Mapping Rat Activity and Urban Vulnerability in Boston

An Analysis of 311 Data and Housing Indicators | 2016 - 2020

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Background

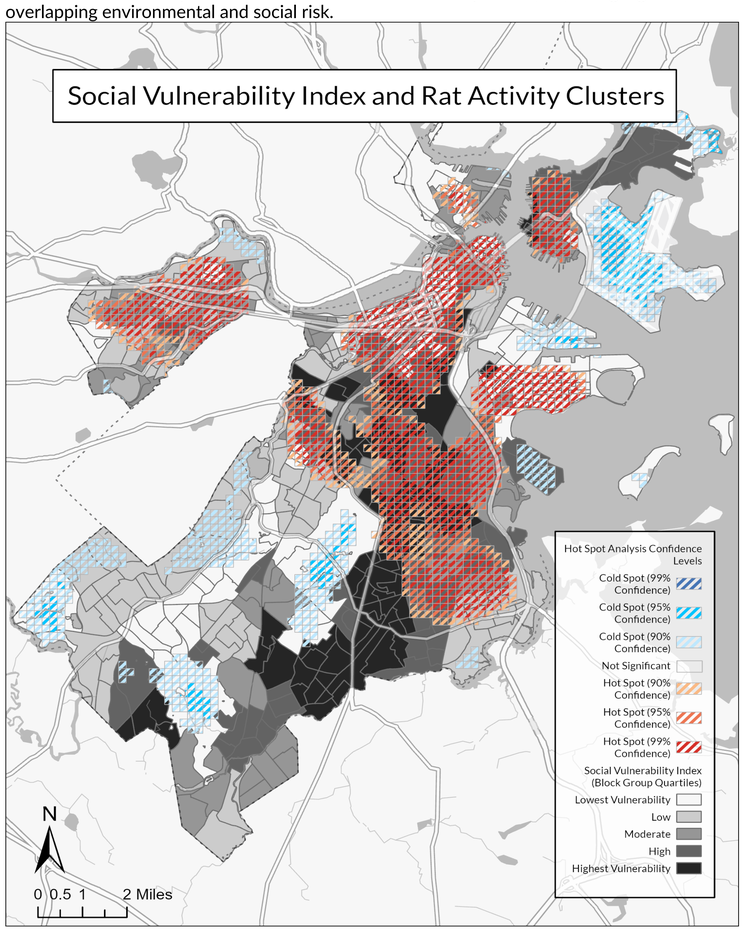
Urban rat infestations pose ongoing public health and environmental challenges in dense cities like Boston. Rat presence is linked to factors such as waste accumulation, aging infrastructure, and limited pest control access—conditions often concentrated in structurally disadvantaged neighborhoods.

Boston's 311 system provides a record of resident-reported rat activity, offering a valuable lens into where complaints occur and who may be most affected. This project uses GIS methods to examine spatial patterns of rat complaints and their relationship to housing and social vulnerability at the census block group level. By integrating 311 data with demographic and structural indicators from the American Community Survey and CDC's Social Vulnerability Index, we aim to identify areas of overlapping risk and inform targeted interventions.

Methods

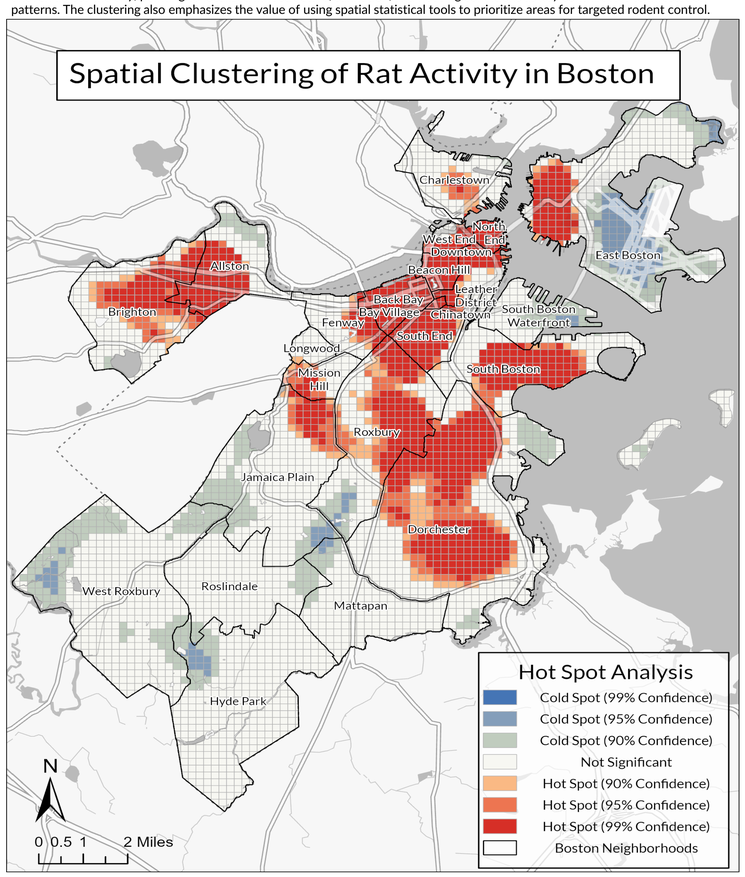
We compiled and analyzed data from multiple sources to examine the spatial distribution of rat complaints in Boston and their relationship to housing and social vulnerability. Boston 311 service request data (2011–2024) were cleaned and filtered in SAS to isolate rat-related calls, with a focus on the 2016–2020 period for spatial analysis. These complaints were geocoded and spatially joined to 2020 census block groups.

Demographic and housing data—including renter occupancy, housing density, and median household income—were drawn from the 2018–2020 American Community Survey. Rat complaint rates were calculated per 1,000 residents. Bivariate choropleth maps were created to visualize the relationship between rat activity and each structural factor. Optimized Hot Spot Analysis (OHSA) was conducted to identify statistically significant clusters of rat complaints. We also overlaid hot spots with the CDC Social Vulnerability Index (SVI) to highlight areas of overlapping environmental and social risk.



This map overlays rat complaint hot spots onto the CDC's **Social Vulnerability Index (SVI)** to explore how environmental and social risk intersect. A strong spatial overlap is visible between the most vulnerable block groups (highest SVI quartile) and rat complaint hot spots—especially in **Roxbury**, **Dorchester**, and **South Boston**. Cold spots appear in neighborhoods with lower vulnerability scores, such as **West Roxbury** and **parts of Hyde Park**. These patterns highlight the compounded burden faced by already disadvantaged communities, where systemic inequities—such as overcrowded housing, limited access to pest control, and aging infrastructure—may elevate both pest exposure and barriers to mitigation. This alignment suggests that rodent control efforts should be integrated into broader environmental justice strategies.

The Optimized Hot Spot Analysis revealed distinct clusters of rat complaints concentrated in central and eastern Boston, particularly in neighborhoods such as **Roxbury**, **Dorchester**, **South End**, **East Boston**, and **Allston/Brighton**. These areas exhibited statistically significant hot spots at the 95% and 99% confidence levels. In contrast, **cold spots**—areas with significantly fewer complaints—were found in **West Roxbury**, **Hyde Park**, and **parts of Mattapan**. These results suggest that rat exposure is highly uneven across the city, pointing to localized infrastructure, sanitation, and housing conditions as key contributors to infestation patterns. The clustering also emphasizes the value of using spatial statistical tools to prioritize areas for targeted rodent control.



Discussion

Our spatial analysis reveals that rat complaint activity in Boston is not randomly distributed but closely tied to patterns of structural and social vulnerability. Statistically significant hot spots are concentrated in historically underserved neighborhoods such as Roxbury, Dorchester, and East Boston—areas that also score high on the CDC's Social Vulnerability Index (SVI). These overlaps highlight the compounded burden of environmental exposure and socioeconomic disadvantage.

Bivariate maps further show that rat activity frequently co-occurs with high housing density, lower household income, and higher renter occupancy. This suggests that rodent presence is not solely a sanitation issue, but a broader indicator of housing precarity, aging infrastructure, and systemic inequality. Renter-heavy areas may experience delayed maintenance or have limited recourse for pest control, while high-density neighborhoods provide more entry points and harborage opportunities for rodents.

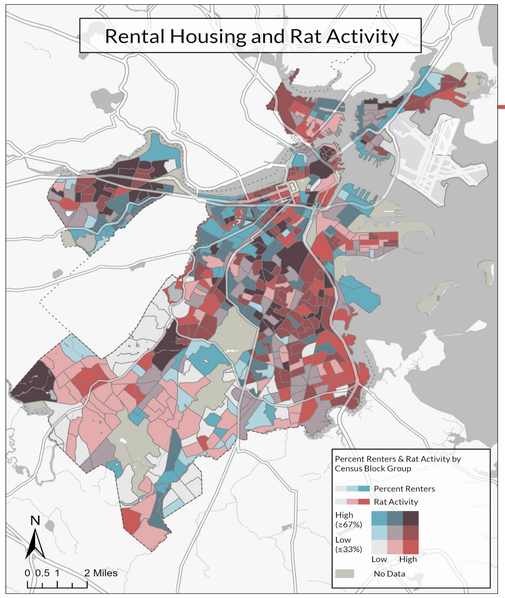
Interestingly, some block groups with elevated social vulnerability but low reported rat complaints raise the possibility of underreporting, whether due to reduced civic engagement, language barriers, or lack of trust in city systems. This highlights the need to interpret 311 data in context and to integrate qualitative or community-informed data sources in future analyses.

These findings support a place-based intervention strategy: targeting pest control efforts, inspections, and housing code enforcement in neighborhoods where environmental risks align with social vulnerability. This data can also be used by municipal agencies to prioritize funding, inform urban planning and zoning decisions, and support equitable resource distribution. Health departments might collaborate with community organizations to increase reporting awareness and advocate for proactive inspections rather than complaint-based responses.

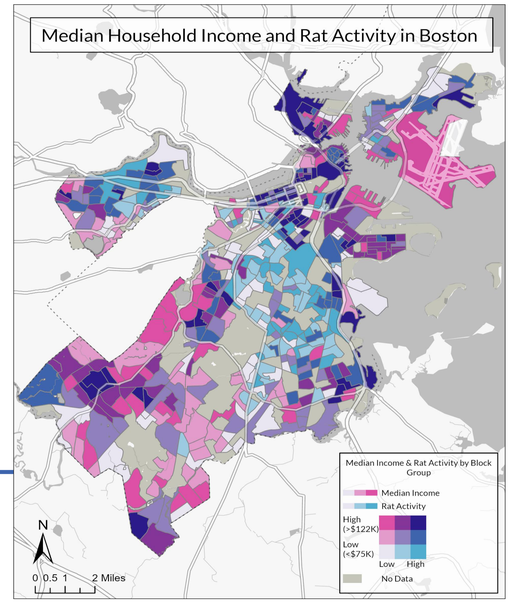
Finally, this project demonstrates the power of combining GIS tools, public service data, and demographic indicators to uncover patterns that are invisible at the city-wide scale. It underscores the importance of data-driven public health surveillance and provides a replicable model for other cities facing similar urban pest challenges.

Areas of Overlap: Socioeconomic Factors and Rat Activity

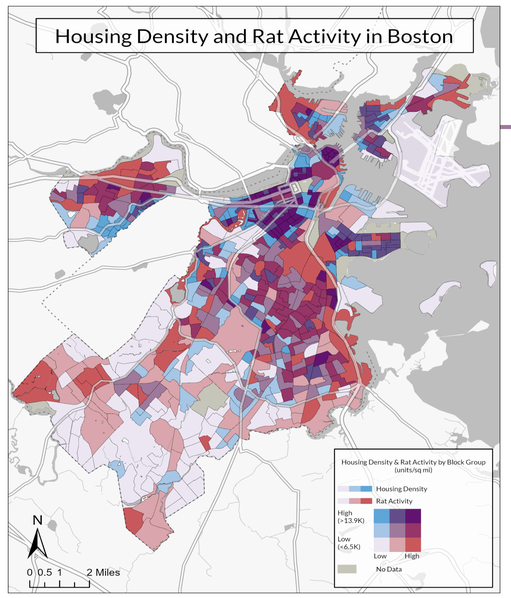
To explore how structural and socioeconomic conditions may contribute to urban rat activity, we conducted bivariate spatial analyses comparing rat complaint rates with key housing-related variables at the block group level. We focused on three indicators: percent renter occupancy, housing density, and median household income, using American Community Survey (2018–2020) data alongside 311 complaint data (2016–2020).



The bivariate map comparing **percent renter-occupied housing** and rat complaint rates reveals a notable correlation in many neighborhoods. High renter percentages coupled with high complaint rates appear in **Roxbury**, **South End**, **East Boston**, and **Dorchester**. These areas often contain high-density, older housing stock where landlords may delay structural repairs or pest mitigation. Some areas with high renter percentages but lower complaint rates—such as **West End** and **Fenway**—may reflect either underreporting or differences in housing conditions. The relationship suggests that renter status may signal increased vulnerability to rat exposure, either due to less control over environmental upkeep or housing insecurity.



In this map, rat complaint rates are inversely associated with **median household income**. Lower-income neighborhoods such as **Mattapan**, **Roxbury**, and **Dorchester** show the strongest overlap with high complaint rates. Higher-income areas, including **Back Bay**, **Seaport**, and **West Roxbury**, report substantially fewer complaints. This disparity may reflect actual differences in rodent activity, but could also be shaped by unequal access to reporting mechanisms or differences in public responsiveness. These findings align with broader literature on environmental justice, suggesting that **income inequality shapes not just exposure to environmental hazards, but also the visibility and response to them**.



This map illustrates the intersection between **housing unit density** and rat complaint rates. The densest neighborhoods—such as **Mission Hill**, **South Boston**, and **Dorchester**—consistently show elevated rat complaint rates. These patterns support the understanding that density increases opportunities for food waste, shelter, and infestation, especially in areas with aging infrastructure. However, some dense areas (e.g., **parts of Back Bay or Fenway**) reported fewer complaints, potentially indicating differences in building management or waste services. These exceptions suggest that while density is a key driver of rodent presence, the **quality of infrastructure and city services** may mediate the risk.

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