THE GROWTH AND SHIFTING SPATIAL DISTRIBUTION OF TENT ENCAMPMENTS IN OAKLAND, CALIFORNIA

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ABSTRACT

Tent encampments have become an especially common form of homelessness in West Coast cities like Oakland, California, where the number of people living in tent encampments increased by 130 percent between 2017 and 2019. Relative to other experiences of homelessness, tent encampments provide residents both potential benefits and risks that depend on their location, size, and stability. Using novel data collected from Google Street Views, I document the growth and spatial dynamics of tent encampments in West and Central Oakland over the last decade. The number and size of tent encampments rapidly increased between 2014 and 2019, varying widely in their stability. City interventions like the city’s outdoor transitional housing sites displaced several large tent encampments. Combined with overall tent encampment growth, these displacements dispersed tent encampments throughout both nearby neighborhoods and other parts of the city.

Keywords: homelessness, tent encampments, spatial dynamics, displacement

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INTRODUCTION

The growth of tent encampments for people experiencing homelessness has been starkly visible in recent years. Also called “tent cities” or “curbside communities,” tent encampments are collections of tents or other non-permanent dwelling structures (e.g., sheds, trailers). Relative to other forms of homelessness, like sheltered or street homelessness, public and political consternation about how to address encampments in public spaces has been especially strong. Encampments have become particularly common in West Coast cities like the San Francisco Bay Area, Seattle, Washington, and Sacramento, California, as have tensions around their presence.

Tent encampments offer a mix of benefits and risks for residents (see Cohen, Yetvin, and Khadduri 2019; Loftus-Farren 2011 for reviews). Tent encampments can form internal communities that offer residents stability, security, and autonomy (Sparks 2016). However, encampments also carry risks, including health risks and potential displacement due to “sweeps” by local governments. Many of the benefits and risks of encampment residence are structured by local governments’ reactions, which often reflect the wishes of housed residents and local businesses (Darrah-Okike et al. 2018; Herring 2014; Speer 2017; Wasserman and Clair 2010).

Given the importance of encampments’ stability for their residents’ well-being, this article empirically examines the spatial dynamics of tent encampments in Oakland, California, over the last decade. Unsheltered homelessness has rapidly increased in Oakland in recent years, and tent encampments were the most common unsheltered living arrangement in 2019 (ASR 2019). The City of Oakland has responded to tent encampments in varied ways, including encampment sweeps and new, high-profile outdoor temporary shelter sites. Oakland could be a useful case for understanding tent encampments in other cities with rising housing costs and economic inequality.
I examine the location, number, size, and stability of tent encampments in Oakland using data collected from Google Street Views, images of city streets and public areas captured by Google between 2008 and 2019. My analysis of the resulting panel data on tent encampments connects to two of this volume’s themes. First, I document trajectories of homelessness in tent encampments within and between neighborhoods. Second, I describe how these trajectories changed following interventions by the City of Oakland.

The number, size, and geographic spread of tent encampments in Oakland grew profoundly between 2014 and 2019. I identify distinct encampment concentrations and describe their neighborhoods contexts. Each concentration became the site of a transitional housing program that displaced several large encampments. The distribution of encampments notably changed both within and between neighborhoods following these displacements, increasing the spatial dispersion of encampments throughout the city. I conclude by discussing strategies to mitigate encampment displacement.

BACKGROUND & MOTIVATION

Homelessness in Oakland, California

The growth of homelessness in Oakland is difficult to overstate. In the point-in-time (PIT) counts—locally conducted biennial censuses of literal homelessness—unsheltered homelessness increased 69 percent between 2017 and 2019. Oakland’s per-capita rate of unsheltered homelessness, 7.4 per thousand, was 11.5 times higher than the national rate in 2019 (ASR 2019; Henry et al. 2019). Strikingly, tent encampments increased 130 percent between 2017 and 2019. Tent encampments were most common form homelessness in Oakland in 2019, including about one-third of people experiencing homelessness (ASR 2019).
Both nationally and in Oakland, unsheltered homelessness is disproportionately common among adult men, People of Color, and LGBTQ+ people (ASR 2019; Henry et al. 2019). Oakland’s racial disparity in unsheltered homelessness is particularly profound. African Americans comprised 70 percent of those experiencing homelessness in Oakland compared to 24 percent of Oakland’s total population in 2019 (ASR 2019).

Many organizations, advocates, and people experiencing homelessness argue an affordable housing shortage is the primary factor driving this growth in homelessness (ASR 2019; Brown et al. 2018; Jones et al. 2015), consistent with past research (Lee et al. 2010; Shinn and Khadduri 2020). In 2018, 44 percent of Bay Area renters paid more than 30 percent of their pre-tax incomes on rent, and 24 percent paid more than half of their incomes (JCHS 2019).

Similar to patterns of gentrification in other places (Hwang 2015), housing costs increased alongside rising economic inequality, arguably displacing many low-income, long-term Oakland residents.

Some advocates also emphasize institutional racism, including histories of redlining and targeted subprime lending, as contributing to both racial disparities in homelessness and the concentration of tent encampments in historically Black neighborhoods in West and East Oakland (Lin et al. 2018). Past research similarly demonstrates the institutional and cumulative nature of racial inequality in access to stable housing (Shinn and Khadduri 2020).

Though these trends are particularly pronounced in Oakland, they are common to many cities in the United States. Oakland can be a useful case for understanding the relationships between tent encampments, neighborhood change, and city interventions.

*Background on Tent Encampments*
Tent encampments have a long history in the United States and exist in or near many urban areas across the country (Cohen et al. 2019; Herring 2014; NCH 2010). Though encampments exist across the country, they are most prominent in areas with high housing costs and limited shelter capacities (Loftus-Farren 2011), like West Coast cities (Herring 2014). Favorable climates may also facilitate encampments, but no studies have firmly established this association. Within cities, encampments often form in relatively secluded places, like near train tracks or in industrial areas. Encampments also frequently form in public parks or near shelters or other service agencies (Gowan 2010; Wasserman and Clair 2010). These spaces offer encampment residents privacy and/or access to essential services, like food assistance.

Tent encampments offer unique benefits relative to other experiences of homelessness. Relief from carrying everything one owns at all times clearly enables working and obtaining services. Many people experiencing homelessness find shelters unappealing (Gowan 2010; Jones et al. 2015; Speer 2017; Wasserman and Clair 2010). The top reasons given for not using shelters in Oakland included “lack of privacy,” “concerns for personal safety,” “bugs,” “too crowded,” and “too many rules” (ASR 2019). In contrast, tent encampments can form internal communities that offer residents stability, social connections, and self-determination (Sparks 2016).

Tent encampments can also expose residents to health and displacement risks, which are structured by local governments’ responses. A recent special report from the United Nations cited Oakland and San Francisco as examples of “cruel and inhuman treatment” for “[a]ttempting to discourage residents from remaining in informal settlements or encampments by denying access to water, sanitation and health services and other basic necessities” (UN 2018, 12). These conditions became especially worrisome in the coronavirus pandemic.
Local governments frequently displace tent encampments from public space in response to traditionally housed residents and local businesses (Cohen et al. 2019). These “sweeps” disrupt encampments’ internal communities, depriving vulnerable people of social support and stability (Loftus-Farren 2011; NCH 2010; Wasserman and Clair 2010). Sweeps often destroy encampment residents’ identification, medications, and clothing. These possessions can be costly to replace, and their loss inhibits working or obtaining services. Those experiencing sweeps have described them as demoralizing and dehumanizing, alienating them from the local government and service agencies (Darrah-Okike et al. 2018; Gowan 2010; Herring 2019; Jones et al. 2015). In short, the negative consequences of encampment sweeps, or even their looming threat, compound residents’ existing hardships.

A strong public backlash against tent encampments in the Bay Area has been evident through news reports, public polling, and complaints to city services (Herring 2019; Jones et al. 2015). Tent encampments more visibly and durably occupy public space than people otherwise experiencing homelessness on the streets or in vehicles, capturing traditionally housed people’s scrutiny (Darrah-Okike et al. 2018; Wasserman and Clair 2010). In a recent poll of Bay Area voters, only 33 percent responded that “homeless people have the right to live in public places like parks and sidewalks if there isn’t enough housing to shelter them” (Kendall 2020). These negative perceptions influence governments’ responses to tent encampments (Herring 2014), undermining tent encampments’ benefits and exacerbating their risks.

_Interventions by the Oakland City Government_

The City of Oakland’s responses to tent encampments have varied. Like many other cities, Oakland has conducted many encampment sweeps following complaints from local housed residents or businesses (Dougherty 2019; Jones et al. 2015; Lin et al. 2018; Tyska 2020).
The precise number of sweeps is difficult to disentangle from interventions like trash pick-up or cleaning, but mostly complete public records between January 2016 and December 2019 show 1,638 work orders for tent encampment actions by the department of public works.¹

Many encampment residents relocated to existing or new encampments nearby following sweeps (Dougherty 2019; Jones et al. 2015), similar to patterns in other cities (Herring 2014; Wasserman and Clair 2010). These new encampments may encounter the same public resistance, subjecting encampment residents to future displacements. The city has partnered with local organizations to provide transitional housing options or other services when clearing some large encampments (Tyska 2020), but it is unclear how many people have received these services.

The city has provided sanitation and other human or social services to some encampments. Public records reported 25 encampments receiving sanitation services (“portapotties,” wash stations) in May 2019.² Encampment residents and advocates have argued these services have been inconsistent or inadequate in many locations (Lin et al. 2018), however. Many encampments receiving these services were also later cleared by the city.

One of Oakland’s most substantial interventions has been a series of outdoor temporary housing sites called “Community Cabins.” Between December 2017 and early 2020, the city established seven sites with outdoor sheds converted into two-person “tiny houses” on land leased or owned by the city, housing up to 38 people at a time. Operating costs have been around one million dollars per site per year, funded by the city government, the state, and private donors (Boyd 2019). The Community Cabins provide temporary shelter while people experiencing

homelessness search for permanent housing in coordination with service providers. The sites also offer assistance with job searches, help obtaining identification or other documents, and mental health or addiction counseling.

City officials have described the Community Cabins as successful (Boyd 2019). As of June 2019, the Community Cabins cumulatively housed 344 people, with 67 percent of exiting residents moving into transitional or permanent housing.³ Oakland Mayor Libby Schaaf argued that the Community Cabins also address key barriers to shelter use, “the ‘4 P’s’: Partners, Pets, Privacy, and Possessions” (KPIX 5 2020). Mayor Schaaf also highlighted the relatively low cost of the initiative relative to other types of shelters and services.

People experiencing homelessness, advocates, and news reports have raised concerns about the long-term success of the program, arguing that some transitions into permanent housing are short-lived (Ravani 2019). The Community Cabins have also been criticized by people experiencing homelessness for their six-month residency limit and “prison-like conditions” (Lin et al. 2018, 15). Perhaps most limiting, the Community Cabins have low capacities relative to the unhoused population in Oakland. The Community Cabin sites also displaced many large tent encampments, accompanied by ongoing “camping bans” in their immediate vicinities. The number of displaced encampment residents exceeded the capacity of the Community Cabins at all locations—in one location by about 166 percent.⁴ The Community Cabins may be effective for participants, but many more tent encampment residents may have experienced undesirable instability instead.

**Motivation & Research Aims**

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This article first documents the number, size, and stability of tent encampments in Oakland over the last decade. These results complement prior qualitative research on specific encampments or encampment residents over a shorter period (Cohen et al. 2019). Second, the article examines the encampments’ spatial dynamics in Oakland. I document how these spatial dynamics relate to neighborhood contexts and how they changed within and between neighborhoods with Community Cabin sites. Motivated by the importance of these spatial dynamics for encampment residents’ well-being, the results will hopefully inform policy makers, advocates, and organizations working with encampment residents.

DATA

*Study Area—West and Central Oakland*

This study collected data on tent encampments observed between 2008 and 2019 in 22 Census tracts in West and Central (Uptown and Downtown) Oakland. Online Appendix A summarizes average neighborhood characteristics, measured using Census tracts in the American Community Survey (Manson et al. 2019), and maps the study area. Typical neighborhoods in Oakland exhibited many changes associated with gentrification in recent years: population growth; rising average income and education; increasing median rents and decreasing vacancy rates; and declining proportions of African Americans. These changes are more pronounced in the study area than in the city overall (Table A1 in online Appendix A).

West and Central Oakland included a substantial fraction of Oakland’s unsheltered homelessness in recent PIT counts (ASR 2019) but with considerable internal variation. The study area also includes three Community Cabin sites established at different times.

*Google Street Views*
I coded Google Street View images to measure the number, size, and location of tent encampments in Oakland between 2008 and 2019. Google repeatedly sends vehicles with 360-degree cameras to photograph public streets. These images are viewable through Google Maps, including the history of images for each location dated with month and year. I manually viewed and coded these images to identify visible tent encampments over time.

To the author’s knowledge, Google Street Views have not previously been used to examine urban tent encampments. However, Google Street Views have been used to measure visual indicators of gentrification (Hwang 2015) and validated with in-person assessments (Marco et al. 2017). This strategy may not be viable in areas with infrequent Street Views, like rural areas, or areas with obstructed visibility, like the wooded Oakland hills. However, Google Street Views were regularly collected with clear visibility throughout the study area.

The Google Street View data may miss some tent encampments. Encampments would be missed in locations not visible in Street Views, but very few locations were not visible in the study area. Tent encampments formed and cleared between Google Street Views would also be missed. Online Appendix A further describes these challenges. Given these limitations, I interpret the observed numbers of encampments and tents as a lower-bound for the true numbers.

Although PIT count data cover a much larger area, they cannot provide panel data on individual encampments in Oakland. Alameda County PIT counts started measuring tent residence in 2017 and have not measured precise encampment locations. These limitations are common to other areas that similarly do not record encampment locations (e.g., Seattle) or do not report tents/encampments at all (e.g., Sacramento).

Data collection required definitions for tents and encampments. A “tent” included any actual tent or make-shift structure that could serve as a person’s shelter. An “encampment” was a
collection of tents separated by less than a couple hundred feet. For example, tents across the street from each other or around the perimeter of the same public park would be coded as the same encampment. I only counted recreational vehicles (RVs) as part of encampments when tents were also present. A single tent without others nearby was also counted as an encampment (results were similar when defining encampments as at least two tents, presented in online Appendix B). Online Appendix A gives visual examples and further describes these coding rules.

I describe a location continuously observed with tents and RVs over time as the same encampment. However, these data cannot identify individual encampment residents or reliably follow individual tents. The data measure changes in the spatial distribution of encampments over time, but they cannot directly observe encampment residents’ migration between locations.

The labor-intensive nature of this data collection is a major challenge. Examining the entire history of Street Views for all city blocks, often including 15 or more images per block, would be prohibitively time consuming even for the 22 Census tracts in the study area. Instead, I targeted data collection at locations previously reported to have tent encampments using several sources (further described in online Appendix A). First, I mapped requests for city services classified under “homeless encampment” in publicly available 311 service data (over 10,000 service requests between 2009 and 2020, but not all actually identified encampments). Second, I verified that this map included known tent encampments from additional sources: local news; Oakland public records listing the tent encampments cleared, cleaned, or otherwise serviced by the city; and first-hand observations from volunteering with homeless service providers and regularly travelling through Oakland.

I viewed all Street View images for all 311 service request locations and coded data for locations where a tent is visible at any time point. I counted the number of tents and RVs in each
Street View, including if none were present. For example, a location where a tent was only visible in one 2019 Street View would be coded with one tent in that observation and zero tents in all others. These data identify the time points for which that location did and did not have a tent encampment. This coding yielded a panel data set with 1,287 observations of 88 locations between 2008 and 2019. Tents appeared in 421 of these observations.

A key assumption is that tent encampments never appeared at locations not identified by the map of 311 service requests. As an additional check, I viewed and coded all Street View images for every block in two Census tracts near Downtown Oakland. These 1,898 Street View images did not reveal any tent encampments missed by targeted data collection.

Finally, the analysis below required some adjustment for Street Views’ irregular or staggered timing between locations. I created a harmonized set of 14 time periods based on the overall distribution of Street Views by month and year. To avoid distorting aggregate time trends, I adjusted for missing observations by linearly interpolating the numbers of tents and RVs using preceding and subsequent observations. These adjusted data include 1,195 observations of 88 areas in 14 time periods (20 percent interpolated, further described in Online Appendix A). Results were similar using the unadjusted data, presented in online Appendix B.

**TRENDS IN THE NUMBER, SIZE, AND STABILITY OF TENT ENCAMPMENTS**

The study’s data capture the entire growth of tent encampments in West and Central Oakland, shown in Figure 1a. The number of tent encampments increased almost linearly after late 2011, peaking at 50 encampments in early 2019. The total number of tents and RVs counted increased starkly over time. I counted 397 tents and RVs in West in Central Oakland in 2019.
(Figure 1b). Excluding RVs, I counted 321 tents in 2019 (grey line in Figure 1b). Online Appendix B presents alternative trend estimates, all demonstrating similar growth.

Encampments also grew in size over time, shown in Figure 2. The average encampment in 2019 included eight tents and RVs (Figure 2a). The first encampment with more than 20 tents and RVs appeared in 2017 (Figure 2b). By 2019, large encampments (at least 20 tents and RVs) included the majority of tents and RVs in the study area.

I assessed encampments’ stability over time with encampment spells, consecutive Street View observations with visible tents at the same location. The length of an encampment spell—the amount of time between the first and last consecutive Street View photo with visible tents—is a lower bound for how long a tent encampment existed in a location without an observed interruption. To maximize available detail, I measured encampment spells using the full set of

Figure 1. Trends in (a) the number of encampments and (b) the total number of tents and RVs counted in West and Central Oakland using Google Street View images. Note: Markers indicate counts from each harmonized time period. Missing values for encampment locations were linearly interpolated using earlier and later observations. The grey line in Figure 1b excludes RVs.
Street View observations. Table 1 shows the number of encampment spells by length, separating those with and without observed endings (i.e., ongoing spells in the most recent Street View).

**Figure 2.** Trend in encampment size measured with the number of tents and RVs per encampment in West and Central Oakland using Google Street View images. Note: Markers indicate counts from each harmonized time period. Missing values for encampment locations were linearly interpolated using earlier and later observations.

**Table 1.** Number of encampment spells by length and whether ending is observed.

<table>
<thead>
<tr>
<th>Length of Spell</th>
<th>Number of Encampments with Observed End</th>
<th>Number of Encampments without Observed End</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single observation</td>
<td>35</td>
<td>18</td>
</tr>
<tr>
<td>Less than one year</td>
<td>25</td>
<td>12</td>
</tr>
<tr>
<td>One to less than two years</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Two to less than three years</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Three to less than four years</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Four or more years</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>78</strong></td>
<td><strong>55</strong></td>
</tr>
</tbody>
</table>

*Note: An encampment spell is a set of consecutive Street View observations with visible tents at the same location. The length of a spell is the time between the first and last Street View photo in the spell. Number of Street Views = 1,287.*

Encampment spells varied considerably in length, but most were short. More than three-quarters of encampment spells with an observed ending were shorter than one year. More than half of encampments still observed in the most recent Street View (without observed end)
formed less than one year prior. Some spells were relatively long, however; one-fifth of all encampment spells lasted at least two years. These large differences in encampment stability suggest similar variation in the consequences for encampment residents.

Encampment sweeps likely contributed to short spells. Sweeps were difficulty to fully identify in public records, but more than one-third of encampments observed for less than one year (ending between 2016 and 2018) were formally closed or had unspecified public works orders near their end. Encampments may also have been displaced by private security or harassment by local residents, as in other cities (Gowan 2010; Wasserman and Clair 2010).

Encampment spell beginnings were most common following other encampment spell endings. In the adjusted data with harmonized time periods, the number of encampment spell beginnings was strongly positively correlated (r=0.79) with encampment spell endings in the previous period. Repeated encampment spells in the same locations were also common. About one-third of encampment spells were in locations with a previous encampment spell.

In summary, the number of tent encampments in West and Central Oakland rapidly increased in the last decade. Tent encampments also became much larger with time, and the majority of tents and RVs were part of large encampments by 2019. Finally, encampment stability varied substantially. Although several ongoing encampments as of 2019 have remained in place for multiple years, the majority of tent encampments lasted less than one year.

SPATIAL DISTRIBUTION OF TENT ENCAMPMENTS AND CITY INTERVENTIONS

The spatial distribution of tent encampments in Oakland changed alongside their growth in number and size. Figure 3 visualizes the spatial distribution of tent encampments over time with kernel density maps. Similar to topographic or heat maps, darker areas represent a greater
spatial concentration of tents and RVs in the study area. Rather than pinpointing specific
encampments, kernel density maps help illustrate the areas where tent encampments were most
commonly located. The maps also include census tract boundaries and major highways (I-80, I-
580, I-880, and I-980). The dashed ovals indicate the three areas with encampment
concentrations that I describe below in greater depth: Downtown, Uptown, and West Oakland.

![Density maps of tent encampments West and Central Oakland, 2014–2019.](image)

**Figure 3.** Density maps of tent encampments West and Central Oakland, 2014–2019.
Notes: Darker colors represent a greater number of tents and RVs in tent encampments, smoothed with kernel
density estimates. Thin black lines mark census tract boundaries for the study area. Thick black lines mark major
highways. Dashed circles identify encampment areas described in the text.

The three periods in Figure 3 represent distinct points in the trajectory of encampment
growth. Tent encampments started growing by early 2014. Early 2019 was the most recent
period in the data and the encampment peak. Late 2016 was roughly halfway between these
periods. Encampment growth is plainly visible with the progressively darker shades in later
maps. The geographic area with concentrations of tent encampments also expanded over time.

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5 Advocates for homelessness have argued that maps pinpointing tent encampments unnecessarily expose vulnerable
populations.
The spatial distribution of tent encampments is correlated with many features of urban space, as described in prior research (Cohen et al. 2019). These characteristics mattered in combination, however. Table C1 in online Appendix C presents neighborhood characteristics for each of the three emphasized areas in Figure 3. The Uptown and Downtown encampment concentrations, commonly in highway underpasses and near large homeless service organizations, were located in Census tracts with very low median incomes (both below $32,000 in 2010). Both the West Oakland and Uptown encampment areas showed signs of gentrification: increasing median rents, median incomes, education, and fractions of White residents; and decreasing fractions of residents of color. The Downtown area showed few signs of gentrification but is a largely commercial area with a persistently disadvantaged population. The West Oakland area had high median income (almost $87,000 in 2010), but its large minimally populated industrial and commercial areas included many encampments.

Neighborhood characteristics also mattered at larger geographic scale. The study area had high levels of unsheltered homelessness relative to most other parts of Oakland (ASR 2019). The study area also had a higher fraction of Black residents and lower median incomes than the rest of the city in 2010, followed by stronger signs of gentrification and displacement (Table A1 in online Appendix A).

The spatial distribution of tent encampments notably changed within and between neighborhoods following establishment of Community Cabin sites in all three encampment areas highlighted in Figure 3. The first Community Cabin site opened in the Downtown area in December 2017, a pilot location that closed after one year when the city’s lease for the land ended. The second Community Cabin site opened in the Uptown area in May 2018. The fifth and sixth Community Cabin sites opened as a double site in the West Oakland area in July 2019,
after the most recently available Google Street View photos. Figure 4 presents the total number of tents and RVs within each of these areas over time; hollow markers indicate observations after Community Cabin sites opened.

![Figure 4](image.png)

**Figure 4.** Trends in the number of tents and RVs in tent encampments in each encampment area. Note: Markers indicate counts from each harmonized time period. Missing values for encampment locations were linearly interpolated using earlier and later observations. Hollow markers and dashed lines represent observations after the establishment of a nearby cabin community by the City of Oakland.

The Downtown and Uptown areas had very similar trajectories in the numbers of encampments and tents prior to the Community Cabin site in the Downtown area. In 2017, each area contained 55 tents and seven encampments. The majority of the tents in the Downtown area were in a cluster of three encampments in highway underpasses, all within a few blocks of a large homeless shelter and service organization. When the city cleared these encampments to establish the first Community Cabin site, the number of tents in the Downtown area subsequently declined. Growth in other neighborhoods continued or accelerated, suggesting the Community Cabin site shifted encampments from Downtown to other neighborhoods.

The number of tents in the Downtown area only partially declined because tents shifted within the neighborhood after the Community Cabin site opened. Two nearby encampments increased by about a dozen tents each in early 2018, and a new encampment with almost a dozen
tents formed. Although these data cannot directly measure migration by individual encampment residents, the spatial distribution of tent encampments changed both within Downtown and between neighborhoods after the establishment of the Community Cabin site.

The spatial dynamics of tent encampments in the Uptown area were similar following the opening of the second Community Cabin site about six months after the first. The Community Cabins cleared a cluster of three nearby encampments in highway underpasses, which contained 52 of the area’s 89 tents in early 2018. Public records show the city counted 101 residents of these and nearby encampments relative to the 38-person capacity of the Community Cabins. After the Community Cabin site opened, the number of tents in the Uptown area declined by about 30 percent. However, two pre-existing encampments in the area increased slightly in size and two new encampments formed nearby, suggesting within-neighborhood shuffling.

While the number of tents in the Uptown area declined between 2018 and 2019, the total number of tents in the overall study area continued to increase. Much of this increase occurred north of the Uptown area. In 2017, the Downtown and Uptown areas contained about two-fifths of tents and RVs in the study area. After the two Community Cabin sites opened, this fraction declined to about one-quarter. Encampments’ spatial dispersion throughout the study area thus increased following these Community Cabin openings.

West Oakland was the last of the three areas to have a Community Cabin site, despite a larger and earlier growth of tent encampments than the Downtown or Uptown areas. In 2019, the vast majority of the area’s tents and RVs were in three large encampments in out-of-the-way areas: an empty parcel between a highway and industrial area, an access road behind a large retail area, and a nearby highway underpass. The West Oakland area also received fewer 311 service requests than the Downtown or Uptown areas in the two years prior to the start of the
Community Cabin program, despite the West Oakland area being geographically larger. The relative seclusion of these encampments may account for West Oakland being the last the last Community Cabin site in the study area.

The double Community Cabin site in West Oakland opened after the most recently available Google Street Views, but I visited the sites for the three large encampments in March 2020. Two of the three large encampments had been cleared. Only the large encampment in the empty parcel between a highway and industrial area remained. The two cleared encampments included at least 50 tents and RVs in 2019. Public records show the city identified 85 encampment residents near Community Cabin site relative to its 78-person capacity.\textsuperscript{vi} Future data from Google Street Views could more fully assess whether tent encampments spread to nearby areas following this intervention, similar to the patterns in Uptown and Downtown.

In summary, tent encampments in the study area formed in distinct concentrations, commonly in highway underpasses, industrial areas, and low-income and/or gentrifying neighborhoods. The geographic area covered by tent encampments expanded as they increased in number and size. Finally, the spatial distribution of tent encampments changed both within and between neighborhoods following the establishment of the Community Cabin sites. After the Community Cabin sites displaced several large tent encampments, encampments dispersed more widely throughout the city.

**CONCLUSION**

Tent encampments have become an increasingly common and strikingly visible form of homelessness in recent years, particularly in cities with rapidly rising housing costs. By coding data from Google Street Views over time, this study documented this growth of encampments in
Oakland, California, over the last decade. The systematic spatial data reinforced conclusions from previous qualitative studies (Gowan 2010; Herring 2014; Wasserman and Clair 2010): encampments increased most in marginalized spaces like low-income neighborhoods, gentrifying neighborhoods, and sparsely populated industrial and commercial areas.

Tent encampments’ benefits, like autonomy and security, are contingent on their stability (Cohen et al. 2019; Loftus-Farren 2011). Sweeps by local governments can harm encampment residents beyond just the loss of these benefits (Darrah-Okike et al. 2018; Gowan 2010). This study found encampments’ stability varied widely in Oakland. Some were continuously in place for at least three years, but most were observed for less than one year. These differences in stability may translate into large differences in encampment residents’ well-being.

Finally, the study showed that the stability and spatial distribution of tent encampments substantially changed following Oakland’s Community Cabins intervention. As the city established these outdoor temporary housing sites, it also displaced clusters of large tent encampments. The Community Cabin sites’ capacities were often well below the number of displaced encampment residents. Nearby encampments grew or new encampments formed following these interventions. The number of tents in nearby neighborhoods also increased.

City public records indicate some success for the Community Cabin program in moving former encampment residents into traditional housing, at least in the short term. An evaluation of the Community Cabin program’s effectiveness is beyond the scope of this study. However, the results suggest the Community Cabins’ encampment displacements spatially disrupted many encampment residents outside of the program. These data cannot directly measure migration of individual encampment residents, but the patterns are consistent with prior reports that those displaced by encampment sweeps often relocate nearby (Dougherty 2019; Herring 2019; Jones et
The program may have also increased the spread of tent encampments throughout the city, potentially stoking stronger resistance from traditionally housed residents in areas with newly formed encampments.

Hopefully these findings can inform strategies for supporting encampment residents’ stability, alongside efforts to transition out of homelessness. For example, future Community Cabin sites could prioritize spatial stability for existing encampment residents when selecting locations. The spatial disruption documented in this study might not have occurred if Community Cabin sites had operated adjacent to at least some existing encampments, rather than displacing them. However, encampment removal was a key selling point of the Community Cabin program for the traditionally housed community.

The study findings also systematically documented the growth of encampments in the neighborhoods adjacent to the Community Cabin sites following the encampment displacements. In addition to services for residents, the Community Cabins could devote resources for increased outreach or other service provision (e.g., sanitation, food assistance) for displaced encampment residents in the surrounding area.

Resident-led camps could be a more inclusive and spatially stable alternative to the Community Cabins, like the recent Tiny House Village for young adults experiencing homelessness in Oakland (Du Sault 2020). The Housing & Dignity Project, a collaboration of community-based organizations and people experiencing homelessness in Oakland, advocates for sanctioned camps on public or donated land with water and sanitation access, self-governance, individually tailored services, and protection from eviction (Lin et al. 2018). Similar to sites in Seattle and Fresno, California (NCH 2010; Sparks 2016), Oakland’s city government could provide public land, sanitation, and funding for ‘tiny home’ structures and social services.
Proactive collaboration with local businesses and community groups could reduce resistance from nearby housed residents (e.g., Elhalaby 2019).

Finally, this study provides an example of systematically collected spatial data to complement prior research on tent encampments. Despite notable exceptions, research specifically on tent encampments has been less voluminous than research on other forms of homelessness (Cohen et al. 2019). Prior studies have provided crucial understandings of encampment residents’ experiences and needs, generally via qualitative data on individual encampments or residents. This study instead provides a neighborhood-level perspective on the spatial dynamics of tent encampments. Its data uniquely offer geographic specificity while covering the entire period of encampment growth in Oakland. These methods are exportable to any area with repeated Google Street View images over time (most likely large cities in wealthier countries). Though data collection for even one city is laborious a single researcher, teams of researchers could collaboratively collect data for several cities. Using the resulting multi-city panel data, these teams could examine the neighborhood- and city-level characteristics shaping the dynamics of tent encampments around the country or world.

REFERENCES


Jones, Justin Patrick, Khalia Parish, Peter Radu, Taylor Smiley, and Jenny van der Heyde. 2015. A place to be: alternatives to unsanctioned homeless encampments. Berkeley, CA: Goldman School of Public Policy. Available from gspp.berkeley.edu
Kendall, Marisa. 8 March 2020. When it comes to the homeless, the Bay Area’s compassion has a limit. The East Bay Times.
KPIX 5. 28 January 2020. Oakland opens 7th Cabin Community to house unsheltered in Chinatown. KPIX 5 CBS SF Bay Area.
Manson, Steven, Jonathan Schroeder, David Van Riper, and Steven Ruggles. 2019. *IPUMS National Historical Geographic Information System: Version 14.0 [Database]*. Minneapolis, MN: IPUMS.


Appendix A. Detailed Data Description

Study Area—West and Central Oakland

This study collects data on tent encampments over time in Oakland, California. The study area includes 22 Census tracts in the areas of West and Central (Uptown, Downtown, and Temescal) Oakland. These areas merit focus because they include a substantial fraction of unsheltered homelessness from recent point-in-time (PIT) counts (Applied Survey Research 2019), but still provide considerable variation between neighborhoods. Tent encampments in these areas have attracted significant news coverage and have been the focus of many of the city’s policy interventions, including the Community Cabins.

Figure A1. Map of Oakland, California, with Census tract boundaries. The darkly shaded tracts are the areas examined in this study (West and Central Oakland).
I measure neighborhood characteristics at the census-tract level using data from pooled waves of the American Community Survey (ACS) (Manson et al. 2019). The pooled 2008–12 waves estimate tract characteristics in 2010 and the pooled 2014–2018 estimate tract characteristics in 2016. Key characteristics include:

- **population**: total tract population, population/square mile of land area
- **socioeconomic composition**: median household income in 2018 dollars, percent of adults (at least 25 years-old) with a bachelor’s degree
- **housing characteristics**: % of housing units that are single-family detached houses, homeownership rate, median monthly gross rent in 2018 dollars, housing vacancy rate
- **demographic composition**: % of households that are families with children; racial/ethnic composition

Typical neighborhoods in Oakland exhibited many changes associated with gentrification, and these changes are even more pronounced in the study area. Table A1 presents average tract-level characteristics for the whole city and the study area in 2010, as well as the average change in tract-level characteristics between 2010 and 2016. Compared to the city overall, tracts in the study area had notably lower populations, median incomes, fractions of single-family detached houses, homeownership rates, median rents, fractions of family households, and fractions of Black residents in 2010. Overtime, tracts in the study area had larger changes in population, median income, percentages of adults with college degrees, and percentages of White and Black residents.

Of course, inclusion of data for a larger portion of the city and adjacent cities would provide a more complete picture of the spatial dynamics of tent encampments. For example, tent encampment residents could systematically migrate from the study area to other parts of Oakland or the nearby cities of Berkeley and Emeryville. There could also be flows in the opposite direction. Both shifts would be unobserved in this study. However, past research has indicated that many encampment residents tend to stay in the same neighborhoods, even after being displaced by an encampment sweep. I have also observed this in my volunteer experience working with tent encampment residents displaced by fires.
Table A1. Means and (standard deviations) for Census tract characteristics in Oakland and the study area.

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>Change, 2016-2010</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Oakland</td>
<td>Study Area</td>
</tr>
<tr>
<td>Tract Population</td>
<td>3,974.28</td>
<td>2,888.84</td>
</tr>
<tr>
<td></td>
<td>(1256.15)</td>
<td>(1206.90)</td>
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<tr>
<td>Population/Square Mile</td>
<td>13,775.58</td>
<td>11,381.12</td>
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<tr>
<td></td>
<td>(7,909.07)</td>
<td>(4,410.09)</td>
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<td>Median Income ($1,000s)</td>
<td>68.47</td>
<td>42.94</td>
</tr>
<tr>
<td></td>
<td>(43.31)</td>
<td>(22.63)</td>
</tr>
<tr>
<td>% College (over age 25)</td>
<td>35.72</td>
<td>30.38</td>
</tr>
<tr>
<td></td>
<td>(25.49)</td>
<td>(14.03)</td>
</tr>
<tr>
<td>% Single-Family House</td>
<td>47.95</td>
<td>20.31</td>
</tr>
<tr>
<td></td>
<td>(26.96)</td>
<td>(14.34)</td>
</tr>
<tr>
<td>% Homeowners</td>
<td>42.82</td>
<td>22.90</td>
</tr>
<tr>
<td></td>
<td>(24.10)</td>
<td>(11.48)</td>
</tr>
<tr>
<td>Median Rent</td>
<td>1,365.35</td>
<td>1,065.74</td>
</tr>
<tr>
<td></td>
<td>(378.98)</td>
<td>(330.97)</td>
</tr>
<tr>
<td>% Vacant Units</td>
<td>10.23</td>
<td>13.73</td>
</tr>
<tr>
<td></td>
<td>(5.08)</td>
<td>(7.30)</td>
</tr>
<tr>
<td>% Family Household</td>
<td>57.33</td>
<td>42.86</td>
</tr>
<tr>
<td></td>
<td>(16.33)</td>
<td>(11.52)</td>
</tr>
<tr>
<td>% White</td>
<td>26.96</td>
<td>22.25</td>
</tr>
<tr>
<td></td>
<td>(23.73)</td>
<td>(14.60)</td>
</tr>
<tr>
<td>% Black</td>
<td>26.48</td>
<td>40.86</td>
</tr>
<tr>
<td></td>
<td>(16.49)</td>
<td>(19.04)</td>
</tr>
<tr>
<td>% Latino/a</td>
<td>25.00</td>
<td>14.47</td>
</tr>
<tr>
<td></td>
<td>(19.81)</td>
<td>(9.45)</td>
</tr>
<tr>
<td>% Asian/PI</td>
<td>17.11</td>
<td>18.55</td>
</tr>
<tr>
<td></td>
<td>(13.47)</td>
<td>(19.08)</td>
</tr>
<tr>
<td>Number of Tracts</td>
<td>116</td>
<td>22</td>
</tr>
</tbody>
</table>


Overview of Google Street Views

To measure the number, size, and location of tent encampments in Oakland, I coded Google Street View images. Google has repeatedly sent vehicles with 360-degree cameras throughout many parts of the world to photograph public streets. These images are viewable through Google Maps, which for many areas includes the history of all images ever taken dated.
with month and year. I manually viewed and coded this history of images for a large part of the city of Oakland to measure the location and number of tents and RVs/trailers over time. This coding yielded a panel data set with 421 observations of tent encampments between 2008 and 2019. The data also include 866 observations of these same locations without tents.

The resulting data have unique strengths relative to the biennial PIT count of homelessness in Alameda county, which includes Oakland. The PIT count in Alameda county has not consistently distinguished tent encampments from other forms of unsheltered homeless over time. The PIT data also do not provide geographic specificity beyond aggregate tract-level counts, preventing identification of distinct encampments and their sizes.

There is precedent for using Street View images for systematically measuring urban characteristics. Hwang (2015) used Street View images to measure visual characteristics of gentrification, like housing conditions, new construction, and signs of disorder like graffiti (also see Hwang and Sampson 2014). Data collected from Street Views have also been validated using in-person assessments of neighborhood disorder (Marco et al. 2017). To the author’s knowledge, Google Street View images have not previously been used to examine urban tent encampments, nor have the histories of images been used to create panel data.

**Targeted Data Collection**

Examining the entire history of Street Views, typically including around 15 images per location, for all city blocks would be prohibitively labor intensive. To make data collection feasible, I selectively coded Street View images for locations previously reported to have tent encampments in West and Central Oakland. Similarly, Hwang (2015) randomly sampled blocks of Chicago and Seattle that past research identified as gentrifying or adjacent to gentrifying areas.

To target my data collection, I used the City of Oakland’s publicly available 311 service data to map geo-located requests coded as “homeless encampment.” Between July 2009 and January 2020, the city applied the “homeless encampment” code to over 10,000 requests. I combined nearby requests into single locations (within 300ft) and overlaid these locations onto a Google Map of Oakland. I then viewed the entire history of Street View images for every location identified by the 311 service requests. The 311 service requests covered an extensive portion of the area of Oakland under examination. For example, one typical Census tract (4015)
had 311 requests near 25 out of 38 intersections. I coded all images in locations for which a tent is ever visible, including images without any tents. For example, I coded data for all 15 Street Views for a location where a tent was only visible in one 2019 Street View. These data identify the time points for which that location did and did not have a tent encampment. However, I did not code images for locations in which a tent is never visible. In total, I coded information from 1,288 Street View photos for the main data set but viewed many thousands more. These data were collected from 88 locations (mean 14.6 photos per location), and the average spacing between photos was 8.9 months.

Google Street Views sometimes did not capture out-of-the-way locations where tent encampments may be likely to form, like train tracks or alleys. I was often able to overcome this limitation by using Street Views from nearby locations, like highway overpasses that overlook the area of interest. In a few instances, I supplemented Google Street Views with satellite images from Google Earth. Ultimately, very few locations on the map of 311 requests were not in some way visible using these strategies.

A key limitation is that these data may have missed tent encampments that formed and dispersed between Google Street Views. As described below, Google collected Street View images irregularly. Observations were frequent in some years, every one to three months, but many areas were not observed once in other years. The vast majority of 311 request locations do not have visible tents in any of the Street Views. For example, I observed only three tent encampment locations out of the 25 merged 311 request locations in tract 4015. Any tent encampments at the remaining 311 request locations may have existing during the gaps between these Street Views.

Upon examination, however, many 311 service requests coded with “homeless encampment” do not refer to tents or other shelters. I read the text of many publicly available requests submitted through the city’s online 311 platform, and several referred to illegal dumping of possessions (mattresses or furniture), shopping carts, or the presence of RVs and trailers rather than tents. These characteristics, as well as people sitting or lying on the street, were visible instead of tents in the Street Views for many 311 request locations. Although it is likely that the data miss some small encampments that do not remain in place for long, the extent of any such bias is likely much smaller than a surface-level comparison with 311 requests would suggest.
A key assumption for this data collection strategy is that locations that never received 311 service requests also never had tent encampments. I check this assumption in two ways. First, I checked that the map of 311 requests included known tent encampments from several additional sources: local news coverage (the *East Bay Times*, the *East Bay Express*, *KQED* public radio, and the *San Francisco Chronicle*); Oakland public records listing the tent encampments closed, cleaned, or otherwise serviced by the city; and my own knowledge and observations from volunteering with homeless service providers in Oakland and regularly travelling through Oakland. These additional sources did not reveal any potential encampment locations not included in the map of 311 requests.

Second, I exhaustively viewed and coded all Street View images from the center of each block for two Census tracts in Central Oakland for comparison. Exhaustive coding for these two tracts included 1,898 Street View images and did not reveal any tent encampments that were missed by the map of 311 requests. These additional checks bolster my confidence that areas without 311 requests likely have not been sites for tent encampments.

Even still, some unknown number of tent encampments are likely missed by these data. I suspect most of the unobserved encampments were established and dispersed between Google Street Views. Given their relatively short duration, these encampments were likely smaller than the ones that are captured in the data. A very small number of 311 request locations were not visible in Google Street Views, but compared to the gaps between photos, these unobservable locations were likely a relatively small source of under-coverage. Given these limitations, I interpret the observed number of encampments and tents as a lower-bound estimate of the true number.

*Measuring Encampments*

Each observation in the data represents a time point for a location that ever has a tent encampment. For each location and time point, I panned around all 360 degrees of the Street View. I also viewed many locations from multiple angles, like industrial areas or large parks that may have obstructed visibility from a single angle. Large encampments that span multiple blocks had to be viewed from multiple locations to fully measure. For densely built areas, I also selected Street Views that could see places like alleys. Each data point may thus be based on several Street Views for the same location.
The presence of a tent was the key criterion for coding a location as an encampment. I defined an encampment as any collection of nearby tents. I also coded a single tent with no others nearby as an encampment. As described below, I included RVs as part of encampments when also in the presence of tents. I generally defined “nearby” as collections of tents separated by less than a couple hundred feet. For example, tents across the street from each other or on either end of the same block face would be coded as the same encampment. Note that I did not limit total encampment size to a radius of a couple hundred feet—many encampments in the data span multiple blocks where all tents are within a couple hundred feet of at least one other tent. However, I made some exceptions for situations where tents were along the perimeter of the same park but two clumps might be separated by more than a couple hundred feet, for example.

The key measure from each Street View photo was the count of visible tents and RVs/trailers. There was some unavoidable subjectivity in these counts because tent encampments frequently included many make-shift structures or coverings that served the same function as tents. However, these apparent tents may have simply contained piles of belongings. In these data, a “tent” included any actual tent or make-shift structure that could serve as a person’s shelter. I counted large tents or structures that could shelter multiple people as a single tent but adjacent tents or distinct make-shift structures as separate tents. However, I did not count make-shift structures or coverings that appeared to contain belongings rather than people, indicated by small size or apparent shapes representing belongings underneath (e.g., the corners of a box or the outline of a shopping cart). Figure A2 illustrates these scenarios.

Though subjective, I based these judgements on personal and volunteer experience in many tent encampments, including the Alameda County PIT count. There is certainly still some measurement error due to the actual ambiguity of some make-shift coverings and/or the photo quality of the Street Views. However, it is not clear that this measurement error would systematically bias the counts either up or down.
a) Four distinct tents

b) Make-shift shelters counted as two “tents” (the background tarps are a construction site)

c) Covered pile of belongings not counted as a “tent.”

Figure A2. Examples of different scenarios counted or not counted as “tents” in Google Street Views.

Another key measure was the presence of RVs. In Oakland’s 2019 PIT count, RVs were the second most common location after tents for people experiencing unsheltered homeless. Including RVs in measures of tent encampments is debatable for two reasons. Substantively, RVs likely do not provoke the same contestation of public space as tents. Though parked in
public space, the interior of the RV remains private space. Moreover, RVs are ostensibly mobile, and thus may not be interpreted as a durable claim to space. Methodologically, occupied and unoccupied RVs were generally indistinguishable in Google Street Views. Nevertheless, RVs are a common form of homelessness and present in many encampments throughout the Bay Area. Figure A3 provides an example of RVs and tents integrated in the same encampment. I coded the number of RVs and trailers for each Street View as a separate variable from the count of tents. In the analysis, I only included RVs that were also present with tents as being part of encampments.

![Figure A3](image)

**Figure A3.** Example of RVs counted as part of a tent encampment in Google Street Views.

In summary, I coded encampments as collections of nearby tents and any adjacent RVs or trailers. However, RVs and trailers were not counted encampments in the absence of nearby tents. Encampments in the data were as small as a single tent, but many spanned multiple blocks.

*Harmonized Time Periods*

The timing of the images between locations was sometimes irregular or staggered by one or two months. I harmonized the timing of the images by grouping images based on the overall distribution of time points. For example, 95% of the locations examined were observed between April and June of 2011, which I collapsed into a single time period for mid-2011. However, eight of the locations were observed more than once during that period. To avoid duplicating locations, I retained only the observation within a harmonized time period that was closest to the average of
all observations within that time period. I also omitted time points for which extremely few locations had images (i.e., only five locations with images in 2009). This strategy unfortunately discarded 334 (26%) of the coded Street View images. As an alternative strategy, I averaged the number of tents observed for repeated observations of the same location within harmonized time periods. The results were very similar to those presented in the paper. Table A2 lists the harmonized time periods and numbers of locations observed within each time period.

Table A2. Harmonized time periods, number of locations observed, and number of locations with interpolated data.

<table>
<thead>
<tr>
<th>Harmonized Time Period</th>
<th>Months Included</th>
<th>Locations Observed</th>
<th>Locations Interpolated</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>April</td>
<td>63</td>
<td>0</td>
<td>63</td>
</tr>
<tr>
<td>mid 2011</td>
<td>April-June</td>
<td>84</td>
<td>2</td>
<td>86</td>
</tr>
<tr>
<td>late 2011</td>
<td>November-December</td>
<td>52</td>
<td>35</td>
<td>87</td>
</tr>
<tr>
<td>early 2014</td>
<td>January</td>
<td>60</td>
<td>27</td>
<td>87</td>
</tr>
<tr>
<td>mid/late 2014</td>
<td>July-October</td>
<td>56</td>
<td>32</td>
<td>88</td>
</tr>
<tr>
<td>early 2015</td>
<td>January-April</td>
<td>40</td>
<td>48</td>
<td>88</td>
</tr>
<tr>
<td>mid 2015</td>
<td>June-August</td>
<td>77</td>
<td>11</td>
<td>88</td>
</tr>
<tr>
<td>late 2015</td>
<td>September-December</td>
<td>74</td>
<td>14</td>
<td>88</td>
</tr>
<tr>
<td>early 2016</td>
<td>January-April</td>
<td>76</td>
<td>12</td>
<td>88</td>
</tr>
<tr>
<td>mid 2016</td>
<td>June-August</td>
<td>79</td>
<td>9</td>
<td>88</td>
</tr>
<tr>
<td>late 2016</td>
<td>September-December</td>
<td>79</td>
<td>9</td>
<td>88</td>
</tr>
<tr>
<td>2017</td>
<td>January-September</td>
<td>52</td>
<td>36</td>
<td>88</td>
</tr>
<tr>
<td>early 2018</td>
<td>January-April</td>
<td>78</td>
<td>6</td>
<td>84</td>
</tr>
<tr>
<td>2019</td>
<td>February-June</td>
<td>84</td>
<td>0</td>
<td>84</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>954</td>
<td>241</td>
<td>1,195</td>
</tr>
</tbody>
</table>

Notes: There are 88 total locations that ever have tent encampments. Observations include Street Views with and without visible tents.

Missing observations for some locations distort the estimated trends in the total number of encampments or tents. For example, the total number of encampments and tents counted in 2017 is artificially depressed because some large encampments were not photographed for Google Street Views in that period. I adjusted for these missing observations by linearly interpolating the numbers of tents and RVs using observations before and after the missing observation. The numbers of interpolated observations for each time period are given in Table A2.
Appendix B. Supplementary Results for Trends in the Number, Size, and Stability of Tent Encampments

Trends in the number of tent encampments and count of tents and RVs presented in Figure 1 of the paper are my preferred estimates because they adjust for the irregular and missing spacing of the Google Street Views. However, there are other reasonable ways to assess these trends. First, I plot all encampment observations from the unadjusted data in Figure B1. This scatter plot includes a point for each encampment observed in the Google Street Views. The time of the observation is on the x-axis and the number of tents and RVs counted at each encampment is on the y-axis.

**Figure B1.** Number of tents and RVs counted in each observed encampment by time in Google Street Views.

The patterns in Figure B1 are consistent with those shown in the main results. The number of encampments increased over time as indicated by the larger number of data points moving from left to right. The number and size of large encampments increased over time. No encampments included more than 20 tents and RVs until 2017, and none included more than 30 until 2018.
The patterns presented in Figure 1 of the paper are also similar without linearly interpolating missing observations, as shown in Figure B2. Hollow markers without connecting lines indicate time periods with fewer than two-thirds of locations observed. Naturally, these time periods have much lower counts of encampments and tents/RVs compared to the trend without high fractions of missing observations. However, both graphs show steep increase in the number of encampments and tents.

**Figure B2.** Trend in number of encampments and total number of tents and RVs counted using Google Street View images, excluding linearly interpolated values.

*Note: Hollow markers indicate time periods with observations of fewer than two-thirds of locations.*

The upward trend is still clearly apparent if I exclude single-tent encampments from the total encampment count. The 2019 PIT count in Alameda county defined encampments as the presence of two or more nearby tents. This trend is presented in Figure B3 along with the trend presented in Figure 1 of the paper for comparison.
Figure B3. Trend in number of encampments counted using Google Street View images with different definitions for the number of tents that constitute an encampment.
Appendix C. Supplementary Results for Spatial Distribution of Tent Encampments and City Interventions

Table C1. Tract characteristics for main tracts in each encampment area and average tract characteristics for the remainder of the study area.

<table>
<thead>
<tr>
<th></th>
<th>West Oakland (tract 4017)</th>
<th>Uptown (tract 4014)</th>
<th>Downtown (tract 4026)</th>
<th>Remainder of Study Area (averages for 19 tracts)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>2010</td>
<td>Change</td>
<td>2010</td>
<td>Change</td>
</tr>
<tr>
<td>Tract Population</td>
<td>2,928.0</td>
<td>74.0</td>
<td>4,113.0</td>
<td>218.0</td>
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<td>Population/Square Mile</td>
<td>1,317.2</td>
<td>33.3</td>
<td>14,049.8</td>
<td>744.7</td>
</tr>
<tr>
<td>Median Income ($1,000s)</td>
<td>86.9</td>
<td>10.5</td>
<td>31.2</td>
<td>8.1</td>
</tr>
<tr>
<td>% College (over age 25)</td>
<td>33.2</td>
<td>17.0</td>
<td>13.7</td>
<td>20.8</td>
</tr>
<tr>
<td>% Single-Family House</td>
<td>32.1</td>
<td>-8.0</td>
<td>18.9</td>
<td>10.2</td>
</tr>
<tr>
<td>% Homeowner</td>
<td>35.7</td>
<td>19.3</td>
<td>16.2</td>
<td>2.7</td>
</tr>
<tr>
<td>Median Rent</td>
<td>1,601.7</td>
<td>77.3</td>
<td>973.7</td>
<td>301.3</td>
</tr>
<tr>
<td>% Vacant</td>
<td>12.5</td>
<td>-4.2</td>
<td>23.3</td>
<td>-14.9</td>
</tr>
<tr>
<td>% Family Household</td>
<td>52.3</td>
<td>-6.7</td>
<td>53.8</td>
<td>-14.3</td>
</tr>
<tr>
<td>% White</td>
<td>16.2</td>
<td>17.9</td>
<td>13.0</td>
<td>10.9</td>
</tr>
<tr>
<td>% Black</td>
<td>29.9</td>
<td>-1.1</td>
<td>50.4</td>
<td>-17.5</td>
</tr>
<tr>
<td>% Latino</td>
<td>39.4</td>
<td>-15.1</td>
<td>19.9</td>
<td>0.0</td>
</tr>
<tr>
<td>% Asian/PI</td>
<td>11.4</td>
<td>-2.5</td>
<td>12.5</td>
<td>0.4</td>
</tr>
</tbody>
</table>