

# Where and When Do Bicycles Disappear the Most in Toronto?

Unveiling the Pattern and Potential Factors of Bike Theft

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## Introduction

Cycling is not only an environmentally friendly mode of transportation, but has also become an important part of urban transportation. At the same time, increased bicycle use has been accompanied by an increase in bicycle theft, a problem that has become a thorny issue in many cities around the world, including Toronto. Bicycle theft not only brings economic losses to citizens, but also directly affects their transportation choices and even affects the safety and quality of life. Hence, we are looking to analyse the data to understand patterns and trends in bike theft in Toronto so we can identify high-risk areas and make recommendations to help address bike theft.

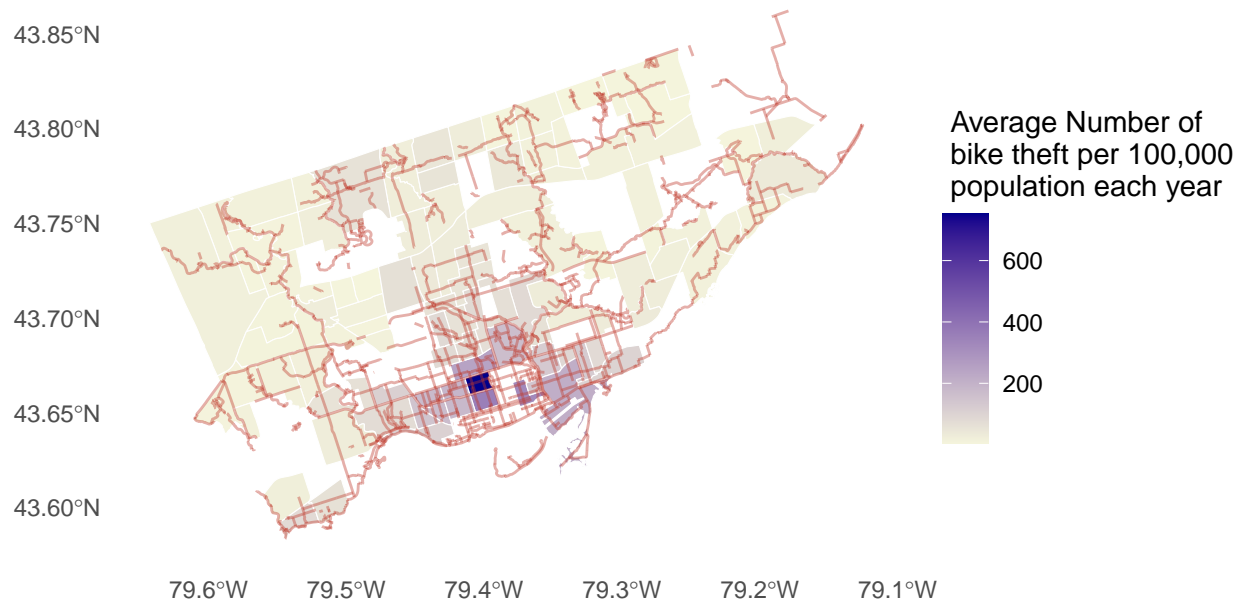
This study conducts a visualisation analysis of bicycle theft data within Toronto from 2014 to 2023, and uses the data to obtain the geographical distribution, time dynamic trends of theft cases, and their correlation with location types and bicycle types. By exploring how different factors influence the occurrence of bicycle theft using five sub-questions, we hope to provide bicycle owners with reliable data analysis and practical prevention tips. We also hope to provide data support to urban planners and policymakers to assist them in designing safer cities. environment, thus achieving the purpose of reducing the occurrence of bicycle theft. The following visualisations are built on two datasets: Bike Theft in Toronto (“Bicycle Thefts Open Data,” n.d.) and Neighbourhood Crime Rates (“Neighbourhood Crime Rates Open Data,” n.d.) which are collected and generated by Toronto Police.

## Interesting Findings

### Sub-question 1: Where do the highest numbers of bike thefts occur in Toronto?

To better understand the landscape of theft in Toronto, we conducted a data analysis of bike thefts in various areas of Toronto, focusing on where these incidents occur and how they impact our communities. These neighbourhoods were defined based on Statistics Canada census tracts. Figure 1 has two layers, one is the Toronto 158 neighbourhood (“Toronto Neighbourhoods,” n.d.) and the other is the bike lane views (“Cycling Network Data,” n.d.). From the dataset provided by Toronto Police (“Neighbourhood Crime Rates Open Data,” n.d.), we mapped bicycle theft crime rates per 100,000 people in different neighbourhoods in Toronto from 2014 to 2023.

Figure 1: Bike Thefts Crime Rate and Bike Lanes in Toronto by Neighborhood

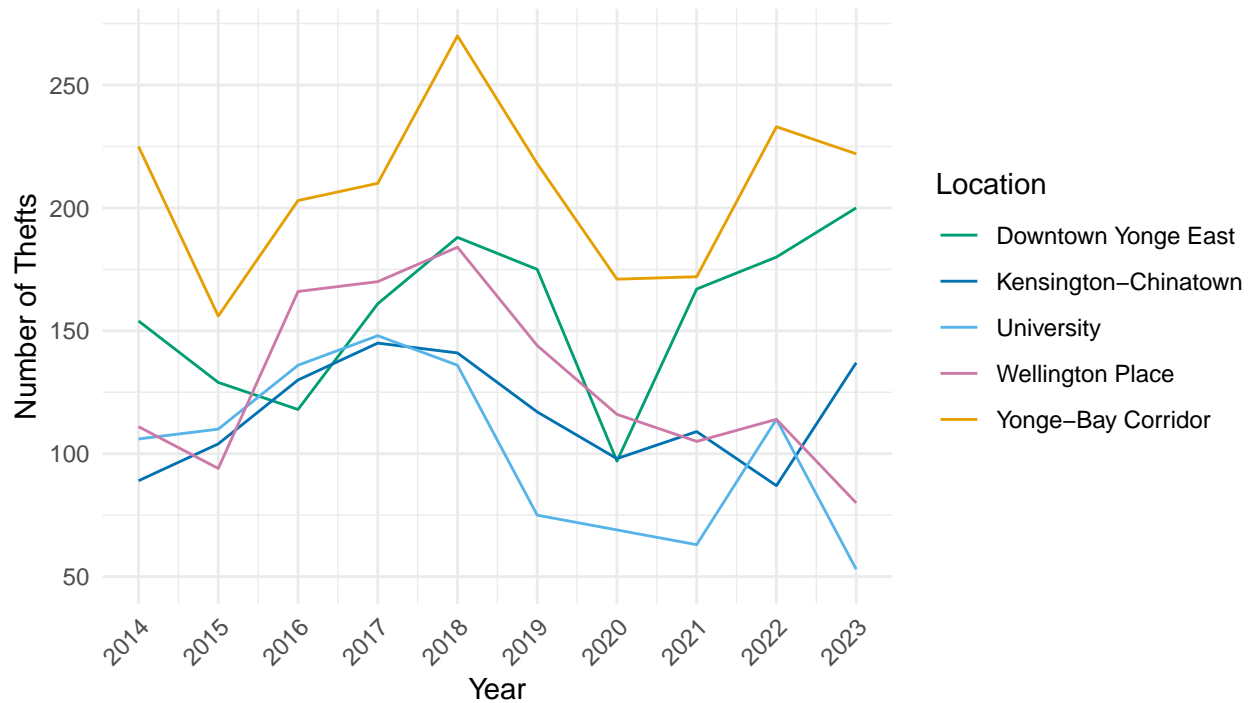


It is clear to see that in the image the shading on the map ranges from light to dark, with **blue** representing neighbourhoods with a higher rate of bike theft per 100,000 people, while lighter colours represent neighbourhoods with a lower rate of theft. It can be clearly seen that the closer to the lake, the higher the theft rate, especially in the city centre, which also shows that the centre of the city has the highest bicycle lanes (in **red** lines). Having more lanes in the downtown area indicates a push towards encouraging cycling, but it also inadvertently raises the risk of bike thefts due to the higher concentration of bicycles in these regions. This image highlights that central city areas (downtown region) are particularly vulnerable and therefore there may be an urgent need for targeted prevention measures in these communities.

### Sub-question 2: Are there any time trends in bike thefts in these high-risk areas?

After analysing geographic factors, we began to wonder if there were other factors that affected bicycle theft. Hence, we included the time factor in Figure 2, and we drew a line chart based on the available data to get a more complete understanding of the issue.

Figure 2: Trend of Bike Thefts Over Time in the Top 5 Hotspots in Toronto

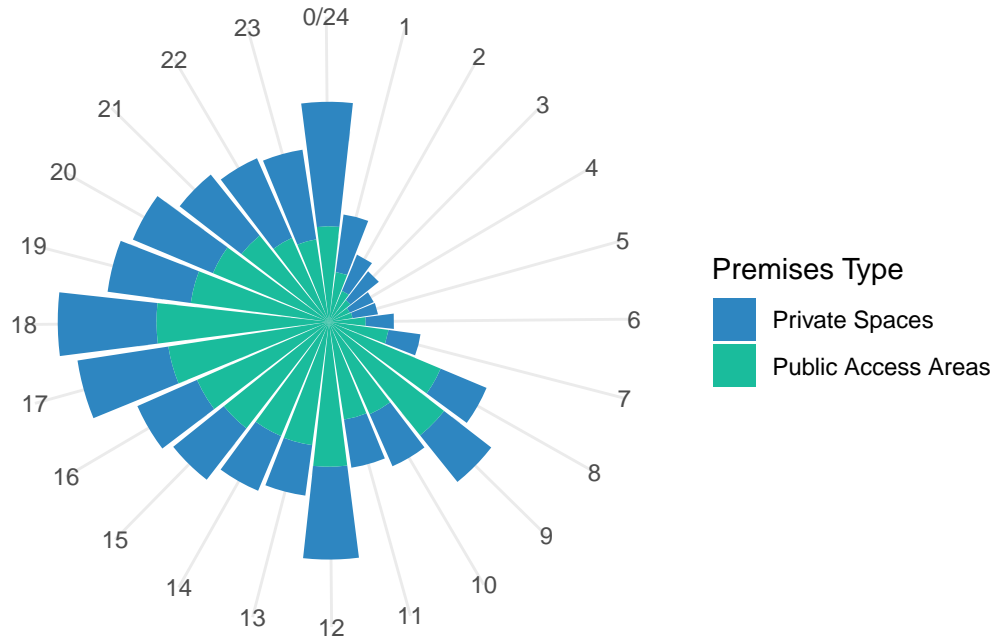


This map includes the locations of thefts, as well as when they are most likely to occur. We filtered out the top five hotspot locations with the highest crime rates from the first hotspot map, and then used a line chart to show trends over time for the top five bike theft hotspots in Toronto from 2014 to 2023. Each line represents one of the top 5 hotspots for bike theft: Downtown Yonge East, Kensington-Chinatown, University, Wellington Place and Yonge – the Bay Corridor, all areas with dense bike lanes and heavy traffic. Now, the graph also shows time trends for each location from 2014 to 2023. Although there are obvious peaks and troughs, the overall pattern is similar. What makes us curious is that there seems to be a general decline in thefts in all locations around 2020. So we thought this might be related to the global COVID-19 pandemic, when lockdowns and outdoor activities were reduced, so the drop in theft rates across neighbourhoods suggests that bike theft, regardless of location, is changing with society. After that, it can be seen that the theft rate has rebounded somewhat after 2020, which also represents the opening of the city and the restoration of normal activities, and the theft pattern has returned to the previous pattern. University areas in particular have seen a sharp increase in theft rates, possibly due to a resurgence in campus activity.

### Sub-question 3: How do patterns of bike thefts in Toronto vary between Private Spaces and Public Access Areas throughout the day in Toronto?

After a visualisation regarding the yearly trend, we would like to further refine factors and dive deeper in the time variable. Therefore, we break down bike theft incidents into 24-hour periods in time in Figure 3, which allows us to observe the frequency of incidents at different times. At the same time, we further divide places into two types: private areas and public areas, so that we can have a more targeted analysis of each area and place type.

**Figure 3: Bike Theft Trends in 24-Hour (Private vs. Public Spaces) in Toronto**

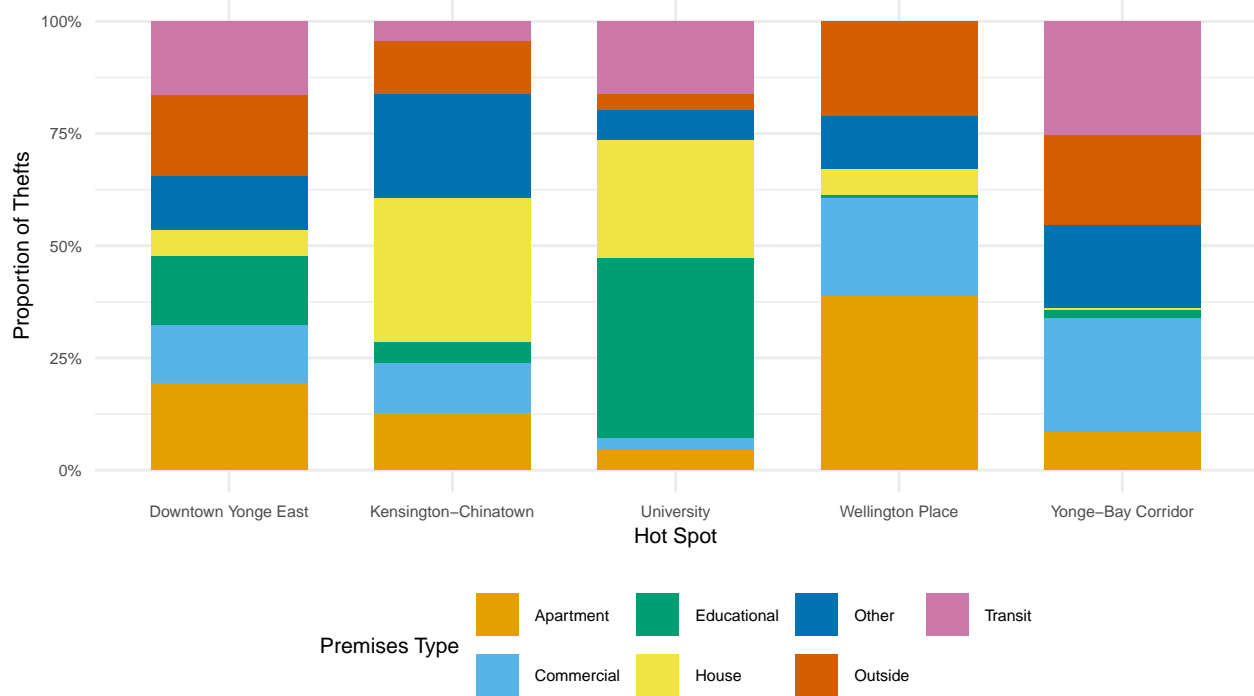


This clock-like graph represents the number of occurrences of bike thefts for each hour of the day, with the length of each segment representing the number of thefts that occurred during that hour. Based on this graph, we can clearly see the changing hourly trends in bicycle theft in private spaces and public areas. The diagram uses two contrasting colours to differentiate between private spaces (e.g. blue) and publicly accessible areas (e.g. green). Through the chart, we can clearly see that thefts in public places are more frequent and spread over a wider time range. The number of thefts in public areas increases from early morning to late evening, with peaks occurring in the afternoon and evening hours, likely due to higher foot traffic and bicycle usage during those times. At the same time, the number of thefts in private spaces surges at night and early in the morning, possibly related to reduced surveillance and increased opportunities for theft.

#### **Sub-question 4: How does the type of area (residential, commercial, industrial) influence bike theft rates?**

We now know the trend of bike thefts in private and public spaces. It would be interesting to refine and focus on various specific premise types. Therefore, Figure 4 demonstrates a distribution of the proportion of bicycle thefts in each type of premises within the main theft hotspots being plotted based on bicycle theft data within the top 5 areas of a specific premises type. These top five locations represent the neighbourhoods experiencing the highest number of bike thefts per 100,000 people. Therefore, we further divided the premise types into seven different categories. This stacked bar chart depicts the proportion and structure of thefts within each category to provide a comparative perspective of the most prevalent instances of bicycle theft.

Figure 4: Proportional Distribution of Bike Thefts Across Premises Types in Toronto Top 5 Hotspots

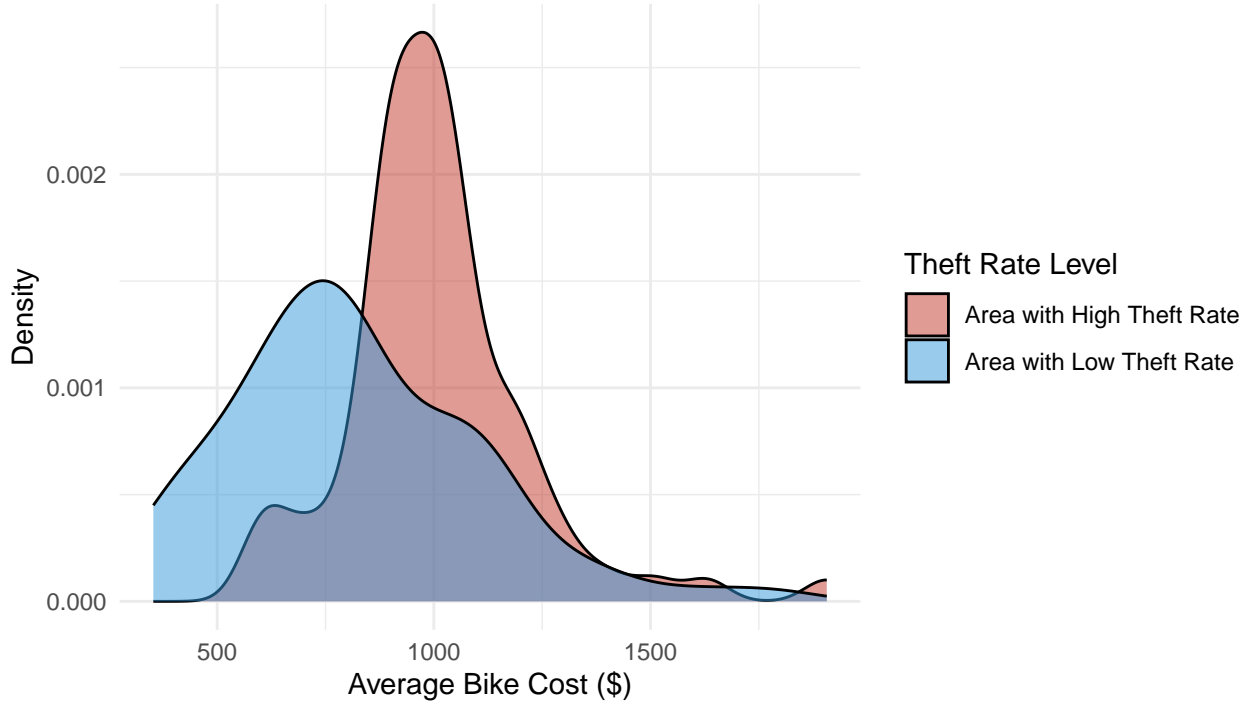


It is evident from the plot that the top 5 hotspots each exhibit a distinct distribution of bike thefts across various types of premises in Toronto. For instance, the proportion of blue parts of the commercial district is larger in the Yonge Street East and Yonge Bay corridors in the city centre, which means that these crowded commercial districts have a higher proportion of commercial theft. In contrast, in the university area, there is a larger proportion of green colour indicating educational places, which means that thefts in educational institutions account for a large portion of the overall thefts in the university area. It is also worth noticing that the ‘Outside’ category, representing public areas such as streets and parks, constantly displays a high percentage of thefts in most of the locations. Additionally, hotspots consistently rank higher in the “outdoor” category in red, as open spaces are common areas for bike theft. The difference is that residential areas such as “apartments” and “houses” have lower burglary rates in some areas but not the others, reflecting the effectiveness/lackness of private security measures or the reality that there are more break-ins in common areas.

### Sub-question 5: What are the cost profiles of bicycles stolen in Toronto?

After analysing objective factors such as geographic and temporal aspects, we began to consider whether the feature of the bicycle itself might also act as another factor influencing theft incidents, especially in the high bike theft rate regions. We decided to focus on the cost of the bike and connect this hypothesis with the results of previous visualisations in Figure 5.

Figure 5: Comparative Density of Bicycle Costs in Areas with High and Low Theft Rates in Toronto



In Figure 5, we first find the median of the crime rates in the neighbourhood, then those with a rate greater than the median is grouped as “Areas with High Crime Rate Area” and others are “Areas with Low Crime Rate”. The purpose of this chart is to analyse the correlation between the value of a bicycle and its likelihood of being stolen, by charting the relative density of bicycle costs in areas with high and low theft rates. We can see that the density plot has two overlapping distributions: one is a red areas with a high theft rate that peaks at about \$1,000; the other is a blue areas with a low theft rate that peaks at about \$750. Therefore, this plot may suggest that on average, areas with higher theft rates will steal more expensive bikes, and thieves will be attracted to higher-value items for high returns.

## Limitations and Future Steps

Our study, focusing on bicycle thefts between 2014 and 2023, faces challenges that impact the comprehensiveness and accuracy of our conclusions. The main one is the restricted time frame of the dataset, as well as the lack of consistent population data for Toronto’s neighbourhoods in these years. Access to this information is important since it will help us confirm whether bike theft rates published by Toronto Police each year are accurate and also improve the visuals we create for more lucidity and insight.

Furthermore, despite our efforts to consider population density, there are numerous other complex demographic details missing in those communities. These demographic data (income levels, percentage of bike ownership and/or efficiency of local law enforcement) may contribute towards the topic thereby yielding a more accurate relationship/ pattern concerning bike thefts within Toronto

In addition, there is also an issue with the reliance on crime data, which likely underestimates the true scale of bike thefts happening in Toronto. Some victims might not report such incidents due to possible perceptions of police receptivity or the belief that the monetary worth of their stolen property is too low to warrant official reporting. This kind of self-reporting bias significantly distorts our knowledge about the

actual crime rate.

How can we overcome these challenges? First, alternative data sources or statistical models that estimate population and demographic change, and also extend the time frame of the dataset, which may add more insight and boost robustness to our analysis. In order to make the data set better reflect the reality of bike theft in Toronto it would be useful to have initiatives targeted at theft reporting and public awareness-raising campaigns. Also, we could expand our study by looking at more neighbourhoods or even doing a comparative study with other cities within Canada so that we give a richer context. This will enable us to confirm if any similar patterns are observed elsewhere outside Toronto while ensuring that our findings are generalizable. Overcoming these limitations can help with accuracy, generalizability, and credibility, as well as deepening insights for future investigations.

## Conclusion

Throughout this study, we combined geographic, temporal, and characteristic aspects with data and graphics to examine bicycle theft in Toronto. According to the data, there was a constant greater incidence of bike theft in neighbourhoods with lots of bike lanes and significant traffic. The results of a multiple-factor analysis demonstrated that these occurrences had a time, place, and type relationship and were not random. Moreover, the distribution plot reveals that expensive bikes were most likely to be taken from high-crime locations, suggesting that cyclists may want to consider travelling with less expensive bikes in these regions.

## Some Implications

From those interesting findings, it is obvious that bike thefts are worryingly common in places with lots of bike lanes. This indicates that we need to do more to keep bikes safe and prevent such things. For urban planners, this could mean the integration of bike theft data into city planning processes to ensure that new bike lanes and cycling facilities are accompanied by adequate security features. It might be also a good idea to have law enforcement agencies targeting initiatives in identified hotspots, potentially utilising predictive analytics to preempt theft occurrences before they happen. As for the cyclists, they should also be aware that more expensive bikes are more likely to be stolen, so they should think carefully about how they secure their bikes, especially when parking in busy downtown areas and near some public spaces. Ultimately, understanding the patterns of bike theft creates a safe and secure urban environment. Expect a collaborative effort between community members, city planners and law enforcement to develop different ways to reduce the bike theft problem in Toronto.

## References

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