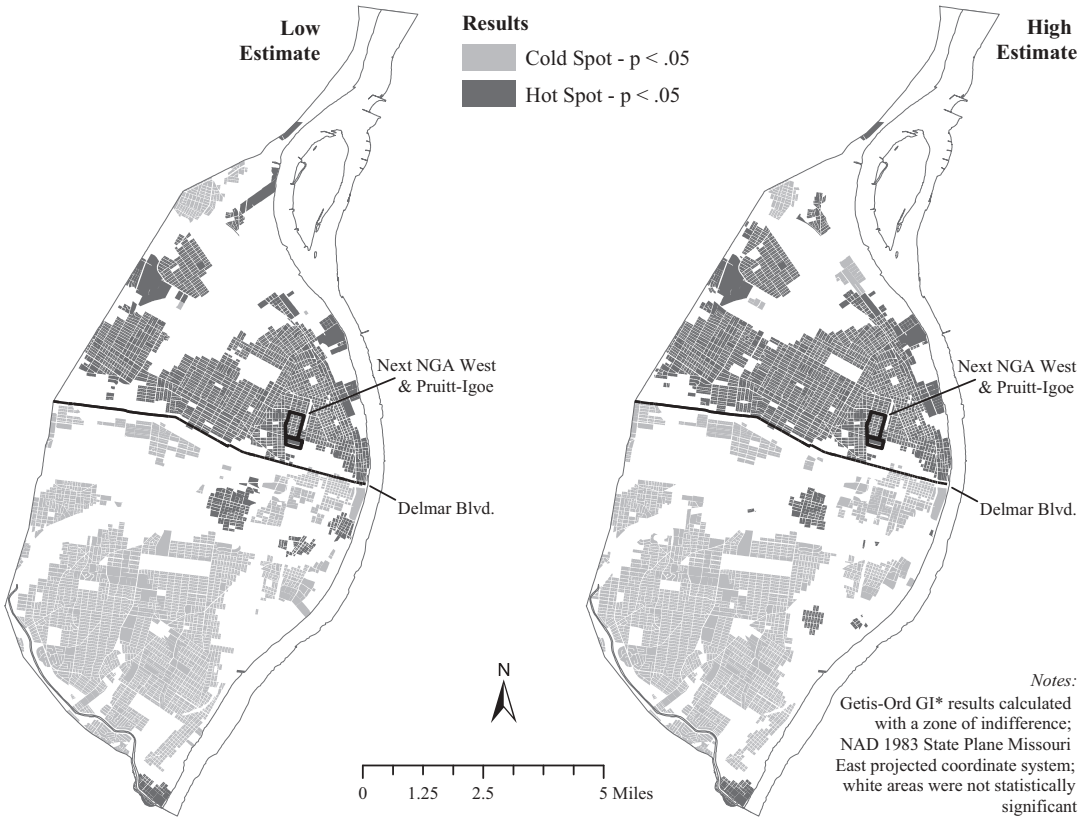

Figure 5. Getis-Ord GI* cluster analysis land area estimated to be vacant per block.

vacant land per grid square. Given the range of the dependent variables in both models (see Table 2), these variables represent not just a statistically significant effect but one that explains a substantial amount of the variation in vacant land per grid square.

One source of bias in OLS models of spatial data is the presence of errors that are spatially clustered, known as spatial autocorrelation. The third models for the low and high estimates (1c and 2c) explicitly try to account for the effect of spatial autocorrelation on our results. The degree of spatial autocorrelation is accounted for the in the lambda coefficient in each model. In both cases, spatial autocorrelation is moderate and accounting for it does yield slight improvements in the models fit. Additionally, the GMM model gives further assurance that the results obtained are not biased by heteroskedasticity, because GMM models are robust to variations in the distribution of the residuals (Anselin & Rey, 2014).

When we account for these various factors, two trends stand out. A positive unit change in population is associated with a 0.23-km^2 reduction in urban prairie ($p < .001$) in the low estimate and a 0.26-km^2 reduction ($p < .001$) in the high estimate. A unit change in the proportion of African American residents is associated with a 0.11-km^2 increase in urban prairie ($p < .01$) in the low estimate and a 0.15-km^2 increase ($p < .01$) in the high estimate. In other words, decreasing population and increasing proportions of African American residents are both associated with increased vacancy. The insignificant relationships between vacancy, poverty, and the median age of physical structures suggests that the story of St. Louis's urban prairie is more situated in the legacies of racism, segregation, and White flight than in explanations rooted in social class. The stability of the findings between the low and high estimates and the robust

Table 4. Demographic associations with vacant square kilometers per grid square.

	Low estimates			High estimates		
Variable	Model 1a (OLS)	Model 1b (OLS)	Model 1c (GMM)	Model 2a (OLS)	Model 2b (OLS)	Model 2c (GMM)
Below poverty line	0.183 (0.082)*	0.058 (0.072)	0.040 (0.085)	0.261 (0.106)*	0.120 (0.097)	0.104 (0.114)
African American	0.148 (0.031) ***	0.105 (0.029) ***	0.111 (0.040)**	0.190 (0.040) ***	0.140 (0.038) ***	0.146 (0.052)**
Median structure age	0.003 (0.001)*	−0.000 (0.001)	0.001 (0.001)	0.005 (0.001) ***	0.002 (0.001)	0.003 (0.002)
Population change	—	−0.256 (0.046) ***	−0.232 (0.056) ***	—	−0.289 (0.057) ***	−0.256 (0.070) ***
Lambda[a]	—	—	0.395 (0.127)**	—	—	0.402 (0.114) ***
Constant	−0.186 (0.086)*	−0.052 (0.082)	−0.125 (0.110)	−0.370 (0.109) ***	−0.219 (0.103)*	−0.283 (0.139) *
F -statistic[b]	29.803***	37.848***	—	33.358***	37.510***	—
Adjusted R^2	0.288	0.408	0.415[c]	0.312	0.406	0.414[c]
Akaike information criterion[b]	−360.857	−399.615	—	−264.495	−294.946	—
Log likelihood[b]	184.428	204.808	—	136.247	152.473	—
Breusch-Pagan test[b]	40.661***	40.766***	—	32.875***	27.276***	—
Moran's *I*	0.309***	0.195***	0.227***	0.308***	0.216***	0.226***

Note. [a]Lambda's coefficient represents the degree to which spatial errors are correlated.
[b]GMM models do not produce classical estimates for model fit like those associated with OLS models.
[c]The adjusted R^2 values for the GMM models are pseudo R^2 measures that do not measure decomposition of variance like classical R^2 values. Following Anselin and Rey (2014), they should be interpreted only as ad hoc measures of fit.
*$p < .05$. **$p < .01$. ***$p < .001$.

nature of the model give us confidence in the conclusion that population shrinkage as well as racial residential segregation are major correlates of the incidence of vacancy in St. Louis.

Discussion

The depth of vacancy we have estimated, even under the low estimate's more conservative parameters, is important not only for researchers but also for planners and policymakers in St. Louis, who ultimately must work to confront an issue that we have found to be more widespread than previously thought. Our analysis leads us to three key characterizations of urban prairie in St. Louis: (a) it is largely constituted by privately held, residential properties, and (b) it is spatially concentrated in neighborhoods that (c) have high proportions of African American residents and that have been dramatically affected by population loss. These findings suggest to us that any possible solutions must contend explicitly with the legacy of race in the city, the residential character of many neighborhoods in North City, and the need for engagement with private landowners. The residential nature of these neighborhoods is an important reminder that urban prairies are not urban wildernesses, and policy interventions must therefore proceed cautiously with an eye toward racial and economic justice for existing residents (Hollander & Németh, 2011; Paddeu, 2017). Current approaches, we believe, do not offer such opportunities for residents. We outline this argument below before suggesting possible pathways forward and limitations to our work.

Current approaches to revitalizing the urban prairie

The imperatives noted above are counter to much of the current approach in St. Louis. The city's programs for addressing vacancy, like Mow to Own, the Garden Lease Program, and targeted demolitions, are focused on publicly owned properties. Their impact is therefore limited, at best, to approximately a third of the prairie parcels in the city that are owned by the LRA and the LCRA. More generally, these programs do little to address the underlying processes identified by our

regression models, including population loss and the disproportionate burden of vacancy born by African American neighborhoods. Indeed, given the large racial wealth gap in the United States (Darity & Nicholson, 2005) and the sheer volume of vacant parcels in North City, residents of these neighborhoods may be least well positioned to take on the added cost of acquiring surrounding property from the city's land banks.

Attracting new investment into the urban prairie is one additional solution being pursued. Neighborhoods in the city's core, running south of Delmar and north of Interstate 44, have indeed experienced marked turnabout in their residential populations, housing quality, and institutional investment (Monti & Burghoff, 2012; Swanstrom et al., 2015). Replicating that success north of Delmar Boulevard could have a large impact on those neighborhoods, and the city has touted the Next NGA West project as the beginning of just such a change. Indeed, there are even hopes for revitalizing the Pruitt-Igoe site as part of this multi-billion-dollar investment that will build a new home for the Department of Defense's National Geospatial-Intelligence Agency (NGA; see City of St. Louis, 2017). The city has obtained title on nearly 550 parcels in the heart of northern St. Louis's urban prairie for this project, 61 of which were occupied when the city purchased them (a figure that speaks to the depths of vacancy in northern St. Louis; see City of St. Louis, 2017). Given the large-scale impact of this project, we have labeled it on each of the maps included with this article.

Though the Next NGA West project will bring development and relocate jobs to North City, the project has not been without conflict: demolitions have proceeded despite the fact that a small number of these properties required eminent domain lawsuits for the city to obtain ownership, and residents have been frustrated both with the process and the dollar amounts offered for properties (Altman, 2016; Devine, 2016). These frustrations speak to the challenges presented by a growth-focused mindset for confronting urban prairie. Erstwhile attempts to repurpose land for an economically functional use has left residents out of a process that ultimately dismantles a residential neighborhood in favor of a physically and socially isolated institution whose ties to the wider community may be minimal.

New directions for managing the urban prairie

Given our assessment that current policies are inadequate, we feel the need to suggest several possibilities for more actively managing urban spaces like northern St. Louis. Social policies, like redlining and deed covenants, have contributed to both the growth of urban prairies by reinforcing segregation and racial divisions that have existed in Missouri since St. Louis's establishment. Moreover, developments like Next NGA West risk displacing residents from surrounding neighborhoods if these projects result in additional residential development. Establishing a series of community land trusts (CLTs; Bourassa, 2006) may be one way to encourage equitable development that supports sustainable population growth around new developments like Next NGA West. Likewise, CLTs that have racial and economic justice as core operating principles can also be part of addressing much longer term disparities in St. Louis.

The protections offered by CLTs to keep rents and purchase prices low could be utilized to limit further displacement of residents and ensure that housing access is preserved for low- and moderate-income residents (Bourassa, 2006). CLTs provide a means to engage with private property owners and are explicitly focused on residential stability, two characteristics that our analysis of St. Louis's existing urban prairie suggests as important. By engaging existing community members, CLTs can increase opportunities for local control over development as well. If implemented carefully, CLTs could benefit existing residents with stable means for homeownership and wealth development while also providing development opportunities to attract new residents to northern St. Louis. Though partnering with the defense industry can be politically contentious, the coming presence of the Department of Defense as part of the Next NGA West development, if implemented alongside CLTs, could provide further opportunities, such as partnerships to provide accessible housing for Department of Defense employees, contractors, and veterans.

Despite the potential of equitable housing, it is also necessary to acknowledge that there may be real limits to the overall possibilities for growth in St. Louis. The long-term prospects, for example, for returning to the population level present in the 1950s seem minimal. Though CLTs may offer means for targeted, equitable growth, growth does not have to be the only outcome. One approach, as part of a broader smart decline plan, is to strategically use demolitions as a means to embrace the concentration of prairie land and increase the biodiversity of the city itself. For example, existing prairie lands contribute to increased concentrations of bees despite current declines in bee populations as a whole (Burr, Schaeg, Muñiz, Camilo, & Hall, 2016; Hall et al., 2017), with particularly high concentrations noted in northern St. Louis (Chen, 2016). Though the Metropolitan Sewer District is actively conducting demolitions of this sort, its mission is only concerned with publicly owned properties, limiting how intentional the current policy can be. Urban agriculture at scale could present another, alternative ecologically grounded approach (Colasanti, Hamm, & Litjens, 2012), though the benefits of agriculture projects for residents remain unclear (Draus, Roddy, & McDuffie, 2014). Once again, the challenge here is putting together large enough areas of public and private land to make agriculture financially sustainable.

Each of these four possibilities for large-scale, top-down development in the form of Next NGA West, ground-up land trusts, the entrenchment of prairie land, or urban agriculture raises a final challenge for redevelopment on the urban prairie. They each force the question of "whom is the development for?" and present a variety of different answers. Without consciously articulating this up front (Draus et al., 2014) and without acknowledging the need to bring deeply rooted structural change to neighborhoods (Paddeu, 2017), each may fail in the long term to reverse the unintended expansion of prairie lands in St. Louis.

Limitations

As with any study, there are several important caveats to make about the data we present. We produced two estimates because the quality of bulk administrative data is often less than ideal. Following O'Brien and colleagues (2015), we suggest that there are both strengths and weaknesses to utilizing administrative data and that models based on administrative data should be viewed in that context. One strength of these data is that they are able to create a more holistic picture of vacancy. However, data quality may introduce considerable noise into estimates (O'Brien et al., 2015). The similarity of the spatial statistical results for both cluster analyses and the spatial regressions leave us to conclude that, though there is considerable variability in the raw count of parcels, both estimates capture similar underlying mechanisms associated with vacancy in St. Louis.

A second caveat to note is that our use of spatial interpolation to create grid-level demographic measures also means that our demographic data should be treated as estimates as well, particularly because they already were drawn from a sample (the American Community Survey) that has a margin of error associated with it (for discussions on the strengths and limitations of the ACS, see Nesse & Rahe, 2015). Again, though this is certainly not ideal, the benefits of a stable number of neighborhoods and equally sized aerial units makes this a sacrifice worth tolerating for our analyses.

Conclusion

Driven by a dramatic shrinkage in population since 1950, neighborhoods in St. Louis have seen widespread expansion of what we term *urban prairie*: concentrated constellations of vacant buildings and vacant lots. Such stretches, like the 1800 block of Laflin Street that we described at the outset, are particularly prevalent in northern St. Louis, an area long affected by segregation, disinvestment, and deindustrialization. It is no surprise, then, that population loss and the proportion of African American residents are significantly associated with the number of square kilometers of prairie land in St. Louis. The city's current plans, like Mow to Own and individual parcel sales through the LRA are unlikely to

have a significant impact given that they can only impact the number of publicly owned vacant parcels, which constitute between a quarter and a third of vacant land. For this reason, we encourage stakeholders in St. Louis to explore a diverse set of smart decline strategies that embrace opportunities for more equitable housing and increased biodiversity that expansive urban prairie lands may provide.

Notes

1. These codes included Debris-Vacant Bldg, Missed Cut-VacantBldg, Unsatisfy Cut-VBldg, VACANT BLDG INITIV, VACANT BLDG INITIV, Vacant Unit Appeal, Vacant Bldg Unsecured, Weeds-Vacant Bldg, WTR-Vacant-BLDG, Building Collapse, Debris-Vacant Lot, Missed Cut-V Lot, Unsatisfy Cut-VLot, Weeds-Vacant Lot.
2. Data and other materials related to this project can be found at https://chris-prener.github.io/vacancy.
3. Other data, including on median house value, median rent, and median income, were also obtained and tested in initial analyses. However, the home value data were missing from a number of tracts for both the 2015 ACS and the 2010 Decennial Census and could therefore not be used. Including median income and median rent in our analyses introduced a high degree of multicollinearity with both the number of African American residents and the number of individuals living below the poverty line. Median income and median rent were therefore not included in our final models. Additional historical variables, including the racial composition and median income of neighborhoods in 1970, did not provide any improvements in model fit and were not included.
4. A predictable number of neighbors is important for spatial weighting, which is a key aspect of calculating spatial statistics. Spatial weights are typically based on either distance or, in our case, the number of shared features between two polygons. Because each polygon is a square, we can rely on it having three or four neighbors with shared sides.
5. A key aspect of GMM regression models is that they relax one of the key assumptions of OLS regression: that errors are equally variable throughout the model. In many spatial regression applications, heteroskedasticity is introduced when data are aggregated from specific points at a given latitude and longitude to a polygon that summarizes points across a given space. GMM models are therefore useful not only because they can compensate for spatial autocorrelation but also because they can be used on data where heteroskedasticity is a concern.

About the authors

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