Cycling in Vancouver:

A portrait of bicycle ridership and safety in Vancouver 2010-2020

Canadian Association of Physicians for the Environment

CAPE
Canadian Association of Physicians for the Environment

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Preface

In 2016 the City of Vancouver committed to Vision Zero: a goal to have zero traffic related fatalities and serious injuries. That Action Plan included steps to enhance available data, evaluate and prioritize locations for safety improvements, an engineering action plan, education and public outreach and enforcement. CAPE's Cycling in Vancouver: A portrait of bicycle ridership and safety in Vancouver 2010-2020, makes a significant contribution toward achieving City of Vancouver's Action Plan.

Cycling in Vancouver builds upon HUB Cycling's recent State of Cycling Report for Metro Vancouver, confirming and adding nuance to findings concerning the growth in cycling, and trends in collisions involving people riding bicycles. CAPE's report notes that bicycle use has remained high throughout the pandemic, that winter cycling is becoming more popular, and that collision risk for people on bicycles is highest in the late fall and early winter. These findings alone can help city staff to target safety interventions aimed at reducing collisions involving cyclists.

Yet CAPE's Cycling in Vancouver does more. Its key contribution is to combine data from automated bicycle counters and point to point trip data involving 7,200 trips made by people on bicycles, producing an estimate of daily bicycle traffic volumes on routes accessible to bicycles throughout city of Vancouver. This information is unprecedented and offers us the opportunity to understand the relative risk of collisions involving cyclists at intersections throughout the city.

Historically, bicycle collision data has been used to identify locations that have a high number of incidents involving cyclists. This information has led City of Vancouver to make bicycle safety improvements at a number of key intersections throughout the City. For instance, virtually all the top 10 reported locations for cycling collisions identified between 2007 and 2012 have since received cycling safety upgrades. However, locations with the highest incidence of collisions involving cyclists are not always synonymous with the highest risk locations. Instead, the highest risk locations are those with a high incidence of collisions involving cyclists relative to the number of cyclists that travel through a location each day.

CAPE's analysis of relative risk identifies different high-risk locations than those listed in Vancouver's top reported locations for cycling collisions. In the City of Vancouver's most recent Cycling Safety Report, 15 (79%) of the top 19 reported cycling collision locations had a designated cycling route on at least one intersecting street. In CAPE's report by contrast, 15 of the top 19 high risk locations for collisions involving cyclists had no existing bicycle facilities on either intersecting street.

Focusing on cycling safety improvements at intersections with a high number of collisions involving cyclists is important. Focusing on cycling safety improvements at intersections with a high risk of collisions involving cyclists is also important. Now that credible estimates of bicycle traffic are available for roadways throughout Vancouver, cycling safety improvements can be focused on intersections with a high numbers of collisions involving cyclists, and at intersections with a high risk of collisions involving cyclists.

HUB Cycling welcomes this ground breaking report and we hope to be able to work with CAPE to extend this research throughout Metro Vancouver, helping local governments throughout the region to prioritize where cycling safety improvements are most urgently needed.

Gavin Davidson and Tim Welsh on behalf of HUB Cycling

Executive Summary

Cycling in the City of Vancouver has significantly grown over the last decades. The bicycle mode share in Vancouver experienced a relative increase of 65% between 2006 and 2016 and now has one of the highest rates of any major North American city at 6.1%[1]. The region of Metro Vancouver has a cycling modal share well above the Canadian average for regions: 2.3% in 2016, compared to the Canadian national average of 1.4%[2]. Female ridership has been a key source of growth, and now accounts for approximately four and of every ten people on bikes[1].

The growth in bicycle mode share and female ridership is due to the City's ambitious policies and actions. The Transportation 2040 Plan outlines the City's long-term transportation targets and goals, most notably that by 2040 at least two-thirds of all trips will be made by walking, cycling or transit[3]. The plan also outlines a target to move towards zero traffic-related fatalities. The target is reflected in the City's actions, particularly in the development and implementation of a well-connected, protected bike network that is comfortable for people of all ages and abilities. Cycling networks that are designed for people of all ages and abilities, typically experience growth in cycling trips and a decrease in collision rates resulting in an overall improvement in road safety[5].

This report illustrates the evolution of the state of cycling in the City of Vancouver between 2010 and 2020. This is accomplished by analyzing the cycling ridership trends over time, the impact of the COVID-19 pandemic on cycling and road safety for people on bikes. The analysis conducted in this report can be condensed into six main takeaways:

1. **There has been a significant and consistent yearly increase in cycling participation over the past decade in Vancouver**. Three downtown Vancouver counting systems have reported a 40% increase in bicycle traffic between 2011 and 2019. This increase has been driven by a large-scale expansion of the protected cycling network. The network grew by 28% between 2010 and 2020, and now covers roughly 328 kilometers of bikeways[6].
2. **Winter cycling is becoming more common among Vancouver residents**. There has been consistent yearly growth over the past five winters. Bicycle traffic throughout the winter months represents almost 1/3rd of the bicycle traffic experienced during the peak summer months.
3. **Bicycle participation grew by 6% during the pandemic despite a reduction in commuting trips**. Cycling activity shifted towards weekday afternoons and on weekends.
4. **Reported collisions involving vehicles and people on bikes have reduced by 15% and 43% in 2019 and 2020 respectively**, when compared to the previous four years. An expanded protected bicycle network and dramatically reduced vehicle exposure in 2020 are the key factors contributing to the reduced collision rates.
5. **Collision risk for people on bikes is highest in the late fall and early winter**. The month of November has twice the crash risk associated with the month of July.
6. **The City of Vancouver has made many impactful improvements to the bicycle network over the past decade**, resulting in safer intersections throughout the all ages and abilities (AAA) bicycle network. **A network screening approach using collision risk at intersections illustrates a handful of higher-risk intersections in Vancouver**. The majority of these intersections are on arterials with high vehicle volumes and without protected cycling infrastructure.

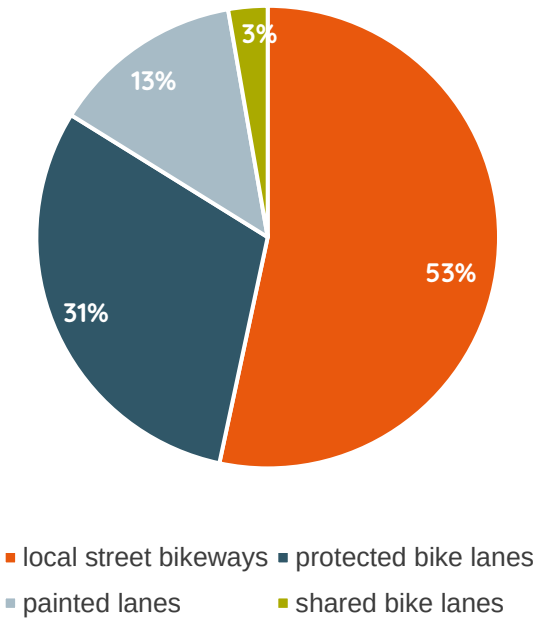
Background

Cycling in the City of Vancouver has significantly grown over the last decades. The municipality currently boasts one of the highest commuting cycling rates of any major Canadian city at 6.1%[1]. Between 1996 and 2006, this rate remained somewhat stable increasing from 3.3% to 3.7% of all commute trips. By 2016, the percentage of people who regularly commute by bicycle rose dramatically to the current rate. The region also experiences a cycling modal share well above the Canadian average for regions: Metro Vancouver had a cycling rate of 2.3% in 2016, whereas the Canadian national average was 1.4%[2]. The increase in cycling rate is in large part due to an increase in female commuters. Between 1996 and 2016, the proportion of female commuters increased from 32% to 39%[1].

The growth in bicycle mode share and female ridership is due, in part, to the City's ongoing commitment and development of its cycling network through ambitious policies and actions, such as the Transportation 2040 Plan. Adopted by the Vancouver City Council in 2012, this plan outlines the City's long-term transportation targets and goals, most notably that by 2040 at least two-thirds of all trips will be made by walking, cycling or transit[3]. Moreover, Transportation 2040 aims to work towards zero traffic-related fatalities. Regarding cycling, the Plan aims to make cycling safe, convenient, comfortable, and fun for people of all ages and abilities. This target is reflected in the City's actions, particularly the development and implementation of a well-connected bike network that is comfortable for people of all ages and abilities. Design guidelines were introduced in 2017 that consider facility type and width, intersection design and speed and traffic volume of motor vehicles[4]. When a cycling network is designed for people of all ages and abilities, the share of cycling trips tends to increase, while simultaneously decreasing the rate of collisions and improving overall safety[5].

The City of Vancouver's cycling network grew by 28% between 2010 and 2020, and now covers roughly 328 kilometers of bikeways[6]. In 2020, the network consisted of 175 km of local street bikeways (space is shared with vehicles on a quiet residential street), 100 km of protected bike lanes, 44 km of painted lanes, and 9 km of shared bike lanes. On shared lanes, people on bikes share a lane with vehicles; while these lanes fill gaps in the cycling network, they are not considered comfortable to ride on for most people on bikes. Of the entire cycling network, 22% or 72km are considered part of the All Ages and Abilities (AAA) bike network, consisting mostly of protected bike lanes and some local street bikeways with lower traffic volumes[6].

(1) HUB Cycling and TransLink, Benchmarking the State of Cycling in Metro Vancouver 2019.
(2) Statistics Canada, Vancouver, CY [Census subdivision], British Columbia and Greater Vancouver, RD [Census division], British Columbia (table). Census Profile. 2016 Census. Statistics Canada Catalogue no. 98-316-X2016001. 2017.
(3) City of Vancouver, Transportation 2040. 2012.
(4) City of Vancouver, Transportation Design Guidelines: All Ages and Abilities Cycling Routes. 2017.
(5) Harris, M. Anne & Reynolds, Conor & Winters, Meghan & Chipman, Mary & Cripton, Peter & Cusimano, Michael & Teschke, Kay. (2011). The Bicyclists' Injuries and the Cycling Environment study: A protocol to tackle methodological issues facing studies of bicycling safety. Injury prevention : journal of the International Society for Child and Adolescent Injury Prevention. 17. e6. 10.1136/injuryprev-2011-040071.
(6) City of Vancouver, Open Data Portal: Bikeways. City of Vancouver, 2021. https://opendata.vancouver.ca/explore/dataset/open-data-change log/log/?disjunctive.datasets&sort=logdate&refine.datasetids=bikeways
(7) Winters, M., et al., Motivators and deterrents of bicycling: comparing influences on decisions to ride. Transportation, 2011. 38(1): p. 153-168
(8) Urban Systems, Cycling Safety Study: Final Report. 2015.
(9) HUB Cycling and Vancouver Coastal Health, Health Research Network Project Report: Workshop Summary. 2021



Examples of each type of infrastructure from top left clockwise: protected bike lane on Burrard Bridge, local street bikeway on E 10th, painted lanes on Cambie St, and shared bike lanes E 22nd Ave. Credit Google maps

In their 2019 report on cycling in Metro Vancouver, HUB Cycling classified the existing cycling network into four categories based on comfort level (most people, some, few and very few). Bikeways categorized as 'Comfortable for Most People' are defined as either protected bike lanes or bikeways on shared roads with low traffic volumes (less than 2,000 vehicles per day) and low speed limits for motor vehicles (30km/h or less)[1]. Despite most bikeways (76%) being considered comfortable for most, there are significant gaps and weakness that exist within Vancouver's 'Comfortable for Most People' network. Particularly, these are identified by HUB as a lack of east-west facilities through downtown, midtown (between 14th and 28th Ave.), and South Vancouver (between 45th and 59th Ave.), and a lack of bikeways linking the city to its surrounding areas[1]. In general, challenges to Vancouver's cycling network include a lack of direct routes to points of interests such as schools, transit stations, employment and shopping areas. Additionally, there is difficulty in finding convenient and secure bike parking. Topography and variable weather conditions can discourage people from riding a bike over other transport modes[3].

However, as is the case in most North American cities, the most significant challenge and barrier for people is road safety, namely interactions with motor vehicles[7]. Between 1996 and 2012, the number of reported collisions involving people on bikes in Vancouver remained relatively consistent, averaging 475 reported collisions annually[8]. However once adjusted for the growth in cycling, the annual cycling collision rate decreased by approximately 59% between 1996 and 2012, from 48 bicycle collisions per one million bicycle trips in 1996, to 20 in 2012[8]. By 2017, the rate had remained constant[9]. This downwards trend in the collision rate suggests that Vancouver's supportive policies and actions towards cycling for all ages and abilities has had a positive effect on cycling road safety within the City's boundaries.

The purpose of this report is to illustrate the evolution of the state of cycling in the City of Vancouver between 2010 and 2020. This is accomplished by analyzing the cycling ridership trends over time, the impact of the COVID-19 pandemic on cycling and road safety for people on bikes.

Methodology

The City of Vancouver runs a mature bicycle count program that uses a combination of permanent and mobile automatic counting systems to monitor cycling activity at key locations throughout the city. Permanent counters collect data over many years allowing for a detailed understanding of traffic trends. This report includes three forms of analysis related to bicycle activity and safety. Firstly, a temporal analysis is performed, in which publicly available data from permanent bicycle counters is analyzed to determine long-term bicycle growth and the impact of the pandemic on cycling activity in Vancouver. Secondly in a geospatial bicycle activity analysis, data from permanent bicycle counting locations is combined with GPS bike trip data to extrapolate bicycle activity throughout the entire road network. Lastly, a safety analysis is completed by exploring where (which intersections) and when (which months of the year) bicycle crashes occur at the highest rates.

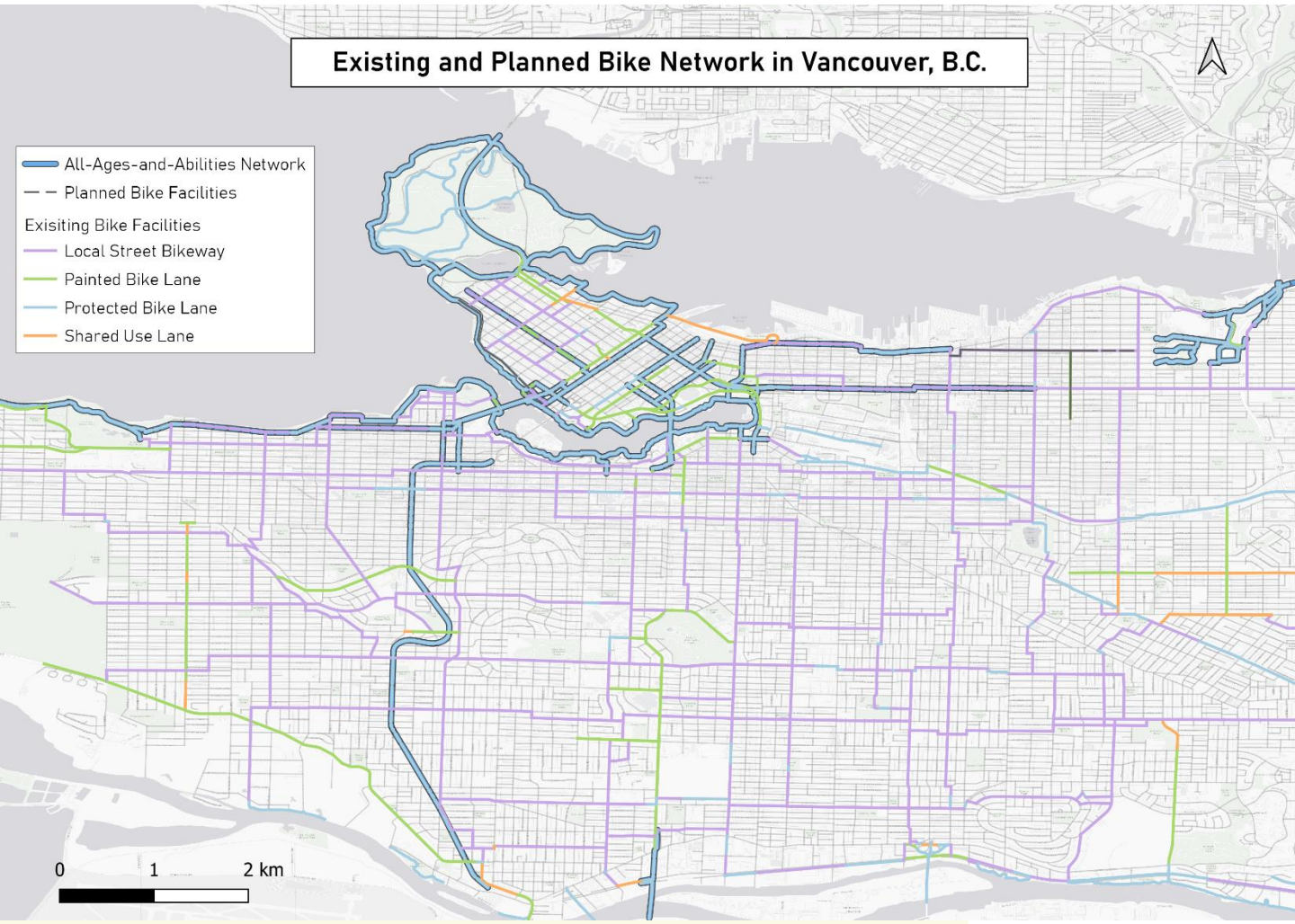
In the temporal analysis, bicycle count data between 2010 and 2020 from 15 permanently installed bike counters were used. Firstly, counts were checked for gaps and anomalies; missing periods of data were reconstructed to create a complete dataset. Secondly, bicycle counts were compared between years and by month at three locations with data dating back to 2010. Lastly, the impact of the pandemic on bicycle activity was measured at all counting locations by comparing pre-pandemic bicycle counts (March-December 2019) with bicycle counts during the pandemic (March-December, 2020).

In the geospatial analysis, data from 20 Vancouver automated bicycle counters (Eco-Counters) and anonymized bicycle route data from SmartHalo users were combined to estimate bike traffic on all roads, multi-user trails and intersections throughout Vancouver. More than 350 citizens with SmartHalo devices were tracked throughout 7200 bike trips (representing 37,000 km of bicycle travel) between January 2018 and February 2020. A geospatial measure of cycling activity (estimated average annual daily bikes) across the road network is used to generate a cycling activity heatmap of all segments and corridors. This analysis can help in identifying where road treatments and maintenance should be prioritized, where bicycle-friendly signalisation can have the greatest impact and where additional bicycle parking is needed.

A bicycle safety analysis is done by exploring collisions spatially and temporally. Cycling activity at intersections is used as a measure of exposure to estimate bicycle collision risk. A network screening approach, to find the highest risk intersections, can be performed by combining bicycle-vehicle crash data at intersections across Vancouver with bicycle activity estimates at all intersections. Collision crash risk is defined as the number of collisions per million people on bikes. Maps are generated that identify the frequency and rate of bike collisions using the location of all reported collisions involving a bicycle between 2015 and 2020. Geospatial bicycle crash data, separated by month and year, are publicly available from the Insurance Corporation of British Columbia (ICBC) Tableau public web page. This dataset is incomplete and may represent only a small proportion of all crashes involving people on bikes; it is limited to reported crashes between people on bikes and motorized road users[9]. However, the ICBC dataset provides the most complete crash set available. Bicycle collisions are also aggregated by month and by year to extract meaningful temporal bicycle crash trends.

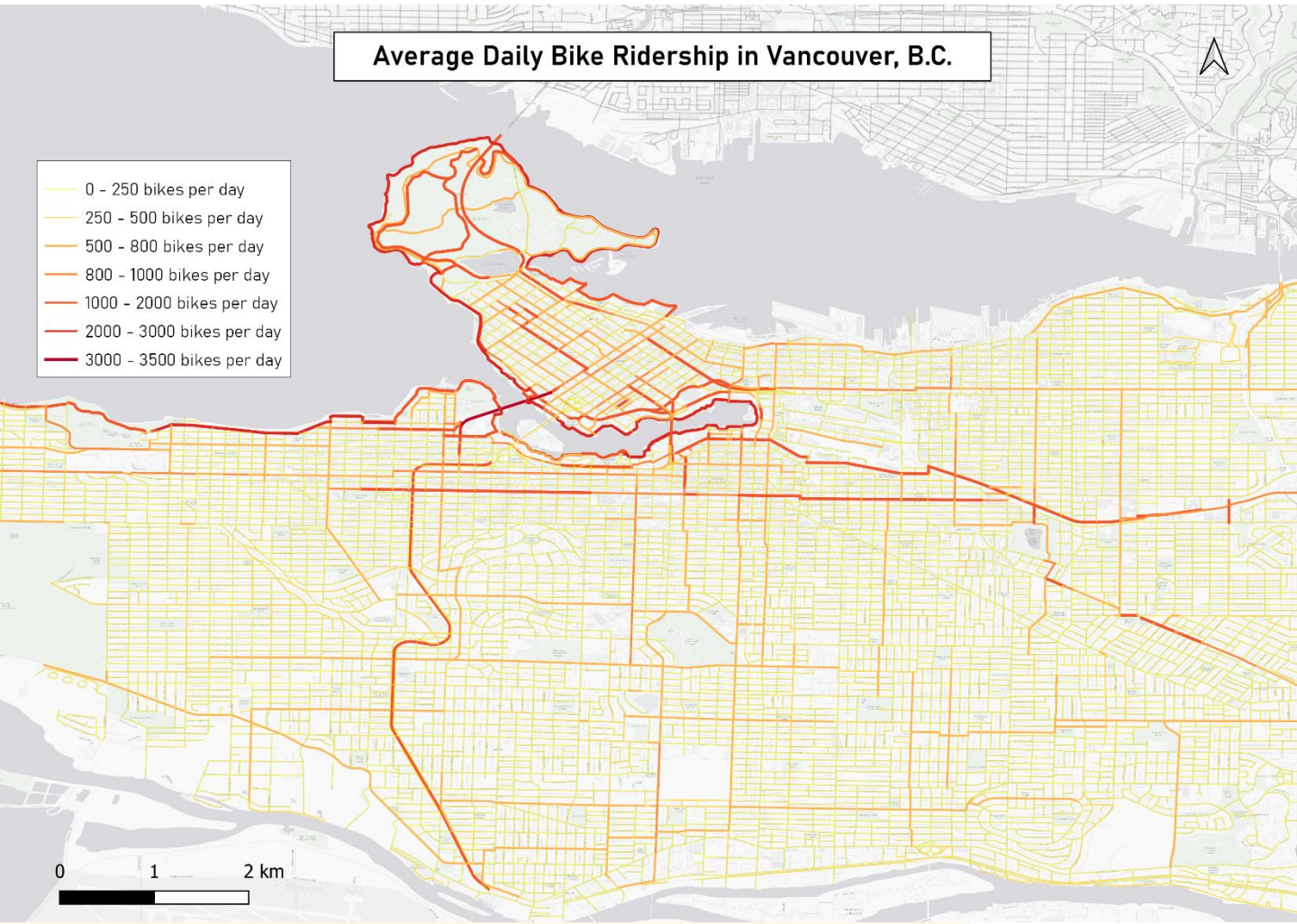
Bicycle Network
Spatial Analysis

The City of Vancouver has an extensive bicycle network. The 328 km of bikeway described in the introduction can be viewed in the bike network map below. The AAA bike network is 72 km in length and includes downtown corridors such as the Hornby and the Dunsmuir Corridors (both upgraded in 2010), the Burrard Bridge (upgraded in 2016-2017) and the Comox-Helmcken Greenway (constructed in 2013), as well as the Arbutus Greenway (constructed in 2017), connecting downtown Vancouver with South Vancouver and the Union-Adanac Corridor (upgraded in 2018), linking downtown Vancouver with Boundary Rd. Recreational facilities are also a component of the AAA bike network, namely the Seawall and Seaside Greenway. Improvements to a portion of this facility were completed in 2018, with more upgrades planned for 2021.



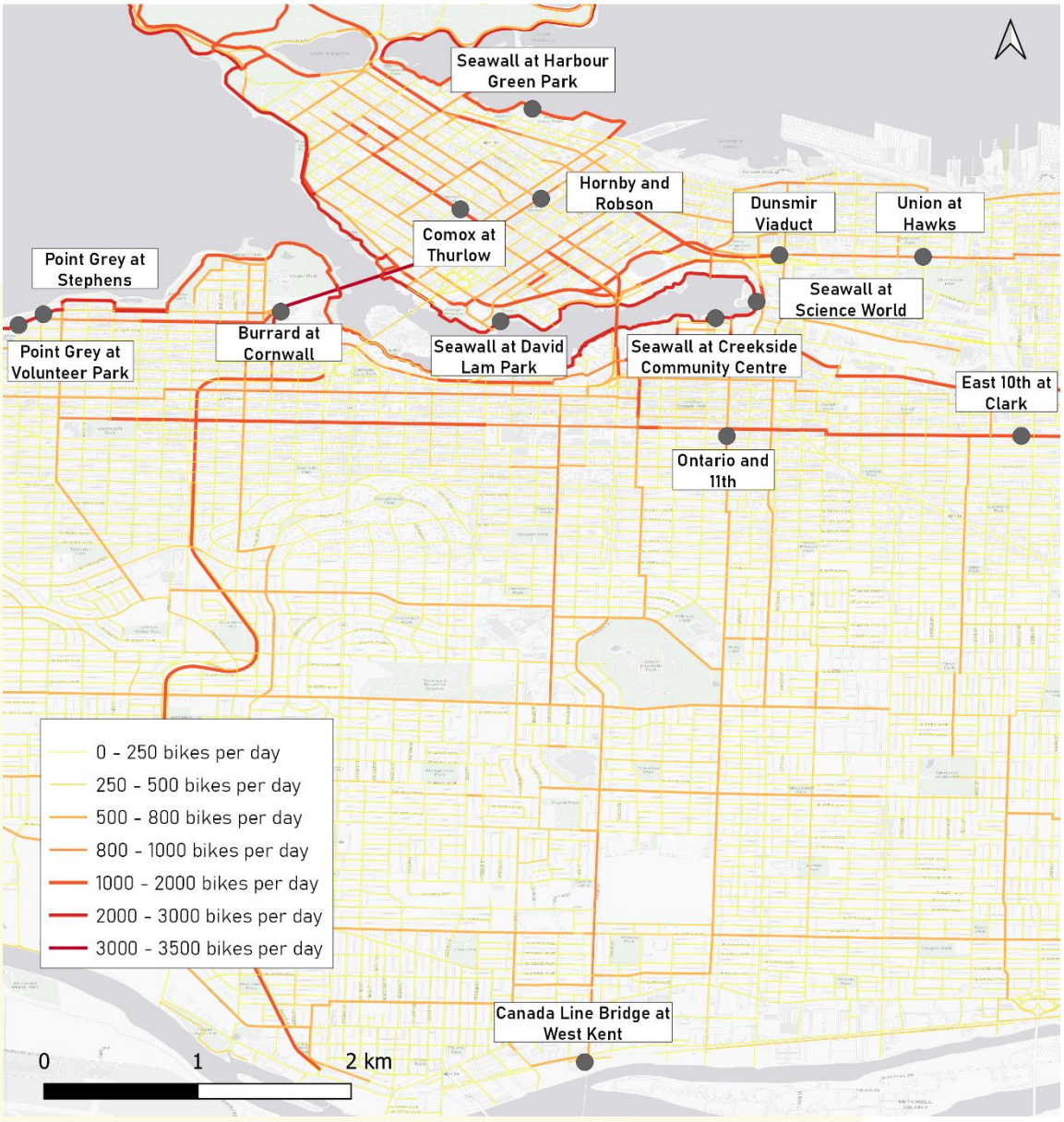
Bike Ridership Activity Heatmap
Spatial Analysis

Average annual daily bikes, a measure of cycling activity was estimated across the road network using a model combining permanent counter data, GPS-based bicycle trip traces and bicycle network attributes. Below is a cycling activity heatmap of the Vancouver network of road segments, bike facilities and corridors. The most active corridors, with more than 3000 bike passes per day, closely follow the AAA bike network described on the previous page. The similarity between these two maps is not coincidence; in general, people who bike prefer protection from vehicle traffic or roads with very low vehicle flow.



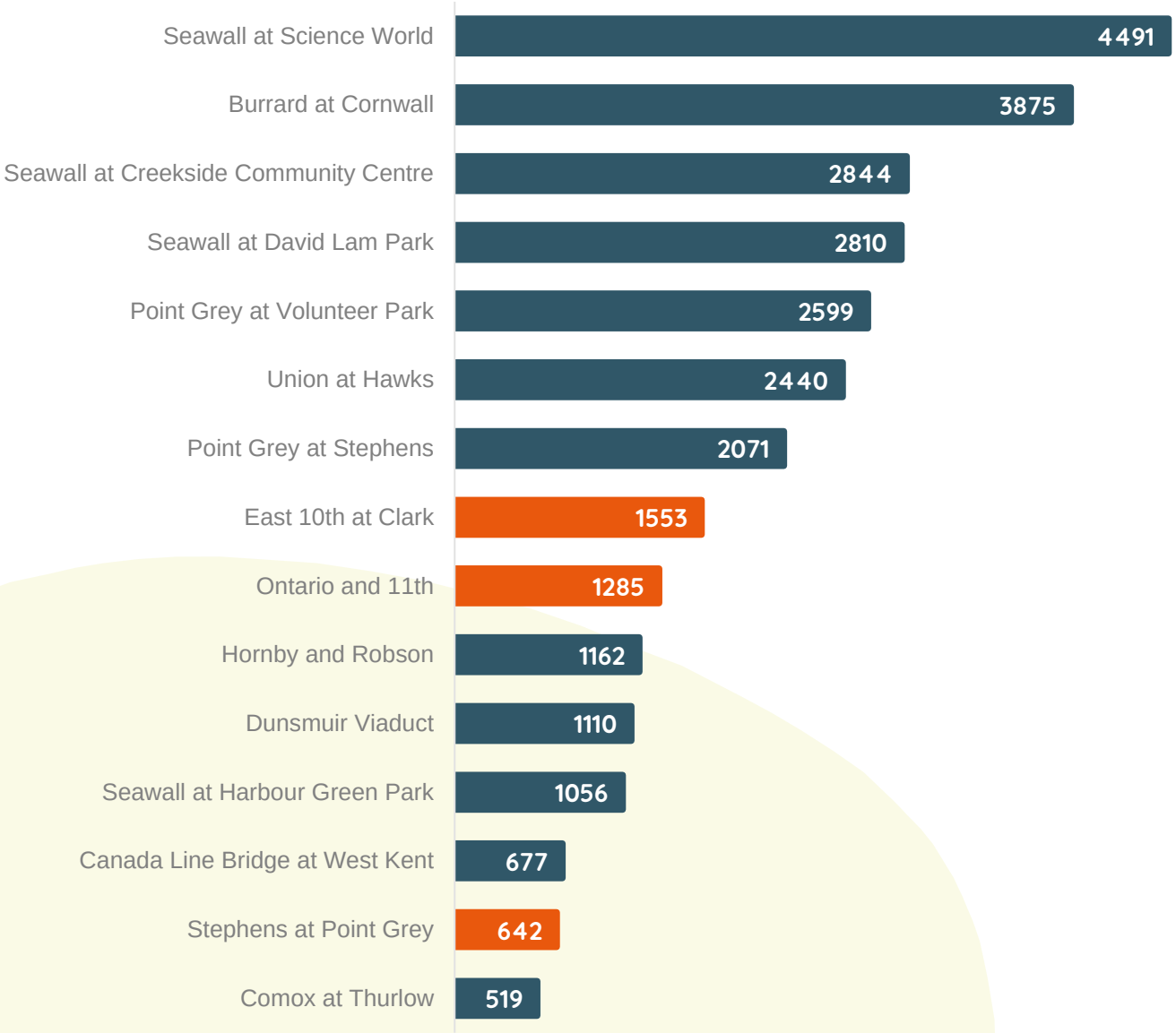
Vancouver Publicly Available Bicycle Counting Sites

The analysis in this report relies on publicly available data from 15 permanently installed, automated bike counters. The bike counters are installed on bicycle facilities and many are located on part of the AAA bike network. Most of these locations count more than 1000 people on bikes on average per day throughout the year; average daily counts for each site are available on the next page. Three of these counting locations: Burrard Bridge, Hornby and Robson and Dunsmuir Viaduct, have been collecting data for more than a decade. These three sites are used to generate long-term bicycle growth estimates and seasonal analysis. The bicycle counting locations are analyzed to determine the impact of the pandemic on bicycle activity by comparing pre-pandemic bicycle counts in 2019 with bicycle counts during the pandemic in 2020.



Vancouver Publicly Available Bicycle Counting Sites

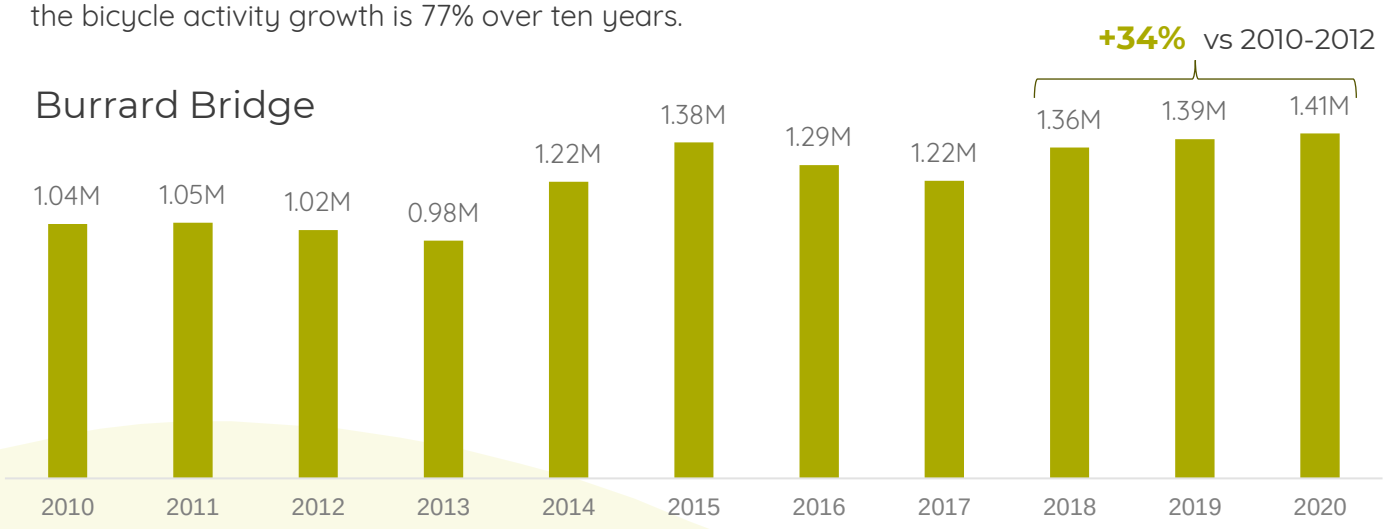
Average daily people on bikes in 2020



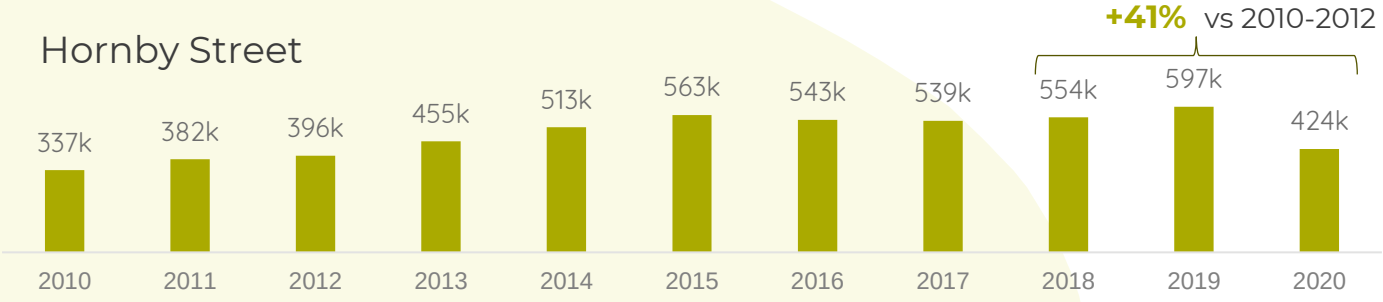
Bicycle Growth Over 10 Years
Analysis by year

Bicycle activity in Vancouver has grown consistently and significantly as the cycling network has expanded. At three downtown locations, cycling has increased by 30% to 40% when comparing 2018-2020 to 2010-2012. These statistics represent high cycling growth for a North American City. Furthermore, this growth is a conservative estimate given a drop in cycling in the downtown core in the context of the pandemic. When comparing counts at Hornby Street in 2019 with 2010, the bicycle activity growth is 77% over ten years.

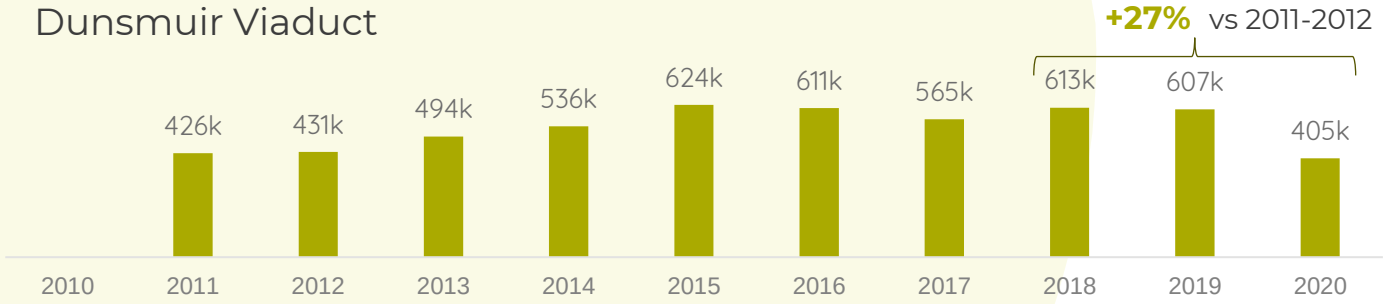
Burrard Bridge



Hornby Street



Dunsmuir Viaduct

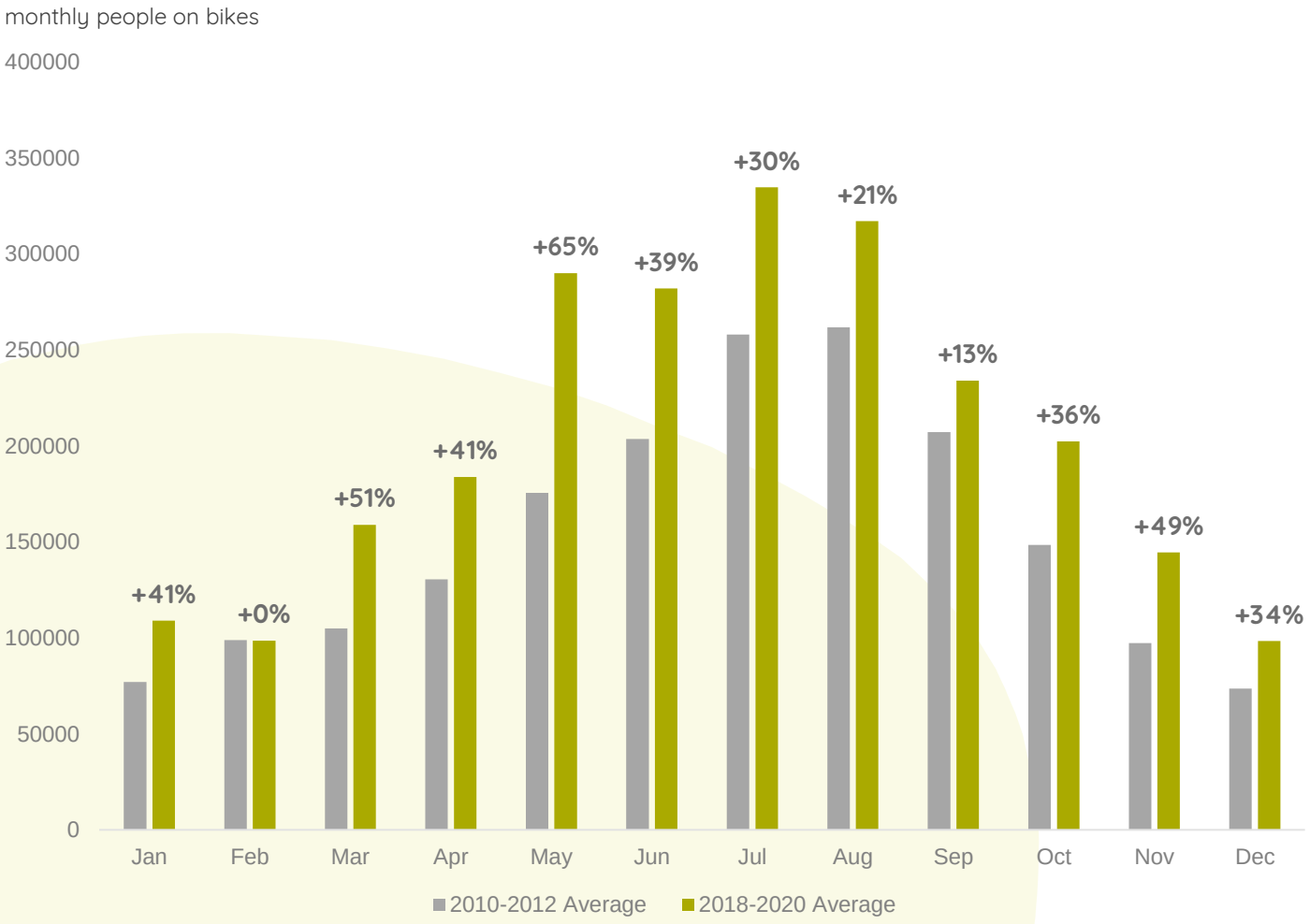


1. Bike counts at Hornby Street are estimated Jan-Feb 2010 and May-June 2020

Bicycle Growth Over 10 Years

Analysis by month, comparing 2018-2020 and 2010-2012

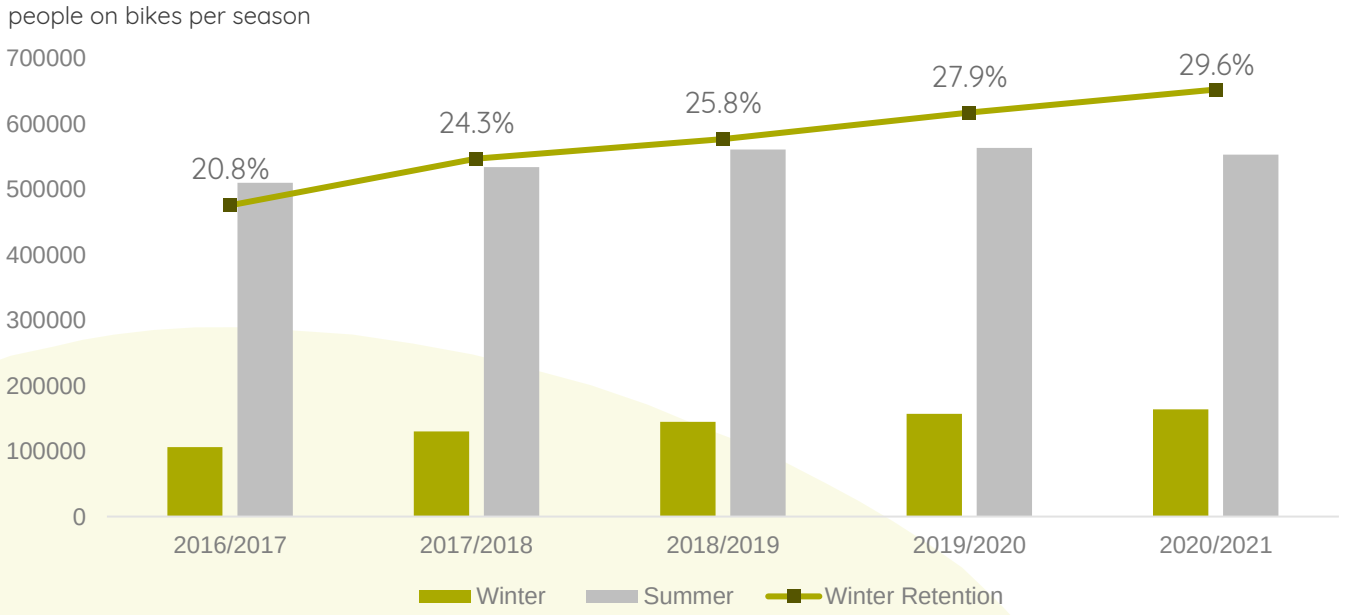
Bicycle activity growth has not occurred uniformly throughout months of the year. Over the past ten years, growth has been more pronounced during the spring months (March – May) and in November. Put together, the greatest increase in cycling has occurred on either side of the summer cycling season, often referred to as the shoulder season. Furthermore, winter cycling (December – January) growth has outstripped peak season growth. Therefore, Vancouver cyclists are riding for more months of the year than they were a decade ago.

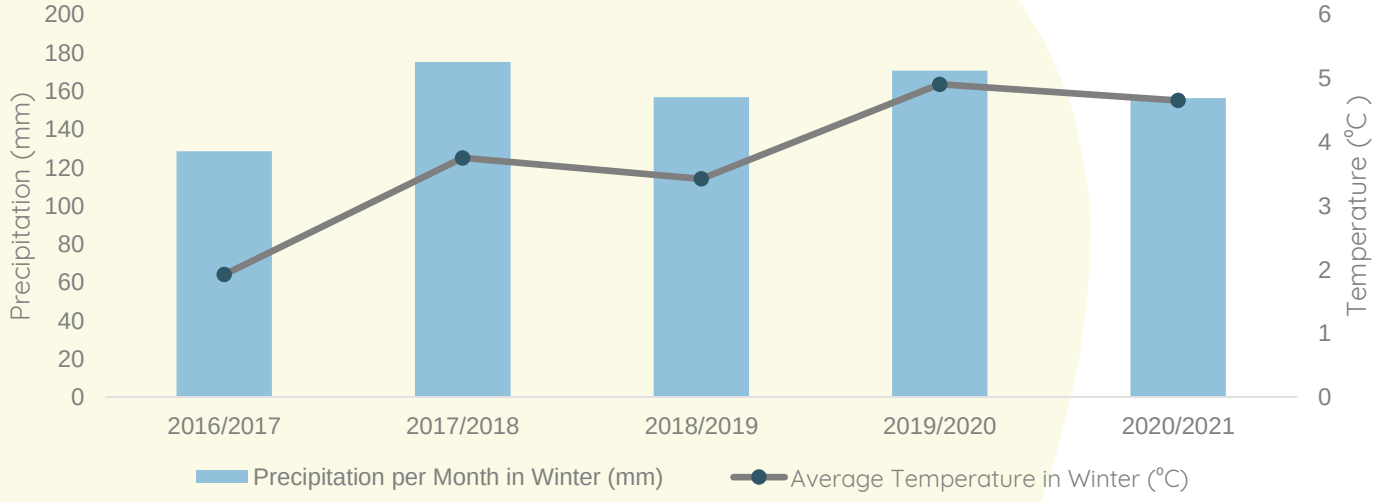


1. Percent changes by month are calculated by comparing 2018-2020 averages with 2010-2012 averages.
2. Monthly totals are calculated as the sum of bike counts at three counting locations: Burrard Bridge, Hornby Street and Dunsmuir Viaduct.
3. Dunsmuir Viaduct data is not available in 2010, thus a reference period of 2011-2012 is used.
4. Bike counts at Hornby Street are estimated Jan-Feb 2010 and May-June 2020.

Winter Retention Over 5 Years

Winter cycling is becoming more common in Vancouver with each year. Five years ago, winter cycling represented 21% of summer traffic on Burrard Bridge. Last winter, cycling increased to 30% of summer traffic. The increase in winter ridership has been constant and consistent over the past five winters. This increase in winter cycling does not appear to be caused by a change in weather. Although winter temperatures appear to have risen (last winter was 3°C warmer than five winters ago), precipitation has also increased. Increased winter ridership is likely impacted by improved and more-connected cycling infrastructure as well as a cultural shift in the cycling community.



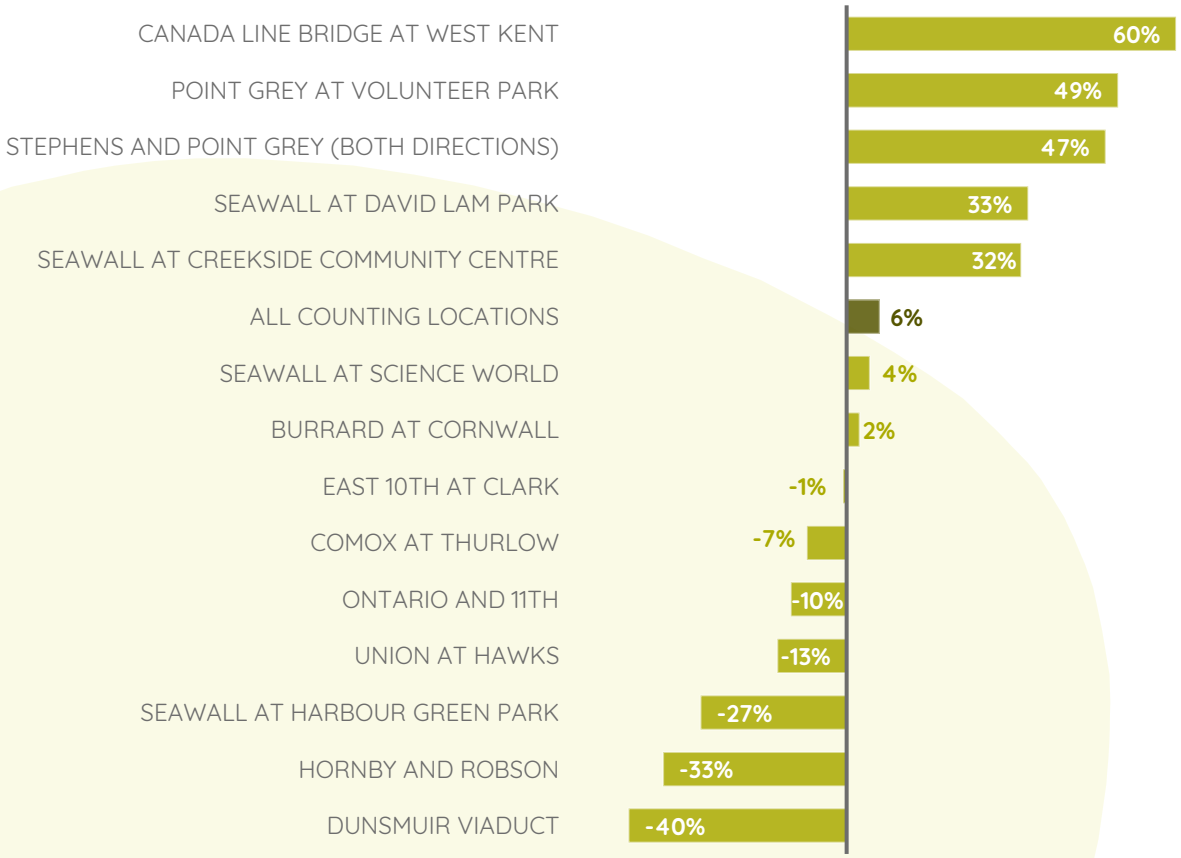


1. The winter season is defined as Dec 1 to Feb 28 and the summer season is defined as Jun 1 to Aug 31.

Impact of the Pandemic on Vancouver Cycling
Analysis by year, comparing 2019 and 2020

Although the pandemic resulted in a cycling boom, activity at bicycle facilities across the city did not change uniformly. Overall, bicycle activity grew by 6% in 2020 with respect to 2019. This overall growth occurred despite a significant reduction in commuting and other utilitarian trips.

Bicycle counting locations in the downtown area, including the Dunsmuir Viaduct and Hornby at Robson, experienced the steepest declines. This decline reflects an overall decrease in commuting trips to the downtown core in the context of the pandemic. Meanwhile, bicycle activity along routes with a recreational focus including locations along the Canada Line, Point Grey and the False Creek Seawall experienced between 30% and 60% growth in cycling. The increase in cycling along protected and off-street cycling facilities demonstrates how versatile these spaces are: they function as safe commuting corridors in normal times and adapted into primarily recreational spaces during the pandemic.

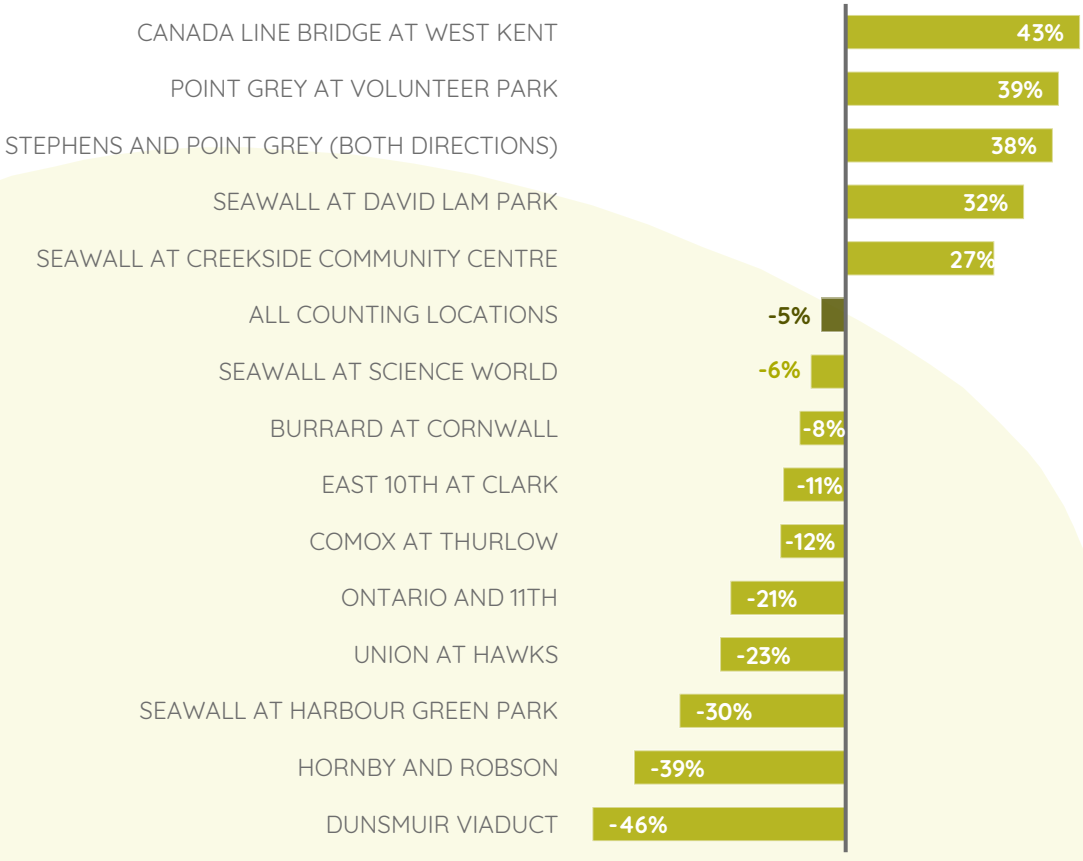


1. Bike counts are estimated at Hornby Street (May-June 2020), Seawall at Science World (May-June 2020) and East 10th at Clark (October-December).
2. The counting periods used for this analysis are Apr 1st – Dec 31st in both 2019 and 2020 in order to isolate pre-pandemic and pandemic periods.

Impact of the Pandemic on Vancouver Weekday Cycling
Analysis by year, comparing 2019 and 2020

Overall, bicycle activity decreased by 5% in 2020 with respect to 2019. This overall decrease is a result of a reduction in commuting and other utilitarian trips. Comparatively, vehicle traffic decreased by 40%-50% in April 2020; while car traffic has gradually increased, it remains 10%-15% below pre-pandemic levels(1).

Bicycle counting locations in the downtown area experienced the steepest declines. Meanwhile, bicycle activity along routes with a recreational focus including locations along the Canada Line, Point Grey and the False Creek Seawall experienced between 30% and 40% growth in cycling during weekdays.

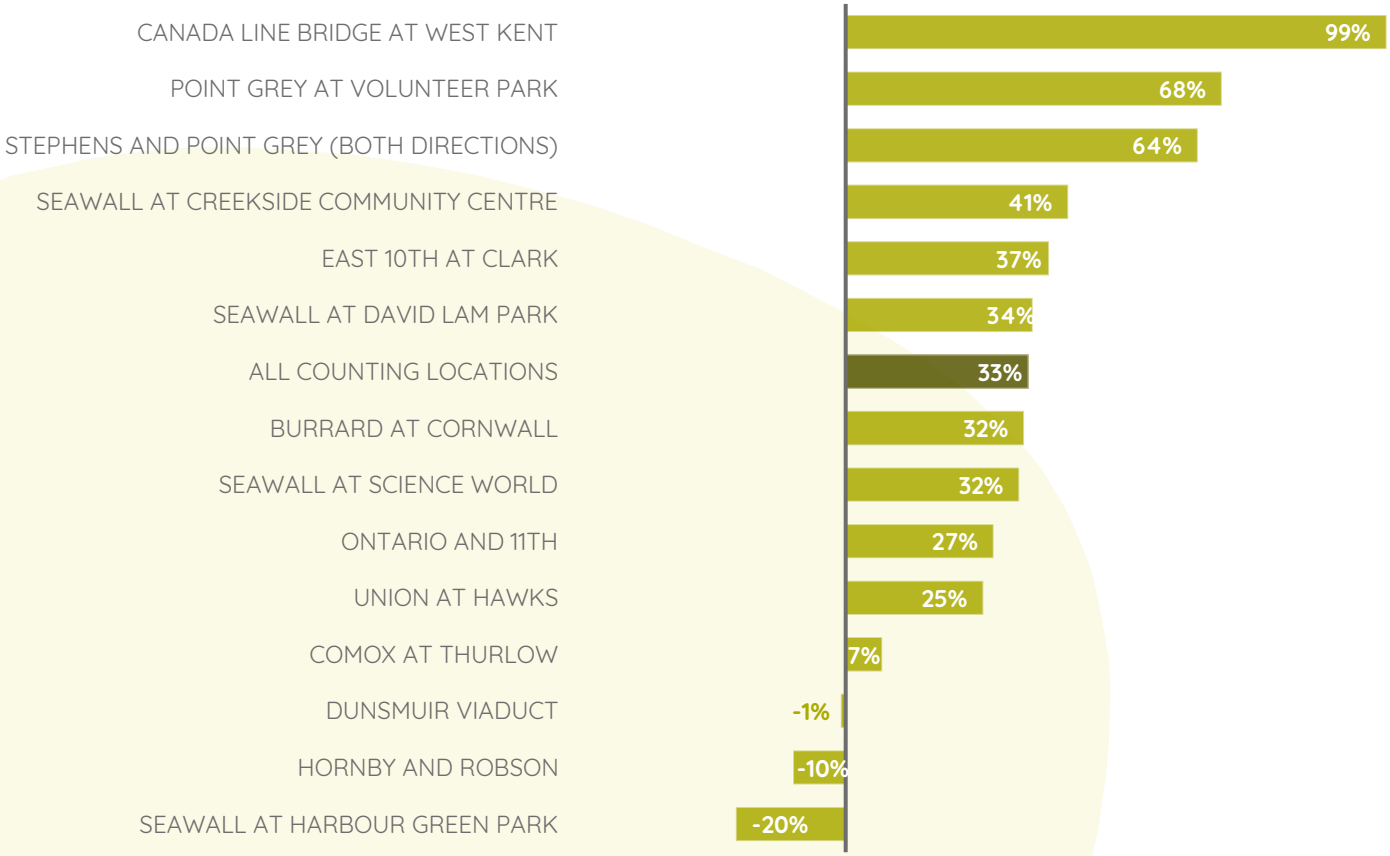


(1) https://vancouver.ca/news-calendar/pandemic-drives-down-vancouver-vehicle-traffic-and-collisions-in-2020.aspx - accessed 2021-08-05

Impact of the Pandemic on Vancouver Weekend & Holiday Cycling
Analysis by year, comparing 2019 and 2020

Activity at bicycle facilities across the city tended to shift from weekdays to weekends in 2020. Overall, bicycle activity increased by 33% in 2020 with respect to 2019. This immense growth in cycling activity on weekends is in stark contrast to the small decrease in cycling on weekdays.

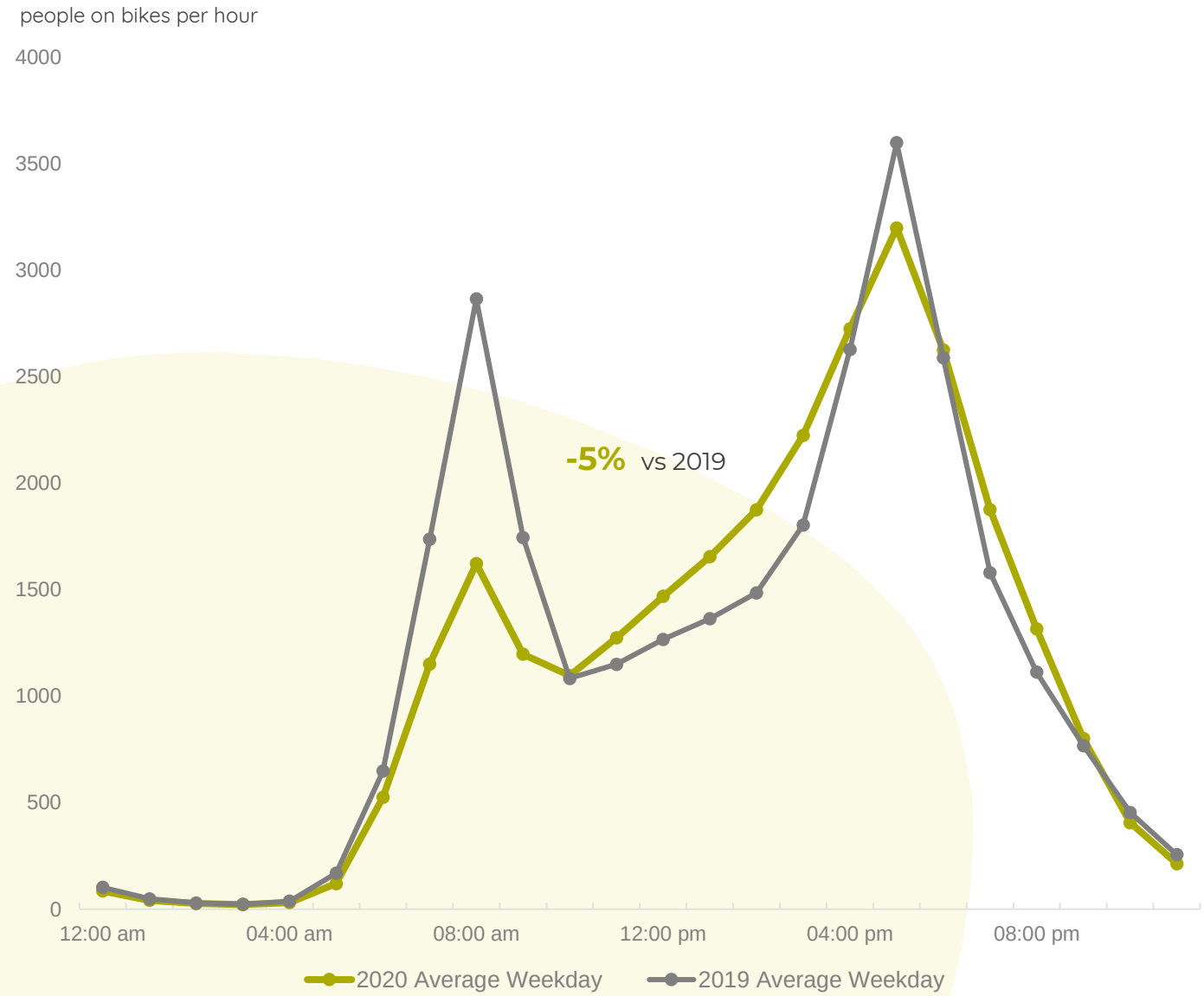
As with weekday traffic patterns, activity at bicycle facilities across the city did not change uniformly. However, all counting locations outside of the downtown area experienced a significant increase in bike activity. Only three bicycle counting locations in the downtown area had slight declines in counts. Meanwhile, bicycle activity along the Canada Line, Point Grey and the False Creek Seawall experienced between 40% and 100% growth in cycling during weekends and holidays.



Impact of the Pandemic on Vancouver Weekday Cycling

Hourly profile analysis, comparing 2019 and 2020

Bicycle activity decreased by 5% in 2020 with respect to 2019 on non-holiday weekdays even though between 10AM and 5PM activity was higher in 2020 than in 2019. This overall decrease is entirely due to a reduction of commuting-hour trips. Bicycle flows were drastically reduced between 6AM and 10AM, especially between 8AM and 9AM when flows were halved in 2020.

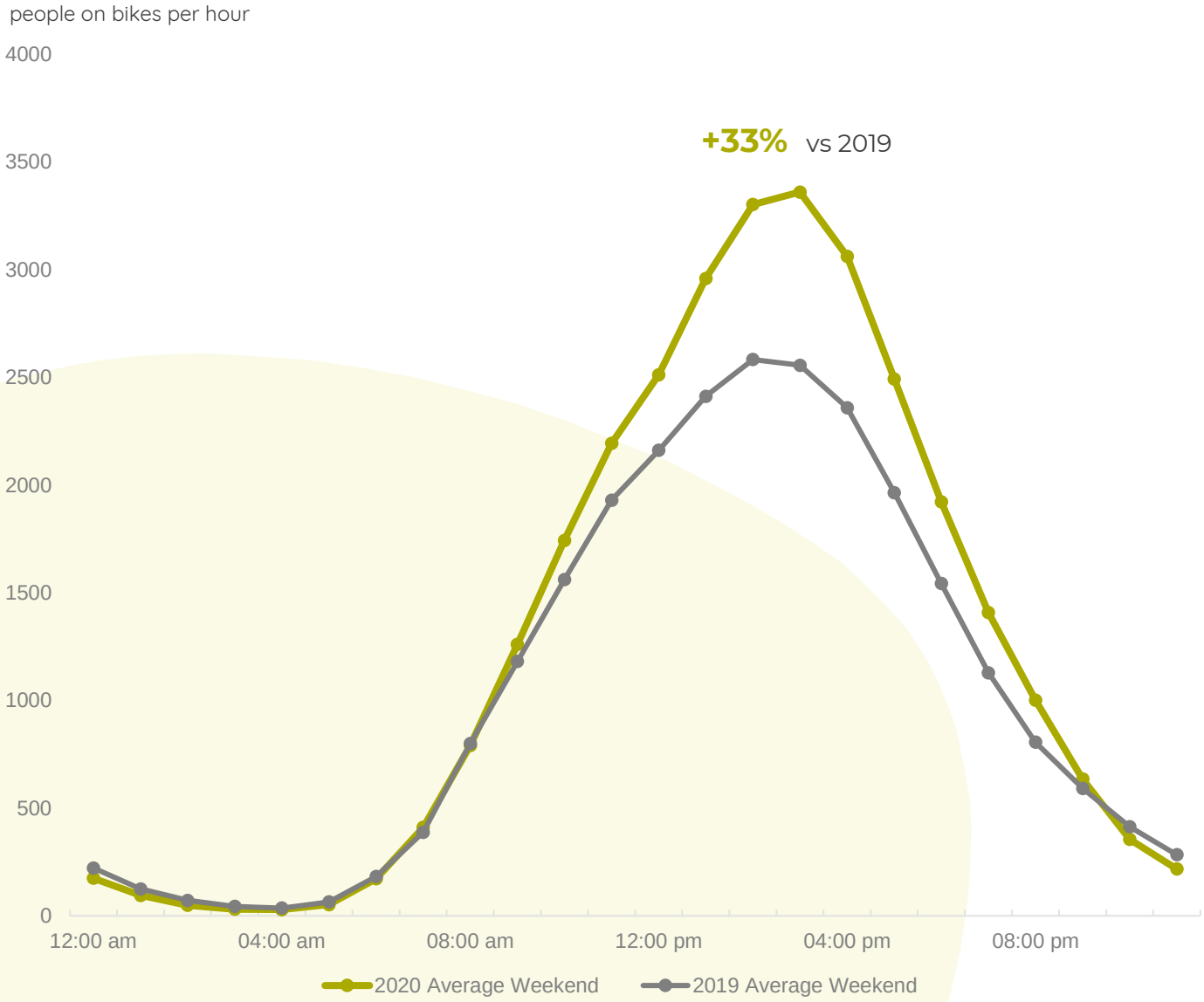


The analysis in the graph above is obtained by aggregating hourly counts at all 14 automated bicycle counting locations reported on in the previous pages. The graph describes the overall bicycle activity in Vancouver on weekdays, by hour, in 2019 and 2020.

Impact of the Pandemic on Vancouver Weekend & Holiday Cycling

Hourly profile analysis, comparing 2019 and 2020

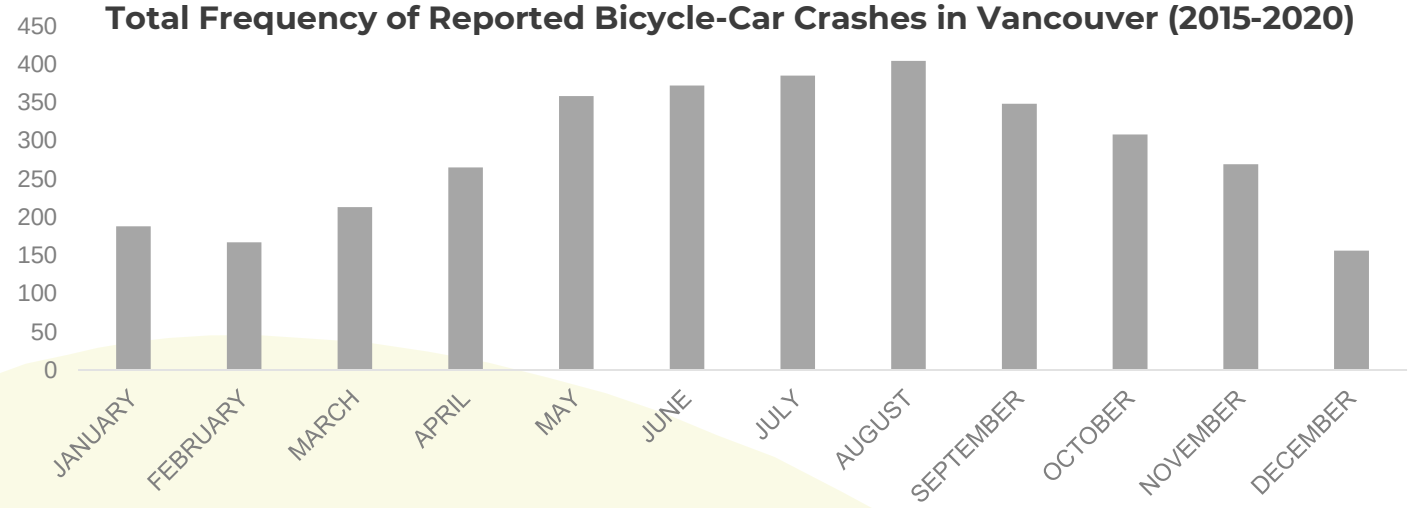
Overall, bicycle activity increased by 33% in 2020 with respect to 2019. This growth in cycling activity occurred between 9AM and 9PM on weekends and on holidays. The dramatic increase in cycling along protected and off-street cycling facilities reveals the resiliency of these corridors; they accommodated thousands of additional people per day when recreational options were limited by the pandemic.

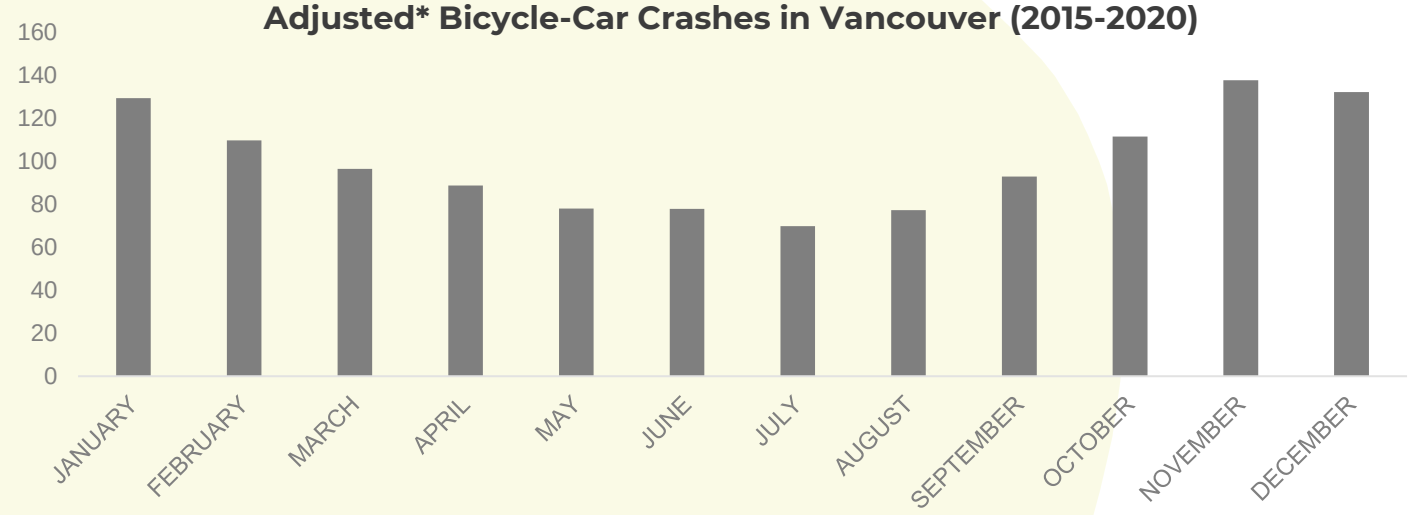


The analysis in the graph above is obtained by aggregating hourly counts at all 14 automated bicycle counting locations reported on in the previous pages. The graph describes the overall bicycle activity in Vancouver on holidays and on weekends, by hour, in 2019 and 2020.

Changes in Bike Safety Over Time
Monthly Analysis

Monthly reported bicycle-car crashes are most common during the peak cycling season (May – September) and are highest in August (see top chart). However, when factoring in cycling exposure, bicycle crash risk peaks in November (see bottom chart) and is highest throughout the late fall and early winter (November-January). The season with the highest risk coincides with a period of reduced visibility due to shorter days and increased precipitation. The month of November has twice the crash risk associated with the month of July when applying this approach to calculate bicycle crash risk.





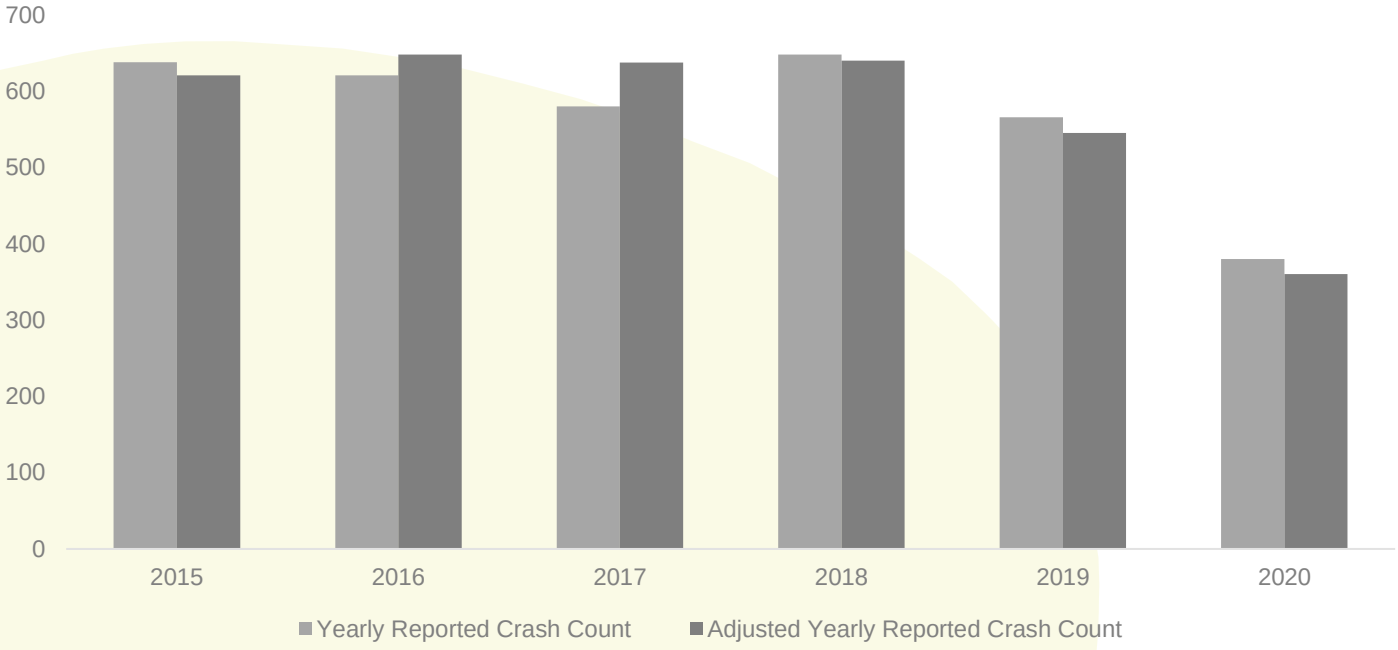
Adjusted bicycle crashes by month are calculated in two steps. First, each total monthly frequency of reported crashes is divided by the average monthly bicycle counts at the Burrard Bridge (2015-2020). Second, the monthly quotients are scaled such that the monthly average is 100.

Changes in Bike Safety Over Time
Yearly Analysis

The number of reported bicycle crashes in Vancouver remained relatively stable by year between 2015 and 2018. When adjusting for bicycle ridership, the number of yearly crashes remained within 2% of the average yearly total of 635 during the period. However, in 2019, crash rates dropped by almost 15% from the previous four-year period.

In 2020 the crash rate plummeted by 43% from the 2015-2018 average. Decreased vehicle volumes during the early stages of the pandemic (April-June, 2020) likely played a major role in the reduction of bicycle crashes(1); the reductions of bicycle crashes by month compared to the previous year were highly correlated to the reduction in vehicle traffic by month compared to the previous year. This relationship between car volumes and bicycle crashes highlights that vehicle exposure may contribute more to bicycle crashes than bicycle exposure. In other words, one of the most effective ways of improving safety for people on bikes is to reduce the number of cars on the road.

Total Frequency of Reported Bicycle-Car Crashes by Year in Vancouver

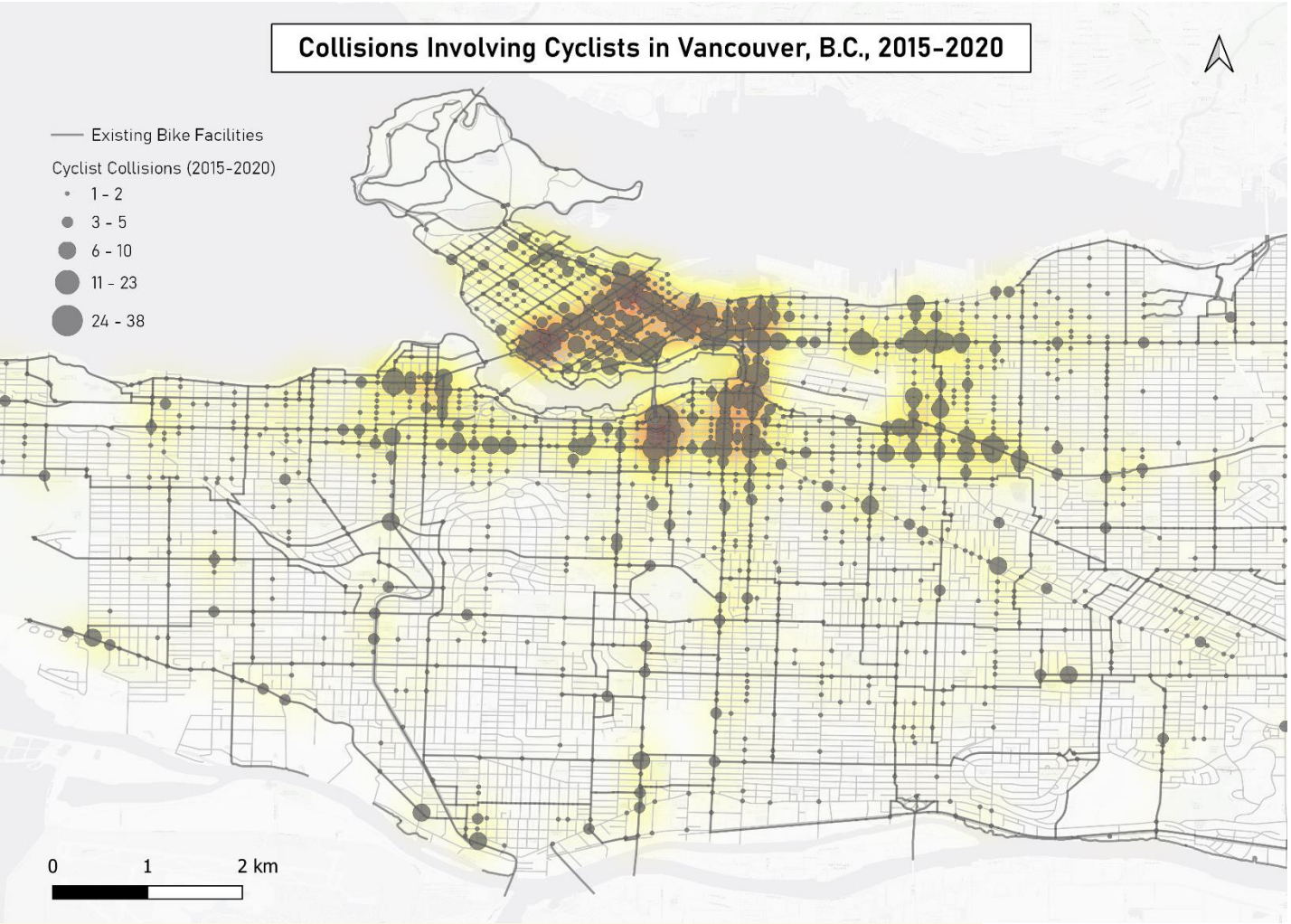


Adjusted bicycle crashes by year are calculated in two steps. First, each total yearly frequency of reported crashes is divided by the yearly bicycle counts at the Burrard Bridge (2015-2020). Second, the yearly quotients are scaled such that the total number of reported crashes between 2015-2020, 3433 crashes, is preserved.

(1) https://vancouver.ca/news-calendar/pandemic-drives-down-vancouver-vehicle-traffic-and-collisions-in-2020.aspx - accessed 2021-08-05

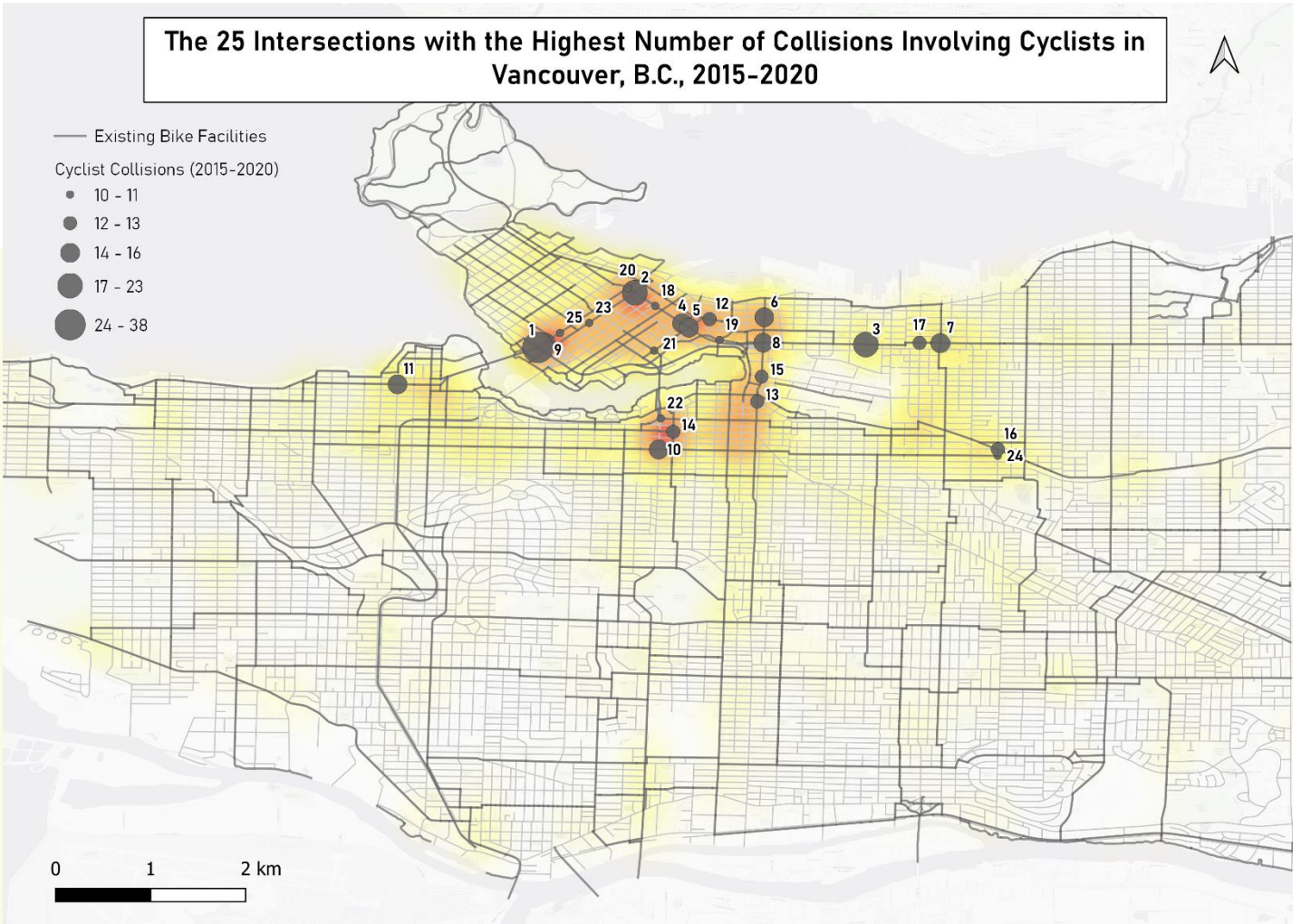
Collision Frequency of People on Bikes
Spatial Analysis

The most heavily used cycling facilities tend to be where the most collisions involving people on bikes occur. The number of reported collisions involving a person on a bike, by intersection during the six-year period between 2015 and 2020 are plotted in the figure below. All 3433 collision in Vancouver between 2015 and 2020 are included. It is evident from the map that collisions involving a person on a bike are concentrated in Downtown Vancouver and along major cycling corridors. However, the map also indicates many collisions at intersections outside of the city center and on roads without cycling facilities.



Collision Frequency of People on Bikes
Spatial Analysis

A list of the 25 intersections with the most bicycle-car collisions between 2015 and 2020 are presented in the map below and in the table on the following page. Most of the 25 intersections are located in downtown Vancouver. Note that these rankings do not necessarily represent the highest priority locations for improvements as some of the locations have received road treatments in the past few years. Ten locations, identified on the following page and highlighted in green, will likely experience a reduction in collisions as a result of the improvements. The analysis and rankings do not differentiate between collisions occurring before and after road treatments were completed.



Collision Frequency of People on Bikes
Spatial Analysis

All of the 25 intersections in the table below had at least ten reported bicycle collisions between 2015 and 2020 and all but three intersections are found on an existing bicycle facility. More than 10% of all reported bicycle collisions across thousands of intersections in Vancouver occurred at these 25 intersections. Ten locations, highlighted in green, received road treatments since 2015.

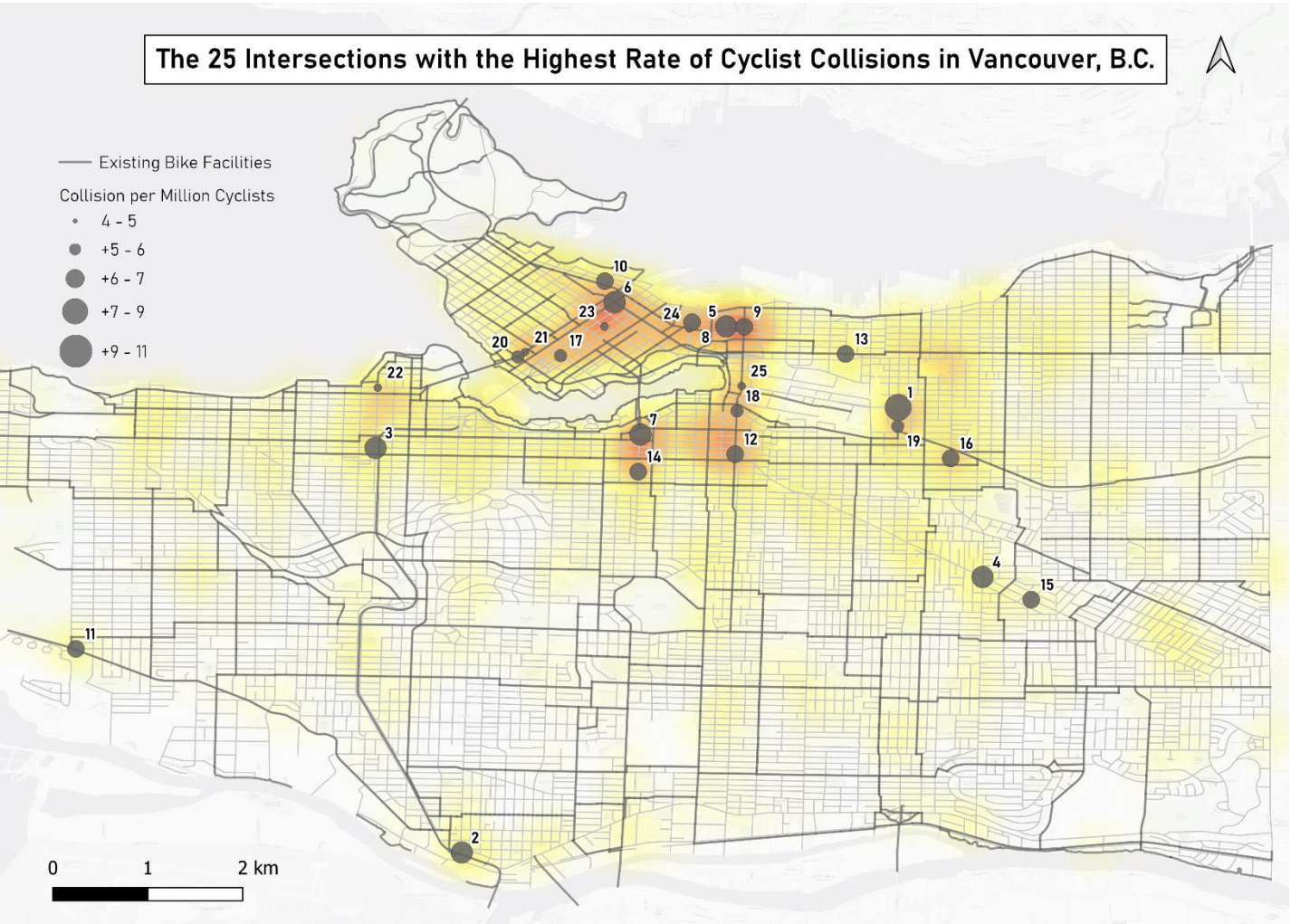
Rank (Highest to Lowest)	Location	Number of Collisions (2015-2020)	Risk (Collisions per Million Cyclists)	Average Annual Daily Bikes	Existing Bike Facilities?	Year of Network Change
1	Burrard St. and Pacific St.	38	5.35	3241	Yes	2018
2	Hornby St. and Dunsmuir St.	23	7.4	1420	Yes	2015
3	Union St. and Campbell Ave.	19	6.31	1374	Yes	2019
4	Dunsmuir St. and Cambie St.	16	4.52	1615	Yes	2016
5	Dunsmuir St. and Beatty St.	16	4.51	1621	Yes	2016
6	Main St. and E. Hastings St.	16	6.64	1100	No	2019
7	Adanac St. and Mclean Dr.	15	4.58	1495	Yes	-
8	Main St. and Union St.	15	3.07	2228	Yes	-
9	Burrard St. and Harwood St.	14	5.01	1275	Yes	2018
10	Cambie St. and 10th Ave.	14	4.38	1459	Yes	2018
11	Arbutus St. and York Ave.	14	4.04	1581	Yes	-
12	Abbott St. and W. Pender St.	13	4.64	1281	Yes	-
13	Main St. and E 2nd Ave.	13	5.64	1053	No	2019
14	W. 7th Ave. and Yukon St.	12	2.49	2200	Yes	-
15	Main St. and Terminal Ave.	12	4.58	1196	No	2019
16	E. Broadway and Victoria Dr.	12	3.42	1604	Yes	-
17	Adanac St. and Clark Dr.	12	4.2	1306	Yes	2017
18	Dunsmuir St. and Seymour St.	11	3.24	1549	Yes	2016
19	Carrall St. and Expo Blvd.	11	2.78	1804	Yes	-
20	Burrard St. and Dunsmuir St.	11	4.48	1121	Yes	-
21	Beatty St. and Smithe St.	11	3.24	1551	Yes	2016
22	Cambie St. Bridge and W. 2nd Ave.	11	2.89	1736	Yes	-
23	Hornby St. and Nelson St.	10	2.63	1740	Yes	-
24	E. 10th Ave. and Victoria Dr.	10	4.28	1066	Yes	-
25	Burrard St and Davie St.	10	2.99	1525	Yes	-

Locations with upgrades/improvements between 2015-2020

Removed from formal cycling network between 2015-2020

Collision Rate of People on Bikes
Spatial Analysis

The collision rates of people on bikes at intersections throughout the city are illustrated in the map below. In contrast to the collision frequency map on the previous pages, intersections with the highest collision rates are spread throughout Vancouver. In fact, none of the five highest risk intersections are located in downtown Vancouver. Several corridors lacking cycling infrastructure including Cambie, Hastings and Main have multiple intersections that are considered high risk. Two of the intersections are located on Cambie, south of the Cambie Bridge, where no cycling infrastructure exists; four of the intersections occur on Main Street; and two of the intersections occur on E Hastings Street. Note that six locations have received road treatments in the past few years (see table on next page) and that the rankings do not differentiate between collisions occurring before and after road treatments were completed.



Collision Rate of People on Bikes
Spatial Analysis

High-risk intersections are more commonly associated with roads lacking cycling infrastructure. Only seven of the top 25 are located on cycling facilities. The table below illustrates the most dangerous intersections throughout the city based on the highest collision rates. A total of 20 intersections had an estimated collision rate of more than five collisions per million bike trips.

Rank (Highest to Lowest)	Location	Risk (Collisions per Million Cyclists)	Average Annual Daily Bikes	Number of Collisions (2015-2020)	Existing Bike Facilities?	Year of Network Change
1	Clark Dr. & E. 1st Ave. & Grandview Viaduct	9.3	393	8	No	-
2	Granville St. & Milton St. & SW. Marine Dr.	7.9	349	6	No	-
3	Arbutus St. & W. Broadway	7.7	414	7	Yes	2017/2018
4	Kingsway and Victoria Dr.	7.6	361	6	No	-
5	Columbia St. and E. Hastings St.	7.6	422	7	No	-
6	Dunsmuir St. and Hornby St.	7.4	1420	23	Yes	2015
7	Cambie St. and W. 6th Ave.	7.4	618	10	No	-
8	Abbott St. and W. Hastings St.	6.8	473	7	No	-
9	E. Hastings St. And Main St.	6.6	1100	16	No	2019
10	Thurlow St. and W. Hastings St.	6.6	416	6	No	-
11	Camosun St. & SW Marine Dr. & W. 41st Ave. & Turning Lane	6.6	485	7	Yes	2018
12	E. Broadway and Main St.	6.5	419	6	No	2019
13	Campbell Ave. and Union St.	6.3	1374	19	Yes	2019
14	Cambie St. and W. 12th Ave.	6.2	366	5	No	-
15	Kingsway and Nanaimo St.	6.2	370	5	No	-
16	Commercial Dr. and E. Broadway	6.1	373	5	No	-
17	Davie St. and Granville St.	5.7	480	6	No	-
18	E. 2nd Ave. and Main St.	5.6	1053	13	No	2019
19	Clark Dr. and E. 4th Ave.	5.6	410	5	No	-
20	Burrard St. and Pacific St.	5.4	3241	38	Yes	2018
21	Burrard St. and Harwood St.	5.0	1275	14	Yes	2018
22	Arbutus St. and Cornwall Ave.	4.9	560	6	No	-
23	Granville St. and Robson St.	4.7	484	5	No	-
24	Abbott St. and W. Pender St.	4.6	1281	13	Yes	-
25	. Main St. and Terminal Ave	4.6	1196	12	No	2019

Locations with upgrades/improvements between 2015-2020

Removed from formal cycling network between 2015-2020

Collision Rate of People on Bikes
Highest Risk Intersections

The highest-risk intersections, established in the study by estimating bicycle collision rates, are located on arterial roads. These intersections typically have multiple turning lanes, and in some cases slip lanes, making crossing by bicycle or on foot difficult. The three photos below provide visual context to these three intersections.

Clark Dr & East 1st Ave: *Eight collisions in six years* representing an estimated rate of *9.3 collisions per million cyclists*

Granville St. & SW. Marine Dr: *Six collisions in six years* representing an estimated rate of *7.9 collisions per million cyclists*

Kingsway and Victoria Dr: *Six collisions in six years* representing an estimated rate of *7.6 collisions per million cyclists*

Key takeaways: bicycle ridership and safety in Vancouver 2010-2020

1. There has been a significant and consistent yearly increase in cycling participation over the past decade in Vancouver. This increase coincides with, and has been driven by, a large-scale expansion of the protected cycling network.
2. Winter cycling is becoming more common among Vancouver residents. There has been consistent yearly growth over the past five winters.
3. Bicycle participation has remained high throughout the pandemic. Cycling activity has shifted towards weekday afternoons and on weekends.
4. Reported collisions have reduced significantly in 2019 and 2020 when compared to the previous four years. An expanded protected bicycle network and dramatically reduced vehicle exposure in 2020 are the likely factors contributing to the reduced collision rates.
5. Collision risk for people on bikes is highest in the late fall and early winter.
6. Network screening of collision risk at intersections illustrates a handful of higher-risk intersections throughout Vancouver. The majority of these intersections are on arterials with high vehicle volumes and without protected cycling infrastructure.

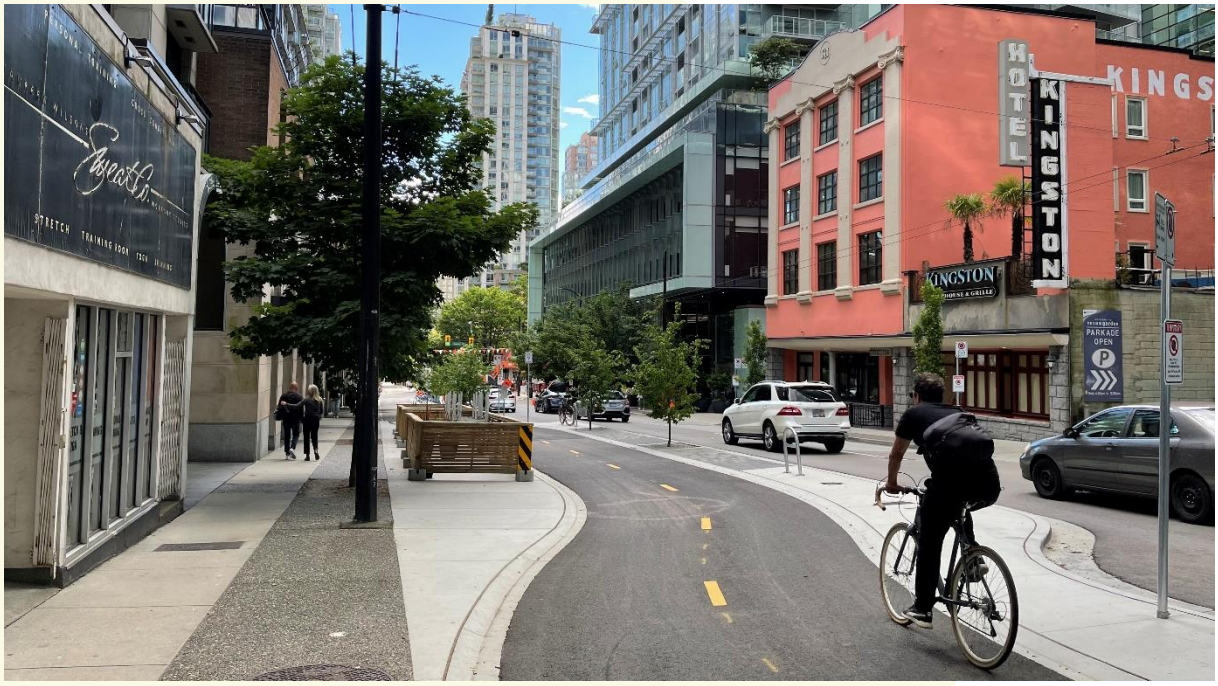
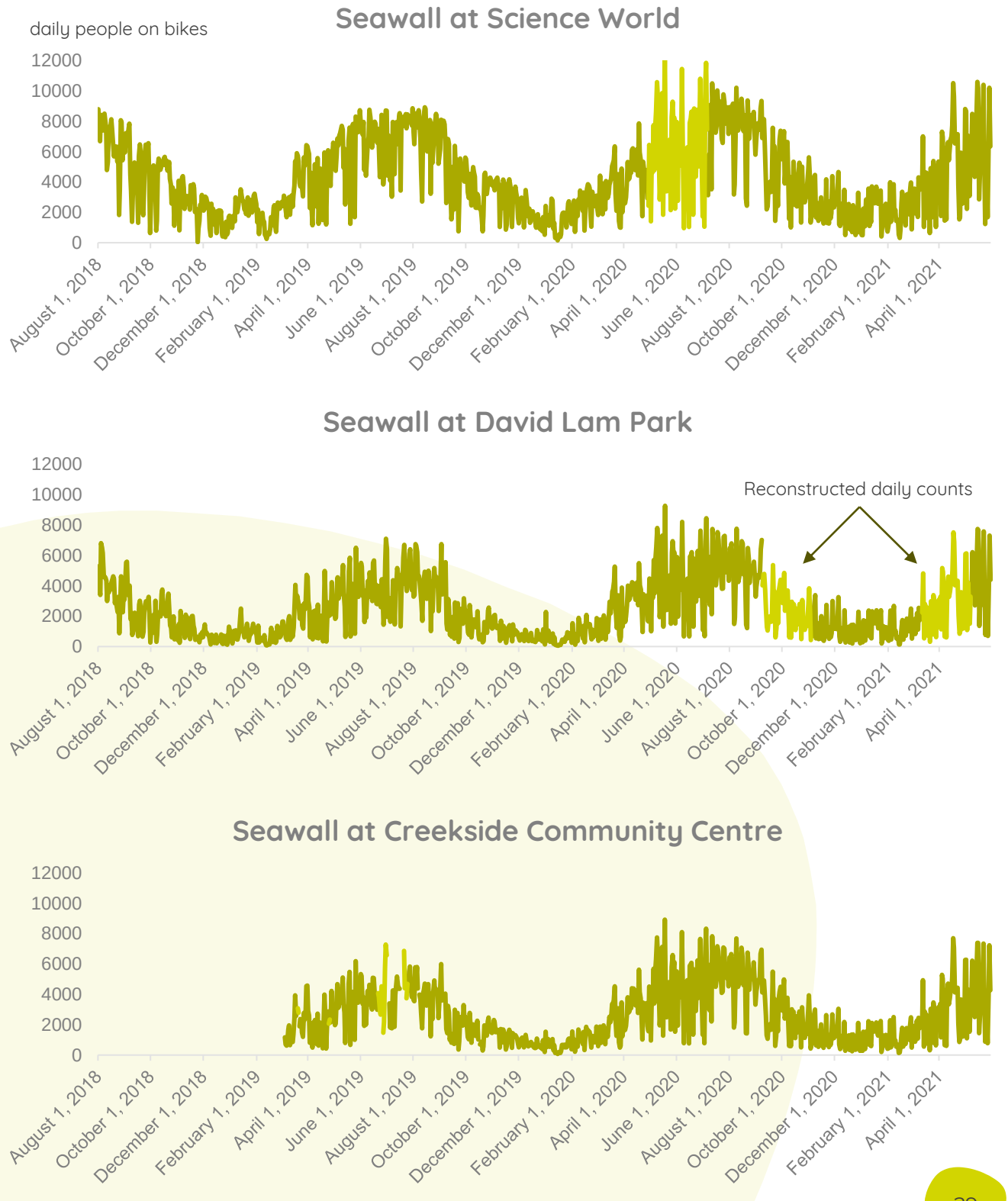
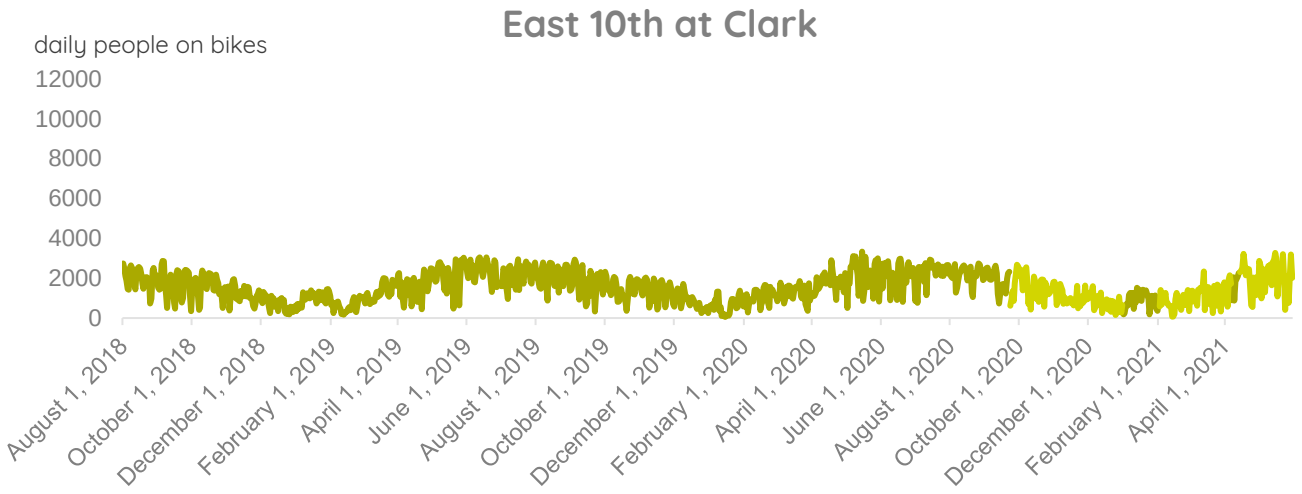


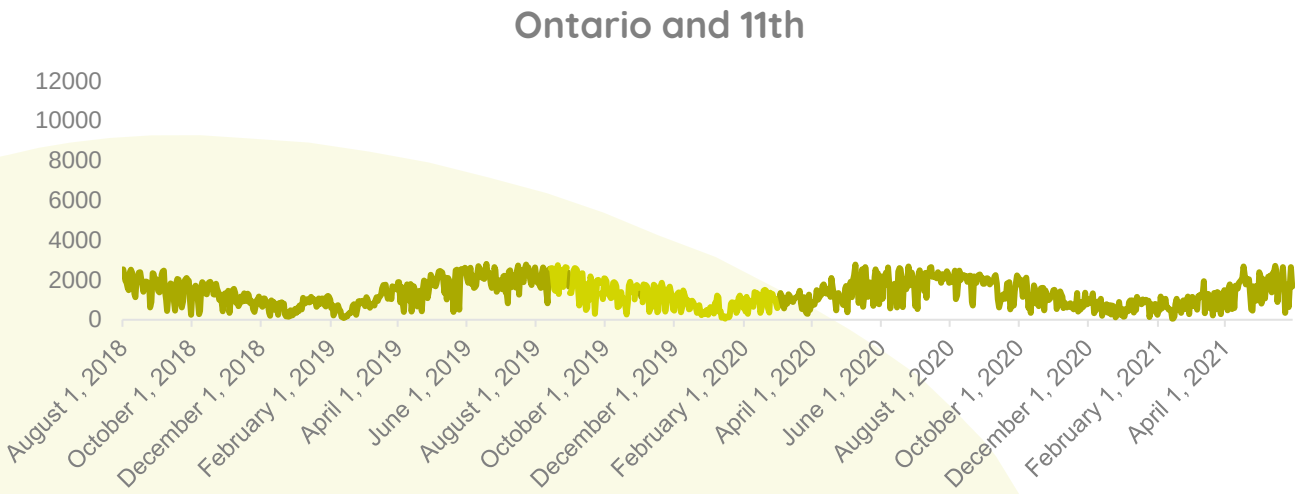
Photo credit: Richards Street Protected Bike Lane, taken on June 9, 2021 by Paul Krueger

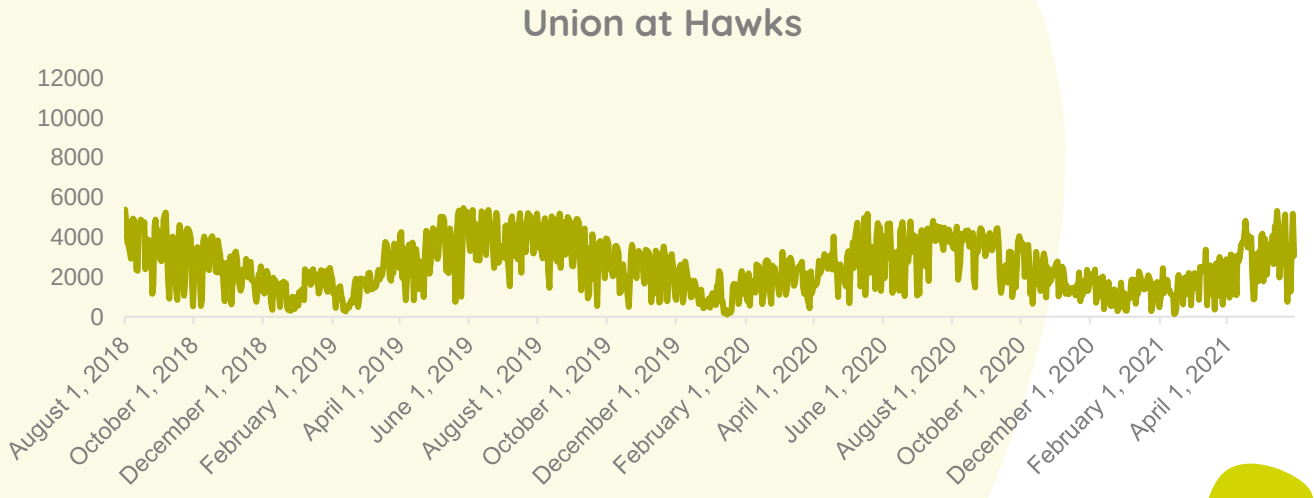
Appendix: evolution of bicycle activity 2018-2021



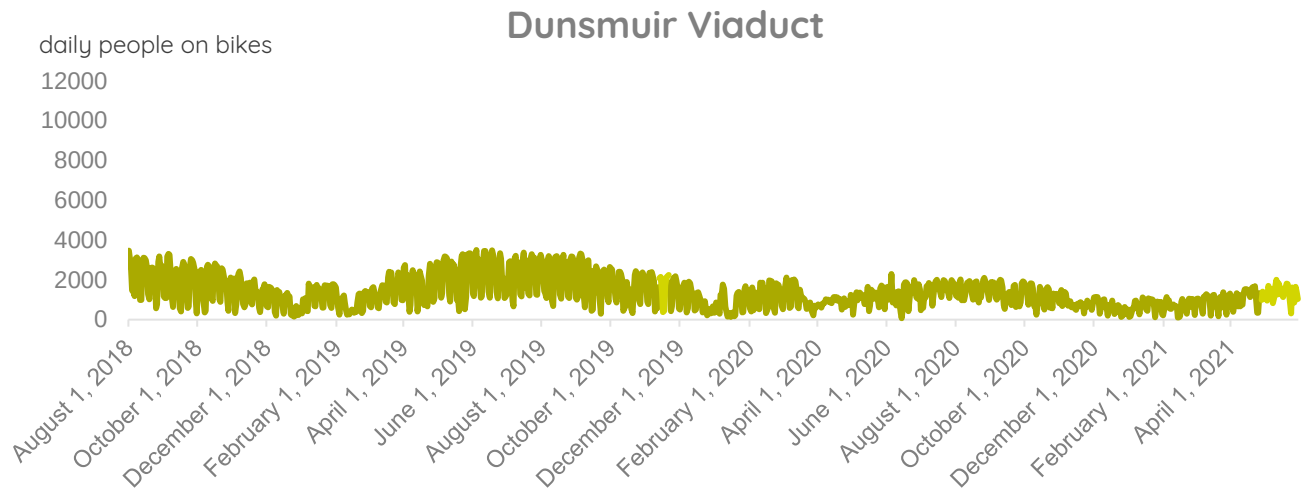
Appendix: evolution of bicycle activity 2018-2021

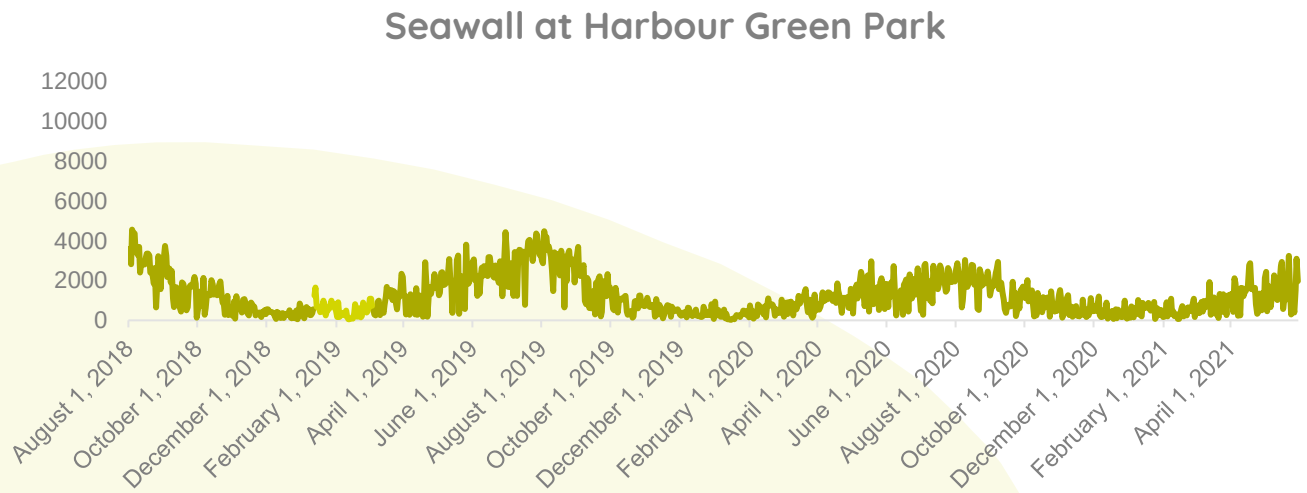


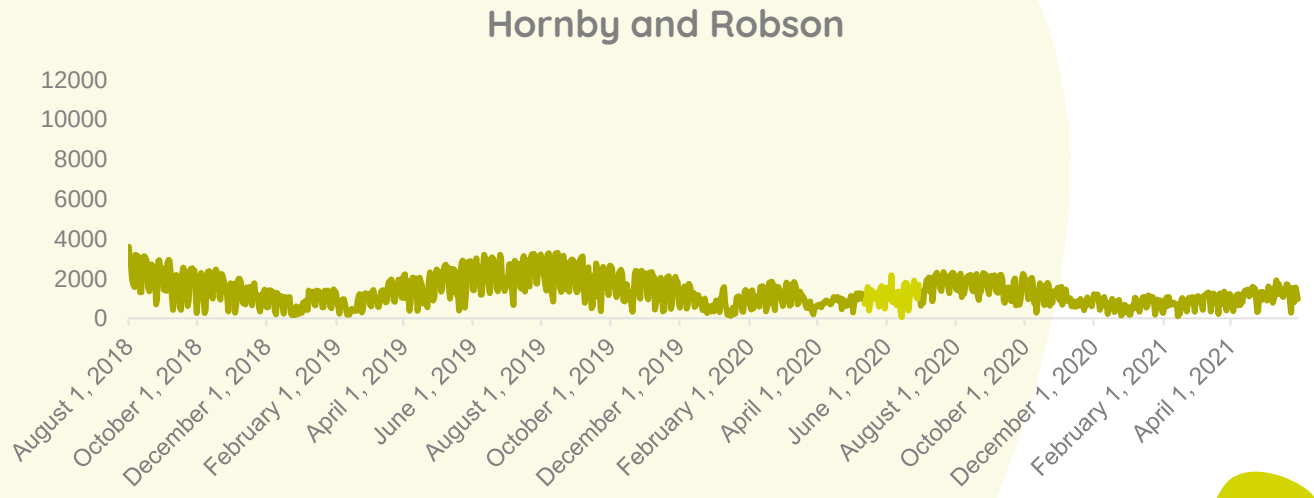




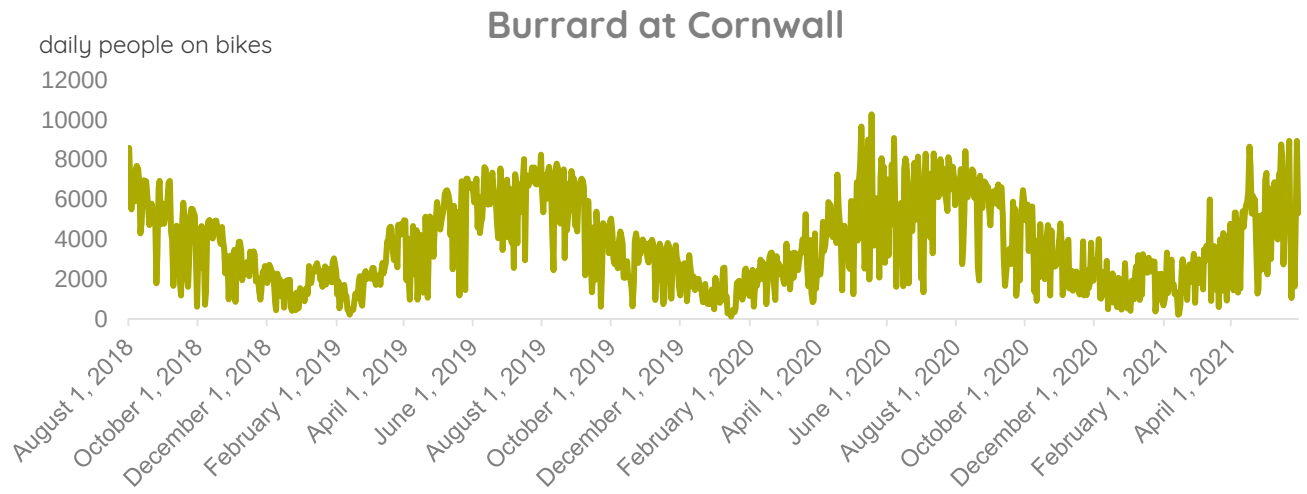
Appendix: evolution of bicycle activity 2018-2021

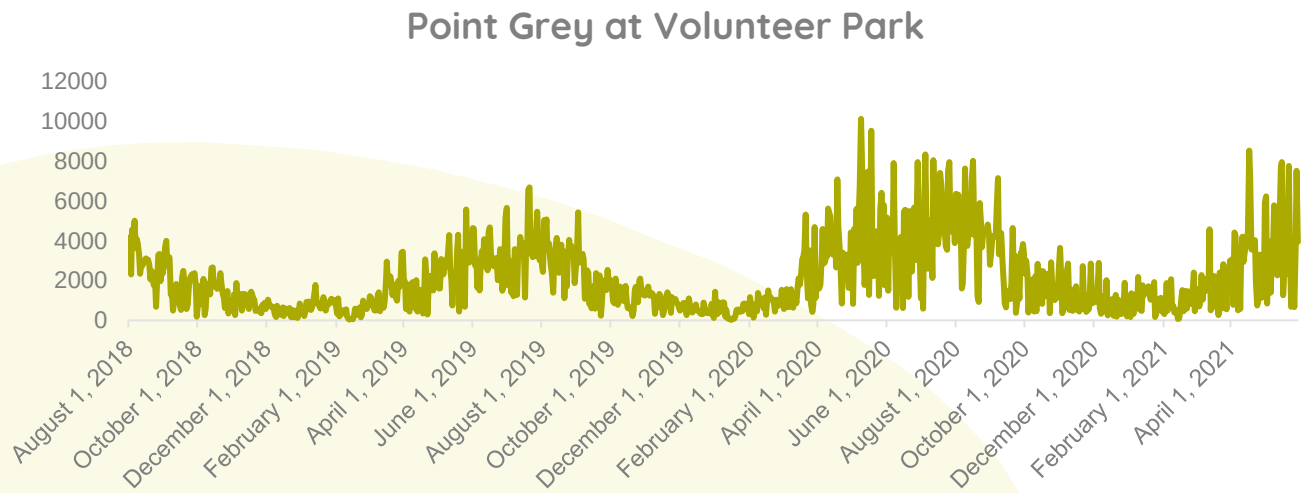


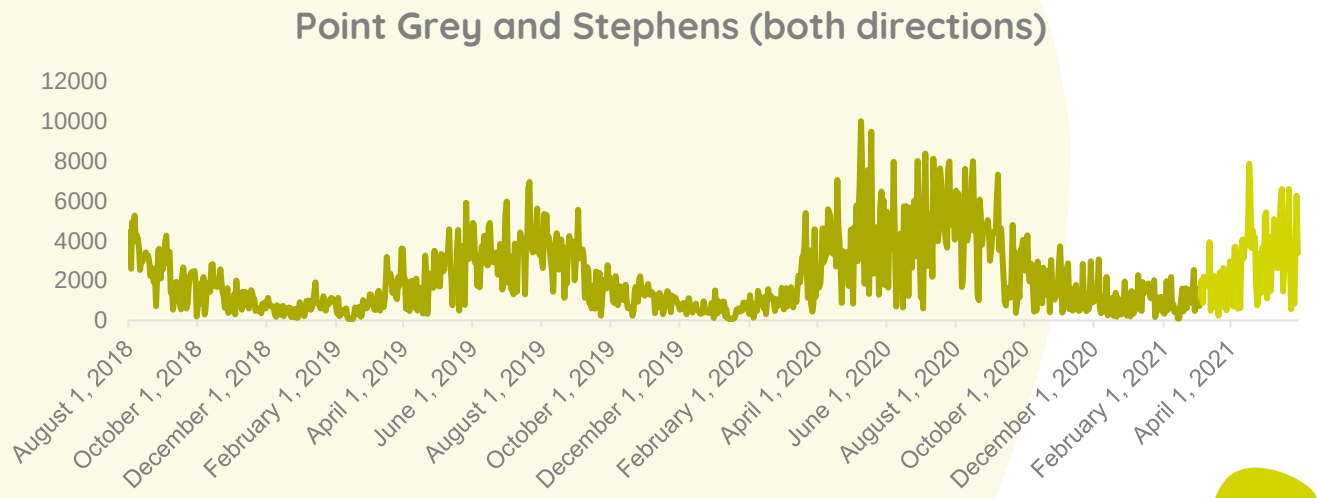




Appendix: evolution of bicycle activity 2018-2021







Appendix: data limitations

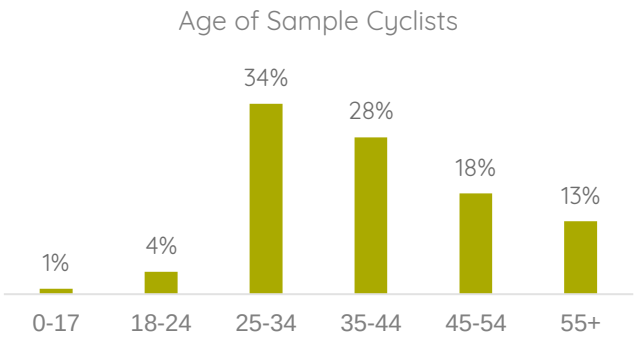
Bicycle trip (GPS) data description

SmartHalo Dataset Trips

Trip Distance (in meters)		Trip Duration (in seconds)	
maximum	60,881 m	maximum	10,232 s
median	2806 m	median	582 s
average	5147 m	average	996 s
Total trips (after filtering)	7166 trips		
Total trips (raw)	12357 trips		

SmartHalo Dataset Users

Unique Smarthalo users	360 users
Gender	
Female	22%
Male	73%
Trans	1%
Prefer not to say	4%



Representativity of GPS trace sample set

SmartHalo devices provide users with navigation information, an anti-theft alarm and a powerful front light. The Smarthalo devices was marketed for users who bike more for utilitarian purposes; the added weight of the device is not desired for recreational sport/road cyclists. Therefore, the trips recorded are biased towards trips focused on commuting purposes. SmartHalo devices are not designed to be installed on skateboards, rollerblades, scooters, e-scooters or other rideable devices considered as micromodes.

SmartHalo dataset underrepresents female riders and older (55+) riders. Females on bikes are underrepresented in the sample bicycle trip dataset, representing 22% of recorded trips; compared to the Census data (2016) where females on bikes represent 37% and the TransLink Trip Dairy Survey (2017) where females on bikes represent 39%. People aged 18-24 (4%), 25-34 (34%) and 35-44 (28%) are slightly overrepresented in the sample bicycle trip dataset when comparing with the TransLink Data. On the other hand, people ages 55 years or older are significantly underrepresented (13% for SmartHalo and 21% for Translink).

The Trip Diary Survey (2017) notes the average cycling trip length in Vancouver to be 4.5 kilometers, whereas SmartHalo's average trip distance is 5.1 km.

Appendix: data limitations

Modeling bike traffic across the network
The geospatial analysis in this study involved the fusion of data from 20 automated bicycle counters and anonymized bicycle route data from SmartHalo users. These data were combined to estimate bike traffic on all roads, multi-user trails and intersections throughout the City of Vancouver. Approximately 350 citizens with SmartHalo devices were tracked throughout 7200 bike trips. These trips represent 37,000 km of bicycle travel completed between January 2018 and February 2020. Although these trips correspond to a large total distance traveled, they represent a relatively sparse dataset when considering the entire Vancouver road network which is more than 2000 km in length. There were many hundreds of local or arterial road segments without bike lanes and with fewer than 5 bicycle trip traces. Furthermore, most of the automated bicycle counters are located near the downtown center and on protected bicycle infrastructure, which is not representative of the entire road network. Thus, the primary limitation in this study is related to the bicycle count data sources: There were insufficient bicycle trips and permanent counting locations to provide accurate estimates of cycling activity across the entire road network, especially on low activity cycling corridors further from the downtown city core.

The model developed to estimate AADB on segments is:
AADB = 3.4 x number_of_GPS_traces + 1094 x if_seawall + 322 x if_separated + 161

AADB = the average annual daily bicycle estimate on each road segment
number_of_GPS_traces = number of cleaned GPS bike trip traces that were assigned to the segment
if_seawall = 1 if segment is located on the Seawall
if_separated = 1 if segment is located on protected or off-street cycling infrastructure

A constant term of 161 was found to be on the higher end of an intuitive range. The intersections between two low-volume cycling corridors have an estimated AADB of least 322. This estimate does not come with the precision of AADB estimates at higher bicycle activity locations (namely the core bike network). The intersection bicycle counts are likely an overestimate on multi-lane arterials corridors: cyclists tend to avoid these due to high road stress. As the intersection counts represent an exposure measure for the collision rates, the conservatively high estimate for AADB at these intersections translates into estimated collision rates that represent a low estimate. It is worth noting that several multi-lane arterial intersections are represented as the highest risk intersections despite an exposure measure overestimate.

Representativity of micromodes in GPS trips and automated counting data sources
As mentioned on the previous page, SmartHalo devices are not designed to be installed on non-standard rideable devices considered as micromodes. Furtherore, Eco-Counters are not designed to count non-standard rideable devices either. Therefore, given the data sources used in this study that focus primarily on standard bicycles, the number users all forms of rideables that is reported is an underestimate.

Representativity of crash data
Geospatial bicycle crash data, separated by month and year, are publicly available from the Insurance Corporation of British Columbia (ICBC) Tableau public web page. This dataset is incomplete; it is limited to reported crashes between people on bikes and motorized road users. Furthermore, crash locations are aggregated to either the intersection or midblock point, limiting spatial resolution of the dataset. However, despite several limitations, the ICBC dataset is the most complete crash set available in Vancouver.

Intersection crash rankings do not necessarily represent the highest priority locations for improvements as some of the locations had received road treatments during the study period (2015-2020). The analysis and rankings do not differentiate between collisions occurring before and after road treatments were completed.

Appendix: network improvements between 2015-2020

Location	Year of Network Improvements	Description
Hornby and Dunsmuir	2015	Protection extended into intersection in late 2015
Beatty and Dunsmuir	2016	Protected bike lanes installed
Beatty and Smithe	2016	One-way protected bike lanes installed
Dunsmuir and Seymour	2016	Bike lane curb extended into intersection and additional no right-turn sign installed to discourage vehicle right turns across the bike route
Dunsmuir and Cambie	2016	Protected bike lane added to Cambie at north leg of the intersection
Adanac and Clark	2017	Bollard and vehicle restriction West of Clark removed to accommodate access when closure implemented at Vernon St (one block west of Clark). No right-turn on red light signs installed Northbound and Southbound on Clark Dr.
Burrard and Harwood	2018	Southbound protected bike lane crossing upgraded, including a raised intersection, new yield sign and smaller radius for Northbound vehicle right turns
Burrard and Pacific	2018	Significant upgrades to normalize the intersection and protect cycling movements
Cambie and 10th	2018	West leg of intersection changed to one-way for westbound vehicles
Camosun and SW Maine/ W 41st Ave Turning Lane	2018	SW. Marine and 41st Ave intersection upgraded
Arbutus and W. Broadway	2018	Constructed in 2017. New signal installed in 2018
Union and Campbell	2019	Corner bulges installed