Urban Bikeway Design Guide

WORKING PAPER

NACTO

Making Bikes Count

Effective Data Collection, Metrics, & Storytelling | March 2022

Acknowledgments

NACTO Board

Janette Sadik-Khan
Principal, Bloomberg Associates
NACTO Chair

Michael Carroll
Deputy Managing Director, Philadelphia Office of Transportation and Infrastructure Systems
NACTO President

Veronica O. Davis
Director of Transportation & Drainage Operations, Houston
NACTO Vice President

Robert Spillar
Director of Transportation, Austin
NACTO Treasurer

Gia Biagi
Commissioner, Chicago Department of Transportation
NACTO Secretary

Ryan Russo
Director, Oakland Department of Transportation
NACTO Affiliate Member Representative

NACTO Project Team

Cary Bearn
Zabe Bent
Kris Chandler
Alex Engel
Kate Fillin-Yeh
Corinne Kisner
Matthew Roe
Celine Schmidt

Working Group Contributors

Kristin Bennett, Grand Rapids, MI*
Stéphane Blais, Montréal, QC*
Erik Bonderud, Vancouver, BC*
Cassidy Boulan, Delaware Valley Regional Planning Commission
Matthew Diemer, Bellevue, WA*
Alex Ellis, Providence, RI*
Nate Fink, Boston, MA*
Jaclyn Garcia, Los Angeles, CA*
Roger Geller, Portland, OR*
Aaron Goldbeck, Washington, DC*
Kristina Hill, Calgary, AB*
Dan Jatres, New Orleans, LA*
Chris Kartheiser, Minneapolis, MN*
Ricardo Light, Long Beach, CA*
Bryan Nguyen, Portland, OR*
Krista Nordback, University of North Carolina
Dylan Passmore, Vancouver, BC*
Alex Riemondy, Charlotte, NC*
Josh Rocks, Delaware Valley Regional Planning Commission
Cara Seiderman, Cambridge, MA*
Stefanie Seskin, Boston, MA*
David Smith, Chicago, IL*
Keith Sorensen, Charlotte, NC*
Tara Tolford, University of New Orleans
Joseph Tryon, Houston, TX*
Scott Walker, Cambridge, MA*
Karen Warfel, Fort Lauderdale, FL*

* from NACTO member city

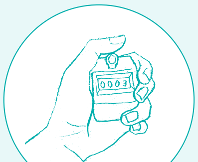
Funder

Trek

Updating the NACTO *Urban Bikeway Design Guide*

Making Bikes Count is one of seven Working Papers being released by NACTO in 2022 as part of the ongoing update to the NACTO *Urban Bikeway Design Guide*. The working papers will cover topics related to equitable planning, engagement, and implementation. NACTO will develop a complete update to the *Urban Bikeway Design Guide* in 2023 by synthesizing these working papers with updated, state-of-the-practice design guide.

Working papers to be completed in 2022:



THIS PDF IS →

Making Bikes Count: Effective Data Collection, Metrics, & Storytelling

SUMMER 2022

Planning and Implementing Equitable Bike Networks

SUMMER 2022

Pathways to Better Enforcement: Creating Safe Spaces for All Travelers

FALL 2022

Micromobility Permitting, Process, & Participation in the Age of Covid-19

FALL 2022

Scaling Success: Moving from Pop-up to Permanent

WINTER 2022

Toward Equitable Access: Community Engagement Tools & Practices

WINTER 2022

Network Design: Planning for Connected Intermodal Networks

Making Bikes Count

In transportation and street design, "what gets counted, counts."[1] Across North America, billions of dollars are spent designing roads based on counts of car traffic, with simple industry-wide practices that nearly every city and state transportation department is familiar with. For bike transportation to get the support it needs, cities and states need to expand their bike count programs. This paper describes how to do that.

Bike count programs face a logistical challenge with big implications: the easiest places to collect consistent bike counts are where there's already good bike infrastructure, but the hardest places to count may be where the most potential for growth can be found. That's a challenge for equity in bike counts, too: bike trips made *away* from the built bike network, and at off-peak times, are more difficult to count and are more likely to be made by delivery workers, youth, older adults, lower-income riders, families or caregivers, and riders of color.

To best understand how bicycling is growing or changing, cities are using Network Trend Counts to gather trendline data on where and when people are riding. These more inclusive counts can help cities decide how and where to invest resources but require long-term organizational commitment. Steps that cities can take to build on their existing programs and work toward a Network Trend Count are outlined below in Building a Trendline Bike Program.

It's not enough, however, to just create a good bike count program; cities must also **proactively tell the story of biking in their communities** using the strategies outlined in this paper.

This Paper Doesn't Answer...

Accuracy of different types of count equipment: See State-of-the-Art Approaches to Bicycle and Pedestrian Counters (2021) and Methods and Techniques for Pedestrian and Bicycle Volume Data Collection (2017).

Installation details and field validation of count equipment: See MnDOT Bicycle and Pedestrian Data Collection Manual (2017) and MassTrails Counter Primer.

Quality and Comfort: See intercept surveys; focus groups.

Project Evaluation: See before-after speed data, multimodal counts, user surveys & feedback.

Large-scale Network Planning: See surveys; focus groups; 3rd-party datasets; origin-destination data.

1 Joni Seeger. https://civic.mit.edu/2016/03/22/missing-women-blank-maps-and-data-voids-what-gets-counted-counts/

Get Counting in 1, 2, 3, 4, 5

A quick-start guide.

0 Pose Questions and Allocate Resources

Identify your questions and determine the funding, staff, and data needed to answer the most important questions facing the bike program and transportation system as a whole.

1 Pick Locations

Choose sites on *and off* the built bike network that will still be good places to count for years to come, so that long-term trends can be analyzed later. See:

Building a Trendline Bike Count Program **page 8**

2 Test and Pick Technologies

Automated counters provide timespan, manual counts add nuance and ground-truth, and large data sources augment counts. See:

Scaling Up With Automated Counts **page 12**

Automated Counts Provide Timespan **page 14**

Manual Counts Add Nuance and Ground-Truth **page 17**

Large Data Sources Augment Counts **page 20**

3 Pick a Metric (or two)

Calculate and visualize trendlines, such as percent increase from a base year. Check for errors and anomalies as you compile and analyze the data. See:

Working With Data **page 22**

Commonly Used Metrics **page 26**

4 Tell the Story

Report the results with enough context to establish a clear narrative, ideally connecting trends to investments. Talk about other data at the same time: bike share programs, surveys, safety data, and 3rd-party travel data sources can add texture to the story. See:

Storytelling and Data Interpretation **page 32**

5 Expand the Program

Get more resources. Scale up with techniques that are working well logistically, and test others to fill in gaps. Explore which types of bike trips or users are missing, and which new questions need to be answered.

Principles

Use data to tell stories, not count beans: Use your bike count data to show how investments in infrastructure result in changes to bike ridership, safety, better access to opportunity, and a more efficient use of the street. By being intentional about what data you are collecting and how you present it, the fuller story of biking in your city can make the case for the most impactful investments in bike infrastructure.

Focus on trends and indicators

Change over time is more relevant to most cities than raw numbers or inter-city comparisons. Set ambitious ridership goals, track them, and build support for future work.

Count more than the core network

An accurate, inclusive bike count spans a variety of locations and street types. More than one technique or technology is usually needed.

Start small and scale up

Use initial results to make the case for a more complete Network Trend Count with automated counters.

Anticipate maintenance & validation

Be ready to staff, test, and maintain new count equipment as count locations are added.

Transparency builds trust

Make the underlying data available to the public. Explain the methods used for quality control and data validation, and how you got to the final reported numbers.

Standardize counting all modes

Biking, walking, and other micromobility counts can, and should, be standard elements of traffic studies and monitoring. Include them in vehicle turning movement counts, vehicle classification counts, and signal/ITS equipment upgrades.


SAN FRANCISCO, CA
SEAL OF THE CITY AND COUNTY OF SAN FRANCISCO
09 35 AM
CYCLISTS TODAY
1440
1 000 000
900 000
800 000
700 000
600 000
YEAR
Photo: SFMTA

Building a Trendline Bike Count Program

Many cities already conduct recurring bike counts focused on their bike infrastructure, central-city commuting, or a small amount of data in a wide area. These types of foundational count programs can help make the connection between investment and ridership, and may include a large number of bike trips with relatively few counters. However, they do not count trips away from the bike network and

FOUNDATIONAL BIKE COUNT PROGRAMS	COUNT DURATIONS	COUNT LOCATIONS	USES AND DATA PRODUCTS
Annual, manual count Short peak-period counts, at dozens to hundreds of locations	Hours	Dozens to hundreds	• Differences in peak-period ridership across infrastructure types/neighborhoods • Use of roadway, sidewalk, or bikeway • Rider behavior • Perceived demographics
Small short-term count About 10 to 30 locations with short-term tube counters, collected for a few weeks per year	Days/weeks	About 10 to 30	• Change over time by location • Can count at many locations and street types, allowing more inclusive geography • Peak-vs-off-peak adjustment factors can be calculated
Small continuous count About 3 to 12 locations with permanent counters Data is typically analyzed in monthly or seasonal averages	Months	About 3 to 12	• Change over time by location or facility type • Seasonal comparisons • Monthly/daily adjustment factors can be calculated • Open data feeds
Network Trend Count 9+ sites per geographic sector with continuous machine counts Short-term tube counts at many locations Video-based manual counts as needed	All of the above	Many; range of types	• Geographic and seasonal comparisons of full-day travel trends • Tracking trends away from the bike network • Open data feeds

may undercount trips in lower-density areas. The table below gives examples of foundational count programs, what's easier and harder to do with the data collected from them, and high-value expansion steps to build on these common foundations as resources are assigned. See Network Trend Counts for more details.

LIMITATIONS	EXPANSION STEPS
• Peak-only counts miss trends in midday or nighttime biking (e.g. cargo / delivery and non-commute trips) • Short counts may have random variation year to year, making comparisons difficult	• Add continuous and/or short-term automated counters at representative sites • Convert to manually processed video • Count select sites around the clock for a fuller count of who's riding and where • Apply factor to old manual counts to calculate 24-hour volume
• Limited geography • Difficult to include major streets without bikeways • True peak weeks may be missed	• Convert to permanent counters as resources permit • Apply seasonal adjustment factors to old counts • Switch to video or manual counts where tubes don't work well
• Limited geography • Difficult to include major streets without bikeways • Riders in lower-density areas may be undercounted	• Add short-term counts to expand geographic coverage and street/facility types • Add manual or video counts at places where automated counters don't work well
• Higher cost and effort than other methods	• Convert more sites to continuous counters • Add new count locations to meet sector goals; add new sectors of the city • Convert remaining manual counts to video if automated counters don't work

Network Trend Count

To monitor bicycling over time, a Network Trend Count is designed to include streets with a variety of time-of-day bike use patterns, resulting in improved accuracy and a more equitable count than a downtown-only or bike-infrastructure-only count, while minimizing the use of expensive all-day manual counts.

A Network Trend Count is most useful when it includes many sites within a particular sector of a city, such as a 3-5 mile radius around a downtown or other hub. For larger cities, counting more than one sector allows tracking of different growth rates over time.

BENEFITS: A more accurate and inclusive way to track trends in bicycling over time. Sets a baseline for measuring how different *types* of bike trips increase as the bike network is expanded.

CONSIDERATIONS: Requires a large number of sites and count types and more challenging site selection.

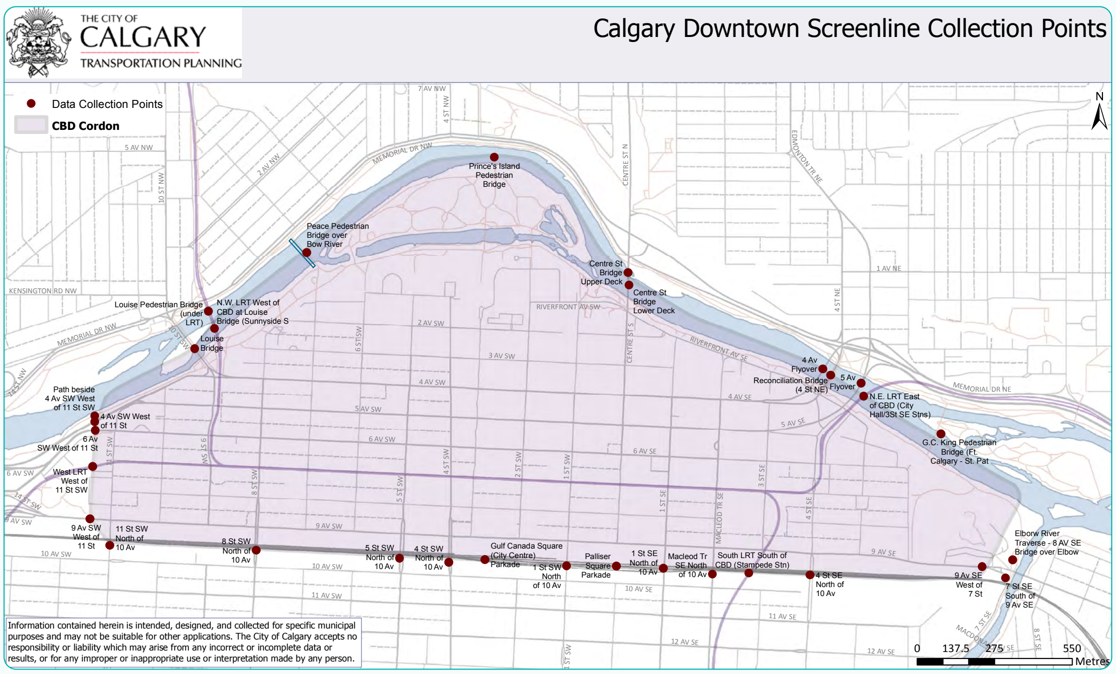
GUIDANCE:

1. Define at least two sectors. For example, a core area with lots of existing bike infrastructure, plus a satellite employment hub and surrounding lower-density neighborhoods, perhaps with little existing bike infrastructure.
2. Within each sector, identify distinct trip patterns, such as:
   - → Peak commute: Streets leading to a downtown/civic/office core have historically generated an AM/PM peak, though many now follow a midday peak pattern.
   - → Midday peak: Streets used for short trips within neighborhoods or within a downtown, or that provide access to parks and trails, tend to generate midday peaks on weekdays and weekends.
   - → Dispersed or multi-peak: Retail/services hubs, entertainment districts, universities, and hospitals tend to generate trips all day or may even have evening/nighttime peaks.
3. For each trip pattern, conduct counts along different facility types:
   - → Existing bike facilities: Conduct continuous counts where possible.
   - → Major streets with planned bike infrastructure or observed bike use: Count with manual or video counts.
   - → Minor streets with mixed traffic (e.g. bike boulevard): Count with manual, video, or tube counts.

   A sector with three distinct trip patterns and three different facility types would have nine different pattern-facility contexts. For each context, count at least three sites and ensure that each context has at least one all-day or multi-day count. A sector with nine contexts would need 27 count locations (3 x 9 contexts) with at least nine all-day counts (one per context).
4. Within each context, apply a scaling factor from an all-day count (or ideally a continuous count) to extrapolate any short-term counts within that same context. See Extrapolating Short-Term Counts.
5. Aggregate the resulting counts for each sector, and for the city as a whole. See Commonly Used Metrics.

Cordon Counts

Network Trend Counts can be designed to include a cordon count. Cordon counts use screenline collection points to measure the total number of people entering or crossing a specific boundary, such as crossing a river or highway, or entering a central/downtown area. The completeness of cordon counts makes them persuasive in tracking change over time, but their geographic specificity has drawbacks. Since they don't include trips internal or entirely outside the cordon, cordon counts will underrepresent shorter bike trips, non-commute trips, and biking to transit. Add context to cordon counts by adding enough other sites to create a network trend count.



Source: City of Calgary Transportation Planning, Central Business District Cordon Count.

Scaling Up With Automated Counts

Cities can learn about bike volumes across more hours of the day and more days of the year by using automated counters. Loop detectors and other permanently-installed counters provide continuous, 24/7-365 coverage, while pneumatic tubes are suited to a few weeks of seasonal counts at a wider array of locations.

Picking the Right Count Technology for Your City

Count technology is evolving quickly but cities don't have to use the newest products to get good counts. To get the best technology for *your* city, cities with established programs recommend the following:

- Do test or pilot each new technology at a few typical locations before committing to using it at a larger scale. Compare output to a manual count of at least 4 hours (32 bins of 15 minutes each). In low-volume settings, ride over the counter at least 100 times or wait for 100 "events." See Counter Validation.
- Don't commit to a large deployment of a specific count technology until it has been tested in conditions similar to your intended sites.
- Don't use bad data—if a counter or type of count technology isn't working, then replace it or try a different technology rather than try to correct for substantial errors.
- When transitioning from one count technology or technique to another, use both the old and new methods for at least one seasonal count period, and ideally one to two years.

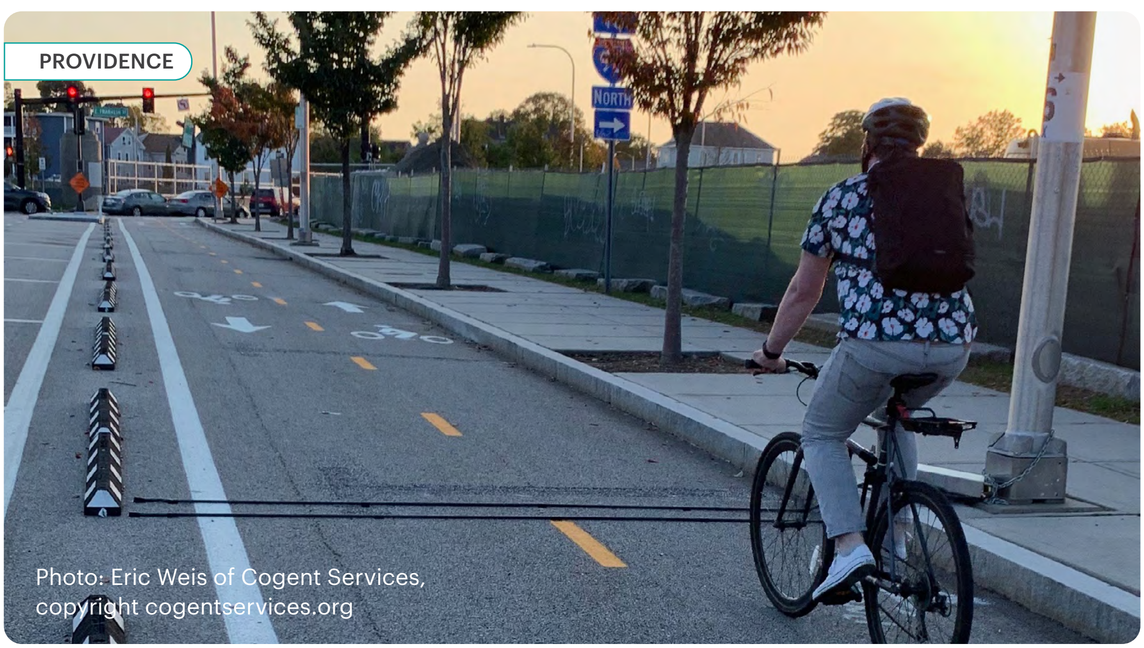


Photo: Eric Weis of Cogent Services, copyright cogentservices.org

Photo: San Diego Fly Rides

Tracking Trends in Micromobility

New micromobility options—including e-bikes, e-scooters, e-skateboards, and one-wheeled devices—are becoming more popular and are increasingly frequent in bike lanes. However, most automated counters cannot differentiate between bikes and other small wheeled devices. Until automated count technologies are better able to capture and differentiate these devices, **start manually counting different types of bikes and scooters to monitor adoption trends over time.** Just as is done for other vehicle classification counts, the manual count can be applied to a longer-duration automated count. For example, if your automated counters don't count scooters, use a manual count to estimate and apply a growth factor. If they do count scooters but can't distinguish them from bikes, apply the manually-collected ratio of bikes to scooters to your counts to estimate the total volume in each category (see Commonly Used Metrics). Also as a remedy, cities with large scooter share systems can use scooter share trip data to estimate the proportion of the scooter trips (see Large Data Sources Augment Counts).

Automated Counts Provide Timespan Coverage

Automated Counts: Short Term

Automated short-term counts can be repeated annually or seasonally, with temporary automated counter equipment. Typical time spans are several days to several weeks.

BENEFITS: Can be implemented at a large scale more quickly than permanent counters. Useful for testing potential sites for permanent counters. A few weeks of counts are more likely than one-day counts to capture the true peak day.

CONSIDERATIONS: Need to be installed and uninstalled repeatedly. Easier to conduct when a qualified contractor can implement and manage a large number of counters for a few weeks a year. See Automated Counter Installation.

TYPES of short term automated counters:

Pneumatic Road Tubes (Tubes) categorize bikes based on the distance between wheels. Tubes can be used on a wide variety of locations but perform best in protected bike lanes, marked bike lanes that have relatively few motor vehicle incursions, or in low volume shared travel lanes. Tubes can also be used on sidewalks and shared-use paths but need to be well secured and taped to the ground to prevent tripping. Speed data recorded by double tubes is useful for reducing false positives from mopeds and motorcycles, whose wheelbase is similar to a traditional bicycle. Parked vehicles on tubes, sweeping/plowing operations, and high truck traffic shorten tube lifespan and/or block data.

Automated Video Processing can be used for short-term or long-term counts, in both dedicated bikeways and mixed traffic, provided sightlines are clear. Video analysis is rapidly advancing, but has not been widely adopted. Local validation studies are needed during a variety of weather, lighting, and crowding conditions. Data protection protocols by both the city and vendors should be in place to prevent the use of video for identification of individuals. Work across teams to determine if cameras installed to capture other things (e.g. near-miss crashes) may also be used to capture bike counts.

Automated Counts: Continuous

Automated continuous counts are conducted with permanently-installed count equipment. These counts are critical to a mature bike count program, yielding seasonal adjustment factors and other tools that can be applied to short-term and one-day counts.

BENEFITS: Year-round data collection allows retrospective counts such as bike volume during specific events, more accurate seasonal data, and easier collection of nighttime data.

CONSIDERATIONS: Larger start-up costs than short-term counts; annual fees must be anticipated and year-round maintenance will be needed.

TYPES of continuous automated counters:

In-ground Inductive Loops (Loop Counters) can be set for higher or lower sensitivity and, with validation, some newer loop counters can be adjusted to differentiate between scooters and bikes. Due to false positives from nearby motor vehicles, loop counters are best at counting bikes in shared-use paths and protected bike lanes.

Automated video processing, pneumatic tubes, and other technologies can be used for continuous automated bike counts.

In-ground Inductive Loops installed in a bike lane.

Saw-cutting pavement to install in-ground inductive loops to count bikes on Gano Path.

Installing pneumatic road tubes to count bikes on a 2-way cycle track on Clifford St.

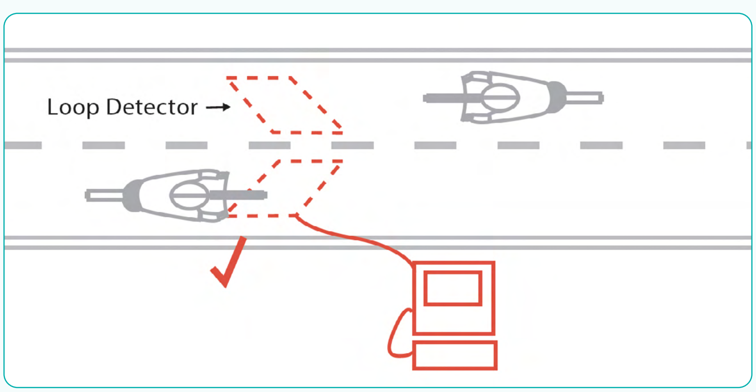
Automated Counter Installation

Placement: Choose sites with a straight, predictable path of travel, ideally where most riders are single-file within a relatively small (~5′) part of the roadway cross-section, with pavement in good condition, where cars and trucks will not park on the device or block the bike lane.

Coordination: Technical and administrative complexity varies by technology and by city. Before installing count equipment at a large scale, determine interagency or interdivisional coordination needs.

Monitoring & Maintenance: Every count technology needs monitoring and maintenance. Designate a count program manager to check for anomalies or missing data and anticipate maintenance needs. See Working with Data.

For detailed examples of the counter installation, see: MnDOT Bicycle and Pedestrian Data Collection Manual (2017), MassTrails Counter Primer, and manufacturer specifications.



In-ground loop detector placement on a two-way bikeway or trail. Source: Minneapolis DPW.

Manual Counts Add Nuance and Ground-Truth

In bike trend count programs, manual counts are a common choice for covering a large number of locations for a short timespan. Peak-period counts typically span 4 to 6 hour per day, ideally on three midweek days and a weekend. Whole day counts for 12-hour, 18-hour, or 24-hour timespans, typically collected on video and counted manually, are used where automated counters are not available.

BENEFITS: Flexible, needing little equipment. Can be combined with pedestrian or motor vehicle counts, and project analysis. More accurate than automated counters for short times or difficult conditions.

CONSIDERATIONS: Day to day variability of volumes limits the reliability of a short count. Peak-period counts can be repeated over multiple days, but miss differences in the volume and attributes of peak and off-peak bike use or users.

GUIDANCE: Improve accuracy by conducting a practice count to refine data entry sheets and clarify ambiguous situations. Debriefing with participants after a count also helps flag potential errors.

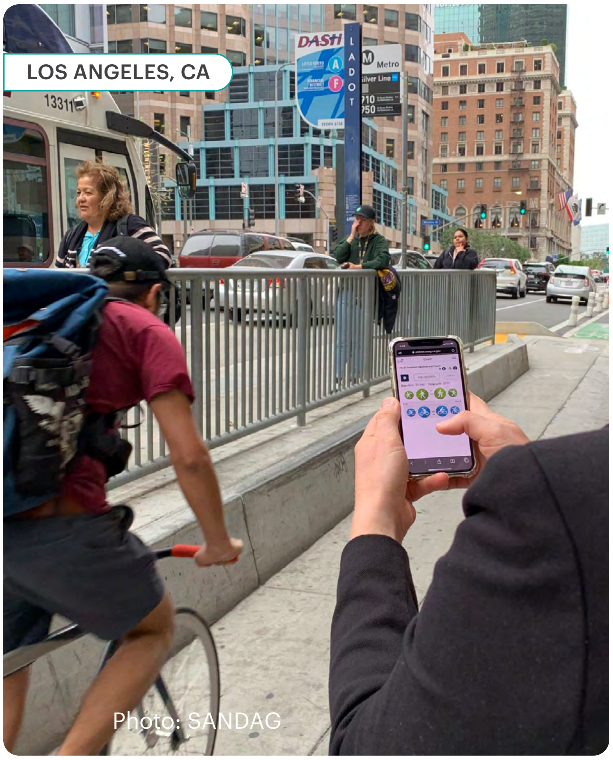
Manual classification counts can be used to collect additional attributes, such as:

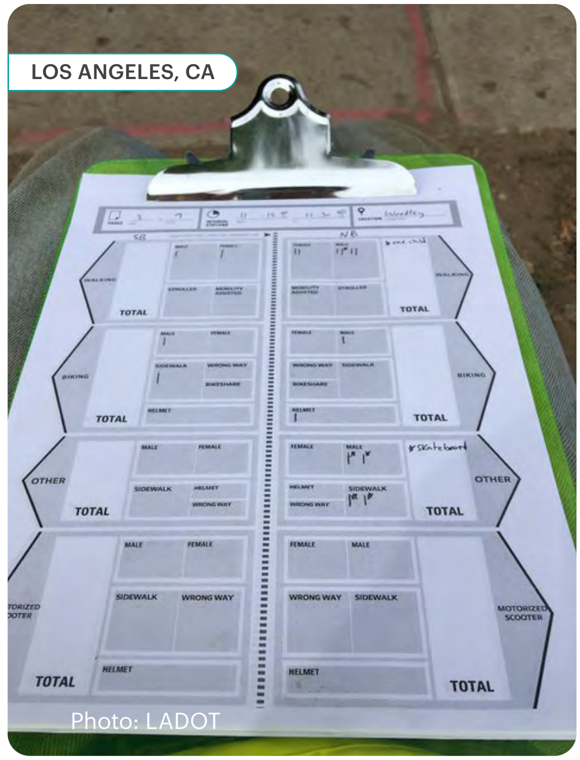
- → Device type: Bikes, scooters, cargo bikes, wheelchairs & personal mobility devices.
- → Bike location and direction: Bikeway, sidewalk, or mixed-traffic lanes-with or against traffic, and side of street.
- → How many people are riding, including passengers.
- → Rider demographics (See Who's Riding and Why?)

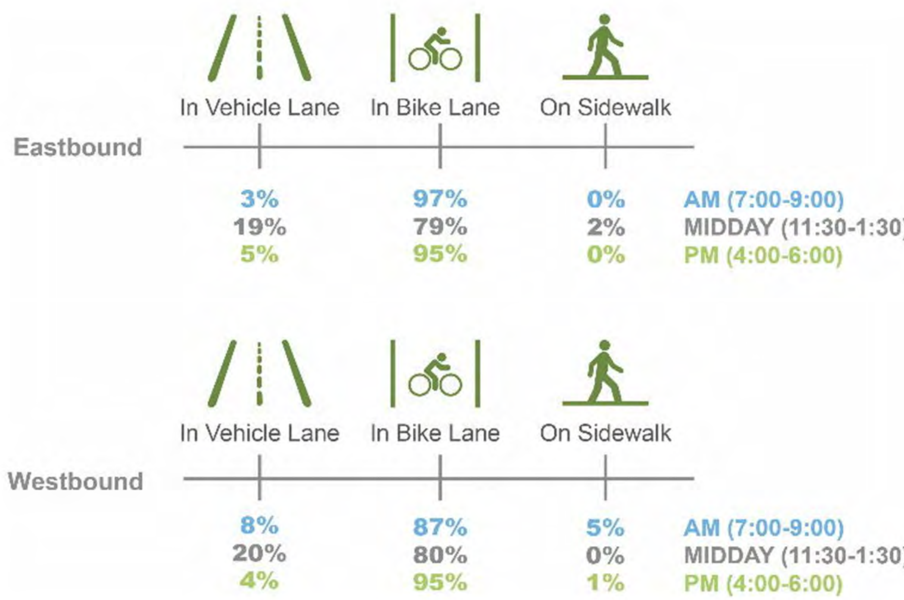
TYPES of manual counts:

Manual Video Processing. Manual review of video at faster-than-real-time allows much more efficient data collection and an opportunity to check counts or watch again to collect more data types. Camera installation for manual video processing need not be as precise as for automated video processing, and a single camera can capture multiple directions of bike traffic.

On-Site Manual Counts typically cover 2- to 3-hours per period, repeated for AM peak, PM peak, and midday and/or weekend peaks. Some programs field longer manual counts for a sample of locations. Manual counts can sometimes be conducted by volunteers from the community to increase the number of sites captured while also building enthusiasm for the count program, but it is critical that volunteers are well trained.


LOS ANGELES, CA
Photo: SANDAG


LOS ANGELES, CA
Photo: LADOT



SFMTA records bicyclist positioning using video data collection.
Source: SFMTA *Safe Streets Evaluation Handbook*.

Who's Riding and Why?

Reporting perceived rider demographics can correct common misconceptions about bicycling, especially as these attitudes relate to gender, age, ability, or race and ethnicity. However, observation is not a substitute for asking riders how *they* identify themselves or why they are riding.

Reporting perceived demographics is most useful when it informs decision-making within broader policy frameworks, such as transportation justice, which require measures of participation, or where specific questions have arisen about who is riding. For example, reporting on perceived rider demographics, such as perceived race, can help dispel myths that the only people biking are coming from outside the community.

See Storytelling and Data Interpretation.

Rider demographics such as gender, age, or race/ethnicity, as well as trip purpose (sometimes inferred from the use of cargo bikes or working e-bicycles) must be reported as *perceived* characteristics. For example, you are counting the number of riders perceived as female or the number of female-presenting riders and not the number of women using the bike lane. To prevent counters from defaulting to male, white, or adult categories, include an 'uncategorized' option. (Note: this is different from a nonbinary or biracial option.)

Intercept surveys, household trip surveys, and focus groups allow people to self-identify, and can additionally provide origin and destination, income brackets, bicycling experience level, disability status and type, and reasons for using a bike for a trip—or not. For more, see the NACTO *Bike Share Intercept Survey Toolkit*, which can be adapted to general bicycling questions: nacto.org/interceptsurveytoolkit

Large Data Sources Augment Counts

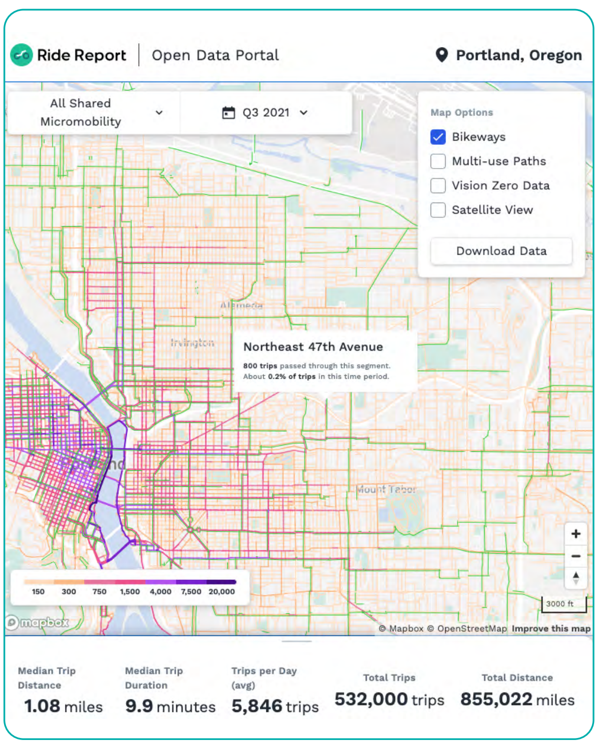
Bike volume estimates based on large data sources, often from a 3rd party vendor, provide a sense of how many bike trips are being made on the vast majority of streets where bikes are not typically counted. Consider these sources alongside bike counts to better understand dispersed bike travel.

GUIDANCE

→ Calculate relative numbers, such as percent change over time in ridership reported in a large data set, to provide a more accurate picture than absolute values that are only a subset of total riders.

→ Use large data sources to inform where to conduct counts in neighborhoods with limited bike infrastructure.

→ Always acknowledge known biases in data sources, noting that short utility trips or connections to transit—especially made by low income people, people of color, and women—may be undercounted by smartphone-based data, purchased opt-in apps, or national surveys.



Mapping Shared Micromobility Trips: Portland's open data portal counts BIKETOWN and E-scooter trips, and can be layered with bike facilities by type and crash network data. Source: Open Data Portal, PBOT and Ride Report.

Types of Large Data Sources

Large scale surveys estimate bike trips from a sample. The most common national examples are the **American Community Survey (ACS)** that estimates commute trips taken by bike and the **National Household Travel Survey (NHTS)** that estimates total bike trips. Data from **smartphone location services** estimate bike trips per street, and can be useful at a large scale. **Bike fitness and navigation apps** provide numbers of app users by street. Shared micromobility services using **Mobility Data Specification (MDS)** report the number of system users per street and shared micromobility services using **General Bikeshare Feed Specification (GBFS)** report the start/end location of system users.

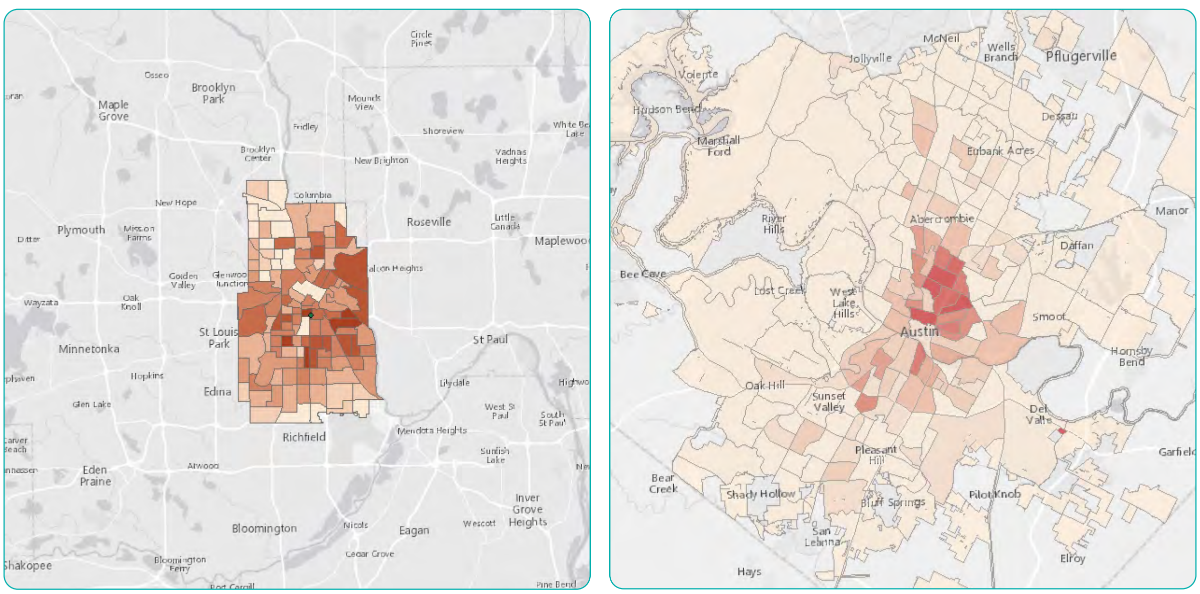
Using U.S. Census / ACS Data

Bike mode share data from the ACS only counts how many people commute to work by bike, not total trips. Daily total bike trips can be estimated as:

DAILY BIKE TRIPS ≈ ACS-REPORTED BIKE COMMUTERS X TOTAL TRIPS PER WORK TRIP X (2 TRIPS DAILY)

The number of total trips taken per work trip is conservatively estimated to be 5. The 2017 U.S. NHTS reports that 17% of trips are work trips, for 5.7 total trips per work trip. ACS data also does not account for the use of bicycling as a secondary mode (i.e. occasional or partial use) for commute trips. Use local ratios where available. For further details,see page 21 of NYCDOT Cycling in the City 2021.

Census mode share numbers do not reflect the bike boom in physically large cities, where bike commuting tends to be concentrated in the urban core. The ratio of central-area bike commuters to car commuters is more relevant to policy decisions; a 1% or 2% citywide bike mode share might hide a 1:1 ratio of bike:drive-alone commutes among central-city residents. Map the ratio of bike commuters to drive-alone commuters by census tract to reveal these geographic patterns in and beyond the core.



Bike commute mode share is often much higher within a few miles of employment hubs than in the city as a whole (left: Minneapolis; right: Austin). Source: Bike Lab, Tom Holub.

Working With Data

Bad data means bad analysis, which means bad policy, leading to bad outcomes for people. Before analyzing data, count programs should assess for data quality, correcting for machine errors and missing data. The goal of data quality assurance and correction is to make sure that the reported numbers match reality on the street.

Document and note all data adjustments in both open data and published reports for transparency. Ideally, open data users will be given the option to use raw or adjusted data. Trendlines and metrics should always use the adjusted, more accurate data.

Counter Validation & Adjustment Factors

Counters should be field-validated when they are installed, every few years as the counter ages, and after any pavement work or street design changes. The purpose of validation is to test whether the counter might need to be recalibrated, moved, or replaced. If successful, this validation process also creates **adjustment factors** that are used to correct for undercounts or overcounts.

For a strong validation process, take the following steps for each new counter:

STEP 1

Conduct a manual count (4 or more hours recommended), broken into small time bins of 15 minutes each.

STEP 2

Calculate an initial adjustment factor as:

$$\frac{\text{SUM OF MANUAL COUNT}}{\text{SUM OF AUTOMATIC RECORDED COUNT}} = \text{INITIAL ADJUSTMENT FACTOR}$$

EXAMPLE: $$\frac{1{,}000}{900} = 1.111$$

STEP 3

If the manual counts are very different from the automated counts, the counter itself needs attention. Counters with adjustment factors larger than 1.5 or smaller than 0.66 don’t provide useful data. If the initial adjustment factor is less than about 0.9 or greater than about 1.3, investigate the counter and installation for potential sources of error.

STEP 4

Adjustment factors cannot correct for equipment that is *inconsistently* under- or over- counting. A more detailed validation process to test for inconsistent errors is:

A. Break the manual and automated counts into short time bins (15 minutes).

B. Apply the adjustment factor to each time bin.

C. Check the adjusted automated count against the original manual count for each time bin. For time bins larger than 20 bikes, check that the adjusted count is within 20% of the manual count. For time bins smaller than 20 bikes, check that the adjusted count is within 4 bikes of the manual count.

D. If at least 80% of the bins 'pass' this test, accept the adjustment factor as valid and move on to step 4. If fewer than 80% pass, adjust the counter itself.

STEP 5

Once the counter is validated as shown above, apply the adjustment factor to future counts.

RECORDED RAW COUNT X ADJUSTMENT FACTOR = ADJUSTED COUNT

EXAMPLE: 345 X 1.111 = **383**

For a detailed procedure, download the draft Counter Validation Template. (Source: Erik Bonderud, City of Vancouver)

Error Detection

Automated counters sometimes fail for short periods of time: they might be blocked by a parked vehicle, go temporarily offline, or count erroneously for an unknown reason. To check for these errors, graph the data in its smallest timespan (e.g. 15 minutes) to examine for unexpected missing periods (such as zero values) or spikes. Identify this time period and, if necessary, adjacent time bins that might have been affected as well. Remember, the parked car might have driven away in the middle of a 15-minute period.

Unexpected spikes or dips are sometimes real counts, related to extreme weather, construction detours, or special events. In these cases, report the data and provide explanatory comments.

Interpolating Missing Data

Interpolating missing data allows aggregate bike counts from multiple counters to be reported accurately when part of the time period for a particular counter is missing. For example, if a few weekday morning hours are missing from a continuous count, the reported average for the day will be artificially low; either the missing hours can be interpolated, or the entire day of counts can be thrown out. If the site is a high-volume location, throwing the entire day out for that site would artificially lower the count for the entire dataset, so interpolating the missing data may be more accurate. The decision is a matter of judgment and context: take the action that results in greater confidence in the reported data.

Adjacent Hour Method: Average the two time periods just before and after the missing data to estimate the missing period. This method can be used for a missing 15-minute period or for up to an hour of missing data.

Similar Day Method: Average the counts of three or more days (at the same site) that are similar to the missing day to estimate the missing period. For example: to estimate a missing Tuesday, average non-Friday weekdays with similar weather within a few weeks of the missing day.

Similar Location Method: Where a short count needs to be scaled from an hour or day to a day or week, or where a counter is broken, apply a scaling factor developed from another working counter location with a similar trip profile to the missing counter.

$$\text{SCALING FACTOR} = \frac{\text{WORKING COUNTER DAY 1 COUNT}}{\text{WORKING COUNTER DAY 2 COUNT}}$$

$$\text{BROKEN OR INCOMPLETE COUNTER DAY 2 COUNT} \times \text{SCALING FACTOR} = \text{ESTIMATE FOR BROKEN COUNTER DAY 1 COUNT}$$

EXAMPLE:

$$\frac{500}{800} = 0.625$$

$$1{,}600 \times 0.625 = 1{,}000$$

Source: City of Minneapolis *Minneapolis Non-Motorized Traffic Counts: Operations and Methodology.*

Extrapolating Short-term Counts

Scaling factors from a continuous counter can be applied to a short-term automated count that ‘missed’ the true peak day of the year.

SCALING FACTOR = 24-HOUR COUNT AT LOCATION A / PEAK-PERIOD COUNT AT LOCATION A

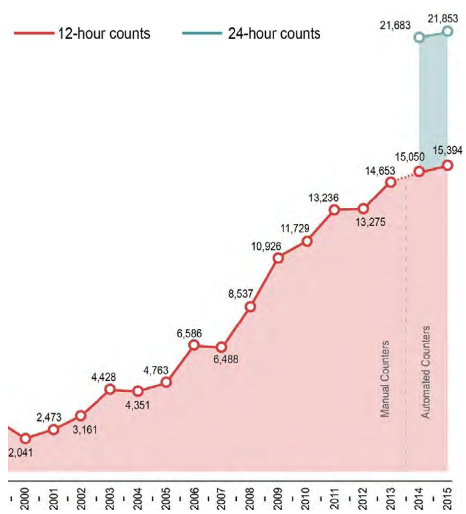
PEAK-PERIOD COUNT AT LOCATION B **X** SCALING FACTOR = **ESTIMATED 24-HOUR COUNT AT LOCATION B**

EXAMPLE:

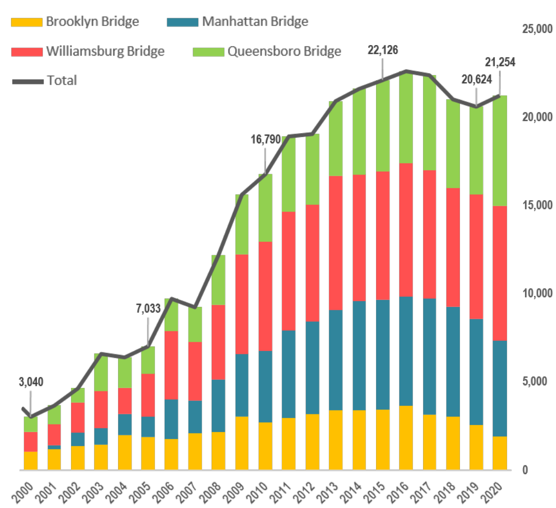
750 / 150 BIKES = 5

110 PEAK-PERIOD BIKES **X** 5 = **550 BIKES PER DAY**

When manual counts are replaced with automated counts, a scaling factor can also be applied to the old peak-only counts to estimate 24-hour bike volume for past years. For the first 1-2 years, report both the old daytime-only counts along with the new 24-hour counts (lefthand figure below). After 2-3 seasons with the new count locations, old daytime-only counts can be scaled to estimate the 24-hour volume for the years when data was only collected for 12 hours a day (righthand figure below).



Historic 12-hour bike counts, with two years of 24-hour counts. Source: NYCDOT *Cycling in the City 2016*.



Historic 12-hour bike counts scaled to be comparable to the seven recent years with 24-hour counts. Source: NYCDOT *Cycling in the City 2021*.

Commonly Used Metrics

A metric is only as good as it is understandable. Data products need to be easy to read, compelling, and provide clear takeaways to the reader.

Indices are a way to quickly let readers see how bike volumes or related data are changing over time. Since the base year is set to zero or 100, rather than being the actual count, it is easy to show more than one type of data on the same graph—all set to the same base year.

Daily Count Index

Daily in-season weekday counts are a typical basis for ridership comparisons from year to year. By converting the daily in-season bike count into an index, cities can more easily talk about how ridership has changed over time.

STEP ①
Define the count season. A count season should have consistent weather patterns, typical bike activity, and include 1-6 weeks of usable count data.

STEP ②
Validate the data for seasonal bike counts. Omit days with unseasonable weather and only include rainy days if they represent a typical day that season (for example, rain may be typical in November but not in September). Document the weather and special events or major disruptions for all count days to inform year-to-year storytelling and provide transparency.

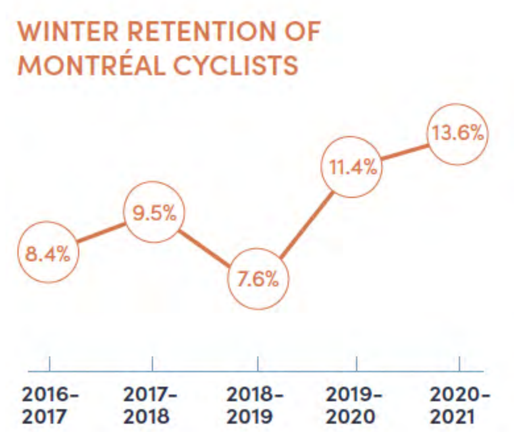
If the true peak week of the year is missing from short-term count locations, consider using the similar location method (see Working with Data*)* and use a scaling factor to estimate the peak week counts by location.

STEP ③
Average all midweek count days (Tuesday, Wednesday, and Thursday) within the validated count season to create the in-season weekday count. Exclude holidays and days immediately before or after holidays (see Ridership Index to calculate a ridership index from this daily count). Alternatively, weekend in-season ridership can be calculated by averaging one or both weekend days over the count season.

Seasonal Count Index

Reporting trends in off-season ridership shows that bicycling is a year-round transportation mode. Growth in winter ridership as a percent of in-season ridership, or an index showing growth in winter ridership over time, are easier to read than a multi-year month-by-month graph.

If certain sites (such as trails, a university area, or dispersed/off-network counts) show a very different seasonal pattern from the citywide counts, consider reporting it separately.



Increases in winter biking is shown as a percent of summer biking. Source: Vélo Québec *Cycling in Québec in 2020.*

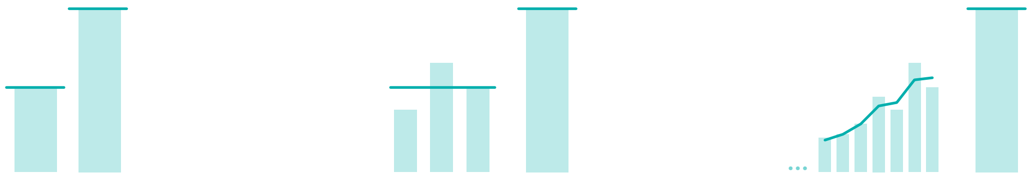
Neighborhood Ridership & Geographic Equity

Reporting neighborhood trends distinctly from citywide or core-network trends is an important part of supporting equitable policy decisions.

If a Network Trend Count or other large data collection effort has been conducted, separate ridership growth metrics (see Ridership Growth*)* can be created for distinct geographies (e.g. downtown, core-area, or neighborhood specific) or for sites representing distinct trip patterns (e.g. such as sites with AM/PM peaks, midday peaks, and dispersed patterns). Particularly where bike networks have recently been expanded, neighborhood counts may show faster growth than downtown cordon counts. Covid-related closures and shifts in commute patterns increase the importance of distinct reporting of neighborhood and non-traditional trends.

Ridership Growth

Key metrics for reporting change in ridership over time are:



Ridership Index: Percent growth in citywide ridership from a meaningful base year.

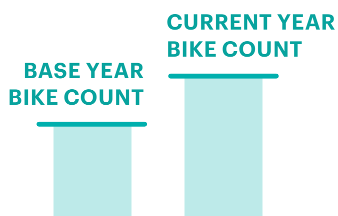
3-Year Comparison: Recent growth rate in bicycling, such as the current year, compared with the average of the past three years.

Rolling Average: A longer version of the 3-year comparison.

Ridership Index

An index allows easy comparison of percent changes over time, and allows you to graph multiple trends on the same axis.

For a ridership index, choose a base year that reflects a change in policy, such as the start of an all-ages infrastructure rollout. Convert the daily count estimate into an index, where the base year's count is set to 100.

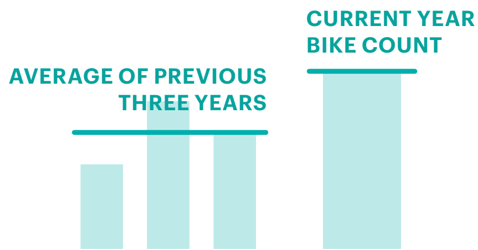


$$\text{CURRENT YEAR INDEX} = \frac{\text{CURRENT YEAR BIKE COUNT}}{\text{BASE YEAR BIKE COUNT}} \times 100$$

The result of this index can be reported as 'Ridership has over doubled as we've built 25 miles of protected bike lanes in the last five years.' Bike lane expansion can also be graphed as an index on the same axis.

3-Year Comparison

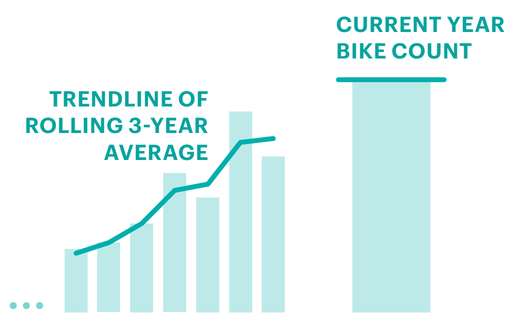
Bike counts sometimes fluctuate from year to year even if the overall trend in ridership is growth over time. To report on recent trends, current ridership is compared to the average of the past several years. By averaging over three years, this year's count is compared to a more stable number while contextualizing the current count as above or below the recent average.



$$\text{PERCENT CHANGE} = \frac{\text{CURRENT YEAR BIKE COUNT}}{\text{AVERAGE OF PREVIOUS THREE YEARS}}$$

Rolling Average

A 3-year rolling average smooths out fluctuations, and makes graphs easier to understand. Show the real counts behind a trendline of the rolling 3-year average. While this metric does not emphasize the most recent changes, it is more consistent over time than a simple year-over-year change.



Risk Index

Bike trips tend to become safer as infrastructure expands, but raw crash data does not illustrate these changes. Instead, show safety trends by creating an injury risk index.

STEP 1: Calculate the Risk Rate

The result should *only* be used to calculate an index, since even the best counts do not capture all rides.

For bike injuries (or severe + fatal injuries), use the same geography as the counts. If the counts are sector-based, or use a large data source that does not cover the entire city, aggregate the crash data on the same geography.

$$\text{ANNUAL INJURIES PER RIDER} = \frac{\text{BIKE INJURIES (OR SEVERE + FATAL INJURIES)}}{\text{BIKE RIDERSHIP}}$$

If injuries or ridership fluctuate widely each year, use a three-year rolling average of *both* injuries and ridership.

For ridership, use either the Daily Count Index, annualized bike counts (not covered in this paper), or total rides per year from a Large Data Source.

STEP 2: Calculate the Risk Index

$$\left[\ \text{THIS YEAR'S RISK INDEX} = \frac{\text{THIS YEAR'S RISK RATE}}{\text{BASE YEAR RISK RATE}} \times 100\ \right]$$

STEP 3: Calculate and graph comparisons

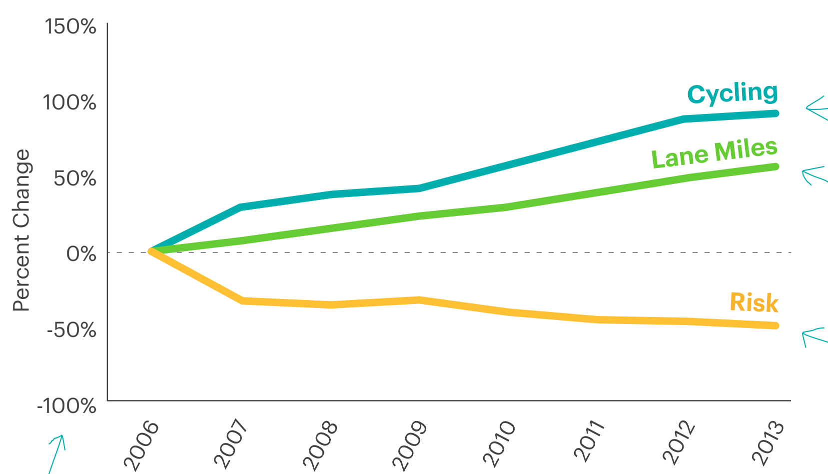
Calculate a ridership index and a bike network mileage index (or another representation of bike network quality) using the same base year and plot all three indices on the same graph. See NACTO Equitable Bikeshare Means Building Better Places for People to Ride and examples of the NYC Cycling Risk Indicator and Portland Bike Crash Index (see p41).

Anatomy of a Graph

The **title** of a graph is the point being made. “Bike Ridership Is Up by X%,” not “City Y Bike Ridership: Month/Year.” If there is no obvious point to make, question whether the graph is helpful.

The **important information** is bigger, has stronger lineweights, and more eye-catching colors than the less important information.

Cycling is getting safer as more people ride.



Aggregate data from Chicago, Minneapolis, New York City, Philadelphia, Portland, OR, San Francisco, and Washington, D.C.

Scale and units are obvious. Scale starts at 0 (or 100 for an index).

Keep it simple: If more is good, lines should go up. If less is good, lines should go down.

Storytelling and Data Interpretation

Trends in citywide bike use and other data-based stories can bolster the case for bike infrastructure, and build confidence in the bike program. Part of this work is getting the right level of detail to each audience—elected leaders and senior officials, journalists and academics, civic groups and advocates, and the broader public—as well as telling a story that's tied directly to your city's values and goals.

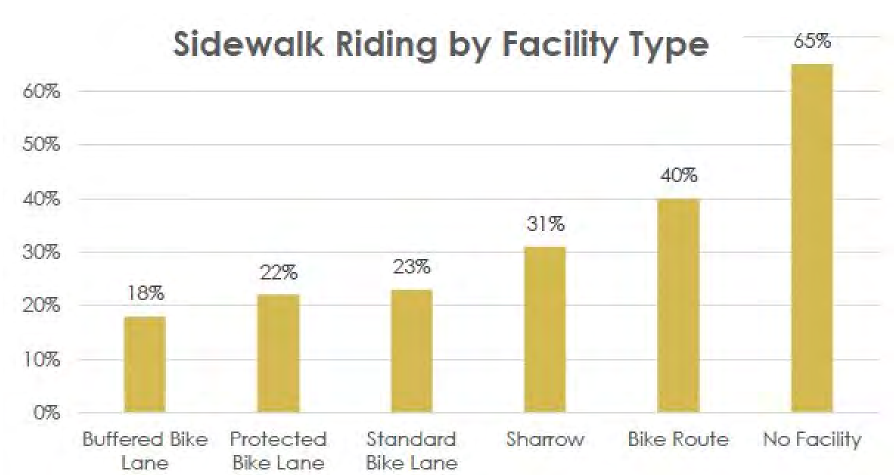
Data is most useful for establishing a narrative from the outset rather than disrupting one that's already taken hold. Compared with other modes, biking is often subject to extraordinary scrutiny, and data is sometimes weaponized against a bike program's policy goals, distinct from potentially constructive criticism about methods. The target audience for ridership statistics is the broad public who hasn't yet formed a strong opinion.

CONSIDERATIONS

→ High-comfort bikeways reduce wrong-way and sidewalk riding, and are more accessible to people with disabilities, women, children, seniors, and caregivers. Consider telling this story with manual observation counts, photos, and testimonial quotes.

→ As bike infrastructure in a specific area is upgraded, growth in a cordon count or Network Trend Count demonstrates that bike trips are increasing, not just shifting from one street to another.

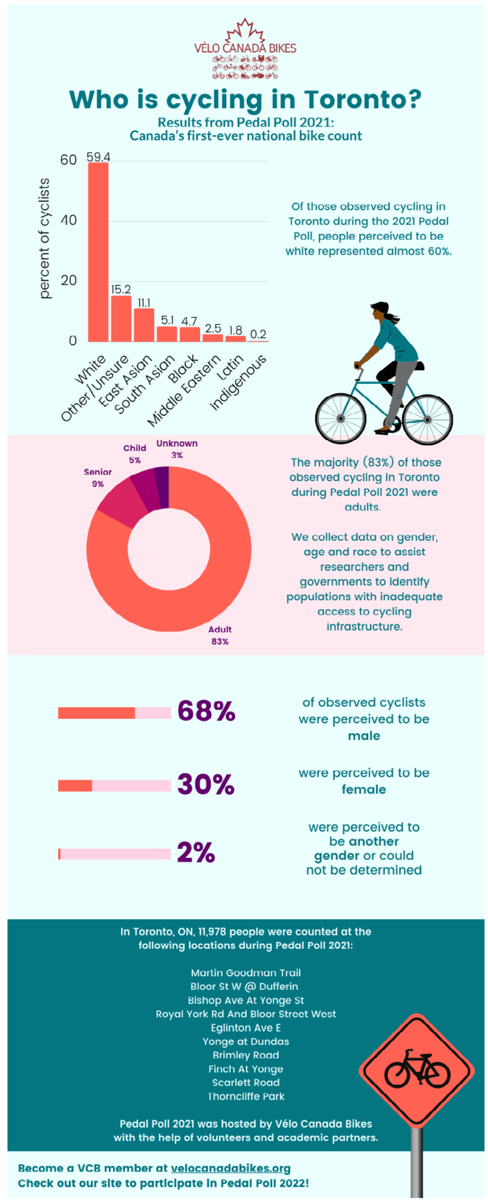
→ If ridership is stagnant, provide context about why it isn't growing and/or what next steps might be coming.



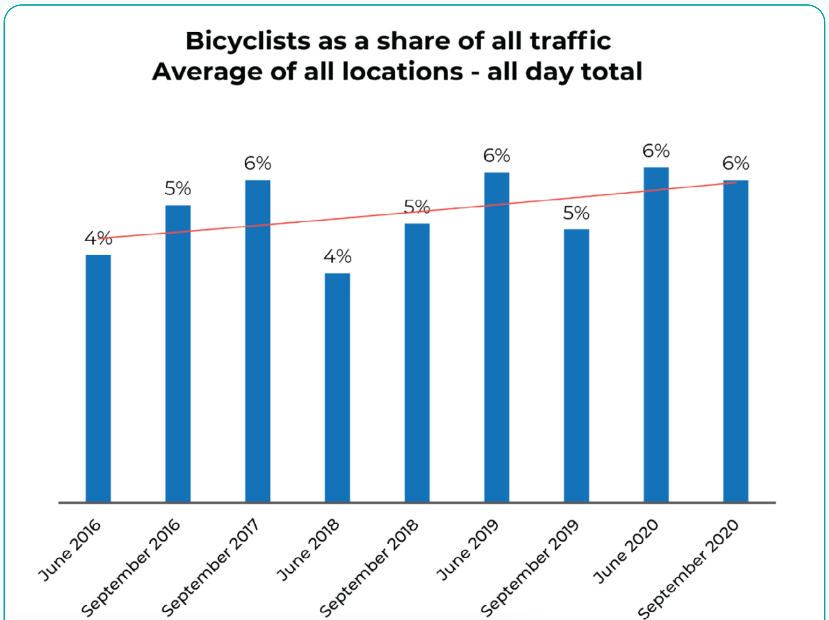
Source: LADOT, *LADOT Walk and Bike Count 2019.*

Use Data To Tell the Story

- Every story needs a theme or a hook. Some examples of hooks: new data shows how bike infrastructure also provides safety benefits to pedestrians and drivers; here's how bike infrastructure is used for transportation; bike mobility is adding to employment or social options and quality of life; few people bike, or biking is dangerous in these neighborhoods because of a lack of infrastructure.
- Connect ridership growth to policy decisions. For example, use data to underscore safe routes to school policy by saying: after prioritizing residential bike boulevards, 50% more kids are biking to school.
- Rather than produce a long annual report, you may choose to use short, graphics-based summaries to make major points, and *separately* document the detailed analysis behind them.
- Information is increasingly consumed in social-media-friendly soundbites and easily-shared images. Ensure that graphics can stand alone to tell the story about the city's goals and choices, even if shared out of context.
- *Every* graph and data table in a report, blog post, or press release should always have a clear takeaway. Unanalyzed (but quality-checked) data, as well as less-relevant graphs or tables, can be moved to an appendix or released as part of routine open data.



Source: Vélo Canada Bikes, Pedal Poll 2021.



Sums represent an average of data collected over two 24-hour periods during the month and year noted on the horizontal axis. Source: Boston 2020/2021 StoryMap.

What if Counts Don't Show Growth?

Reporting bike counts during long-term disruptions

Part of making the case for a bike program is discussing why ridership may be falling short in places that have not received sufficient investment in bike infrastructure, or how broader changes in travel patterns affect bike counts. During and since 2020, travel patterns have shifted away from the morning downtown-bound commute in particular, a common focus of bike counts. Analyze all-day bike trips as a percent of vehicular traffic to illustrate the continued, or even increased, role of bicycling. Show time-of-day changes in bike counts to demonstrate off-peak increases.

Examine survey data, user feedback, and site conditions to identify issues that might lead to renewed action, such as a lack of bike facilities leading to newer employment hubs, bikeway maintenance or design issues, or lack of secure bike parking.

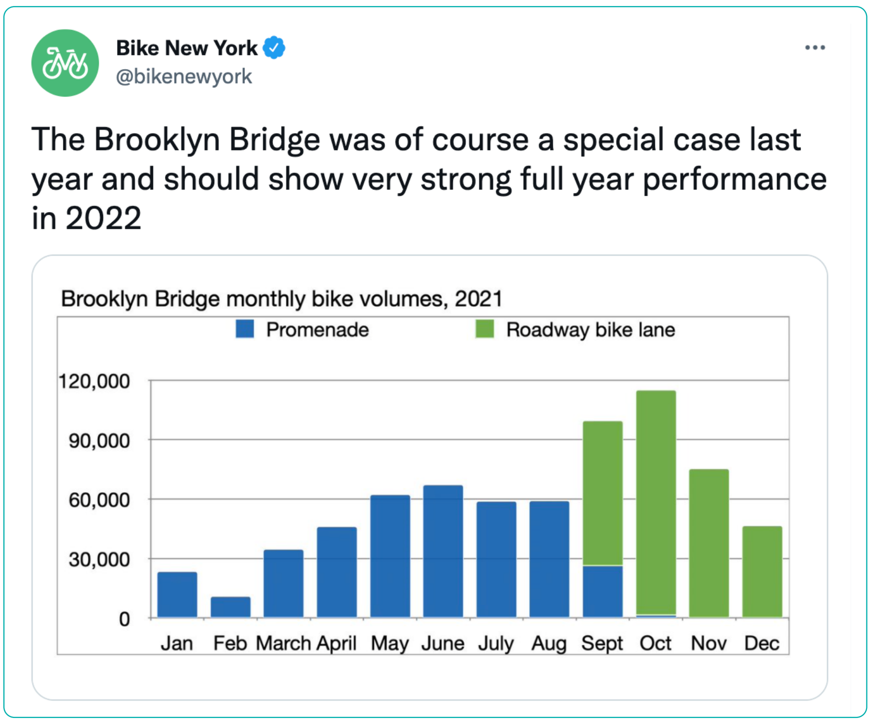
A broad-based network trendline count helps find the riders who may have been missed in the past. As housing costs have increased, high-bicycling groups (such as youth, families with more adults than cars, and young adults) may be living further from the city center. In addition to network counts, use large datasets, survey data, and Census data for insight into the dispersion of bike trips or high-bike households.

Get the Story Out

GUIDANCE

- When the story is good, look for ways to tell people about it. City press offices can work with reporters, bloggers, or news outlets to feature exclusive or deep-dive data stories based around city policies or goals. When appropriate, data points can be included in a higher-attention press release or event. Alternately, create a media strategy specifically for the data publication.

- Not every data publication needs a full written report. Release count data regularly, but rather than writing commentary on each year or season's count, wait until there is news to share that will focus attention on the analysis rather than on raw numbers. And when there is news, share graphs and conclusions in a blog, with stories in news outlets, through your advocacy community, and on social media, not just in reports and presentations.



- Add key ridership, bike network quality and mileage, and public engagement statistics to all agency presentations about bicycling & bike projects. Consider ways to tailor them to distinct agency goals, missions, or work plans.

- Publish monthly or weekly data from continuous counters on an open data portal or similar platform with your contact information for follow-up. Raw data and cleaned data should both be shared, along with explanatory comments for any real spikes or dips in riderships and a description of data cleaning methods.

References and Citations

Capital Regional District. *Bike Counts*. www.crd.bc.ca. https://www.crd.bc.ca/about/data/bike-counts

City of Boston. (2020, October 7). *2019 City of Boston Bike Counts Report*. ArcGIS StoryMaps. https://storymaps.arcgis.com/stories/26a27e118ac84ee4ae62bd134788ec1c

City of Calgary. (n.d.). Central Business District Cordon Count. Calgary. https://www.calgary.ca/transportation/tp/planning/transportation-data/central-business-district-cordon-count.html

City of Minneapolis. (2013). *Minneapolis Non-Motorized Traffic Counts: Operations and Methodology*. https://www2.minneapolismn.gov/media/content-assets/www2-documents/government/Pedestrian-and-Bicyclist-Count-Methodology.pdf

City of Minneapolis (n.d.) . *Walking and Biking in Numbers* (P. Longenecker, Ed.). Arcgis.com. https://cityoflakes.maps.arcgis.com/apps/Cascade/index.html?appid=21e2404e7be444abb8d5a071215b5708

Eco Counter, & The League of American Bicyclists. (2021, July 20). *How to Make Your Bike Data Count* [Webinar]. https://bikeleague.org/sites/default/files/HowToMakeYourBikeDataCountWebinar_Combined.pdf

Fewer, D., Grieman, K., Kwan, J., & Williams, S. (n.d.). *Bike Counting: Privacy Implications*. Samuelson-Glushko Canadian Internet Policy and Public Interest Clinic. https://cippic.ca/sites/default/files/file/CIPPIC-BIKE_COUNTING_%26_PRIVACY.pdf

Figliozzi, M., Monsere, C., Nordback, K., Johnson, P., & Blanc, B. (2014, June). *Design and Implementation of Pedestrian and Bicycle-Specific Data Collection Methods in Oregon*. Civil and Environmental Engineering Faculty Publications and Presentations. Statewide Planning and Research (SPR) 754. https://pdxscholar.library.pdx.edu/cengin_fac/345

Holub, T. (n.d.). *Thoughts from Austin*. Bike Lab, project of Totally Doable Consulting. https://bike-lab.org/cities/austin/

kanarinka. (2016, March 22). Missing Women, Blank Maps, and Data Voids: What Gets Counted Counts. Civic Media; MIT - Center for Civic Media. https://civic.mit.edu/2016/03/22/missing-women-blank-maps-and-data-voids-what-gets-counted-counts/

Los Angeles Department of Transportation. (2021). *LADOT 2019: Walk & Bike Count*. https://ladot.lacity.org/sites/default/files/documents/ladot2019walkandbikecount.pdf

MassTrails. (2021, July 28.). *Know Your Path: Collecting Long-Term Bicycle and Pedestrian Counts on Shared Use Paths*. https://www.mass.gov/doc/masstrails-counter-primer/download

Minge, E., Falero, C., Lindsey, G., Petesch, M., & Vorvick, T. (2017, January). *Bicycle and Pedestrian: Data Collection Manual*. Minnesota Department of Transportation: Research Services & Library. https://www.dot.state.mn.us/research/reports/2017/201703.pdf

Minnesota Department of Transportation. (n.d.). *About - Bicycle and Pedestrian Traffic Counting - MnDOT*. www.dot.state.mn.us. http://www.dot.state.mn.us/bike-ped-counting/about.html

National Association of City Transportation Officials. (n.d.). A How-to Guide for Learning More about Bike Share in Your Community. National Association of City Transportation Officials. https://nacto.org/interceptsurveytoolkit/

National Institute for Transportation and Communities. (2020, December 15). *The New BikePed Portal Dashboard: A National Non-Motorized Count Data Archive*. National Institute for Transportation and Communities. https://nitc.trec.pdx.edu/news/launching-bikeped-portal-dashboard

New York City Department of Transportation. (n.d.). New York City Cycling Risk. https://www1.nyc.gov/html/dot/downloads/pdf/nyc-cycling-risk.pdf

New York City Department of Transportation. (2016, May). *Cycling in the City: Cycling Trends in NYC*. https://www1.nyc.gov/html/dot/downloads/pdf/cycling-in-the-city-may2016.pdf

New York City Department of TransportationNYC. (2021, September). Cycling in the City: Cycling Trends in NYC. https://www1.nyc.gov/html/dot/downloads/pdf/cycling-in-the-city-2021.pdf

Nordback, K., Kothuri, S., Johnstone, D., Lindsey, G., Ryan, S., & Raw, J. (2019, May 16). Minimizing Annual Average Daily Nonmotorized Traffic Estimation Errors: How Many Counters Are Needed per Factor Group? *Transportation Research Record: Journal of the Transportation Research Board*, *2673*(10), 295–310. https://doi.org/10.1177/0361198119848699

Ozan, E., Searcy, S., Geiger, B., Vaughan, C., Carnes, C., Baird, C., & Hipp, A. (2021, March). *State-of-the-Art Approaches to Bicycle and Pedestrian Counters*. North Carolina Department of Transportation Research Project No. RP 2020-39. https://connect.ncdot.gov/projects/research/RNAProjDocs/RP2020-39%20Final%20Report.pdf

Portland Bureau of Transportation. (2015). Portland Bicycle Count: Report 2013-2014. https://www.portlandoregon.gov/transportation/article/545858

Ryus, P., Butsick, A., Proulx, F. R., Schneider, R. J., & Hull, T. (2017). *Methods and Technologies for Pedestrian and Bicycle Volume Data Collection: Phase 2*. Transportation Research Board National Cooperative Highway Research Program (NCHRP) Web-Only Document 229. https://doi.org/10.17226/24732

Ryus, P., Ferguson, E., Laustsen, K. M., Schneider, R. J., Proulx, F. R., Hull, T., & Miranda-Moreno, L. (2014). *Guidebook on Pedestrian and Bicycle Volume Data Collection*. Transportation Research Board. National Cooperative Highway Research Program (NCHRP) Report 797. https://doi.org/10.17226/22223

San Francisco Municipal Transit Agency. (2017, September 22). *How many people are biking?* SFMTA. https://www.sfmta.com/getting-around/bike/bicycle-ridership-data/how-many-people-are-biking

San Francisco Municipal Transit Agency. (2018, July). *Safe Streets Evaluation Handbook*. https://www.sfmta.com/sites/default/files/reports-and-documents/2018/10/safestreetsevaluationhandbook_july2018.pdf

Texas Department of Transportation. (2022). *Bicycle & Pedestrian Count Resources*. Texas Department of Transportation. https://www.txdot.gov/inside-txdot/modes-of-travel/bicycle/bicycle-pedestrian-count/bicycle-pedestrian-count-resources.html

Vélo Canada Bikes. (2021). Pedal Poll/Sondo Vélo 2021 Results. Vélo Canada Bikes. https://www.velocanadabikes.org/pedalpoll/pedal-poll-sondo-velo-2021-results/

Vélo Québec. (2021, June). Cycling in Québec in 2020. https://www.velo.qc.ca/wp-content/uploads/2021/06/vq-edv2020-en.pdf