1 Introduction

> "Bicycling should not be reserved only for those who are trained, fit, and daring enough to navigate busy traffic on city streets" (Pucher 2001).

Many cities, including Washington, DC (DC Office of Planning 2011; DC Department of Transportation 2014), have policies to increase the proportion of people who ride bikes and walk for personal transport, and generally to reduce the numbers who drive cars on a regular basis. However, many people are reluctant to bike and walk more because so much of their cities' transportation infrastructure has been dedicated to moving passenger cars—"bicycle riding in many American towns and cities is neither enjoyable nor safe because of the dominance of the automobile" (Nelson and Allen 1997).

Several authors have asked to what extent do city policies actually matter for bike riders' choice of mode (such as Goetzke and Rave 2011; Rietveld and Daniel 2004), with some even arguing that for many trip types, policy is less influential than "social network effects" (i.e., do other people ride?) (Goetzke and Rave 2011). Even if such authors are correct, even if people *will* ride regardless of whether city policy and infrastructure support their choice, it is still incumbent upon the government to make it possible to do so safely. As Pucher and Buehler (2016) suggest, it "is crucial to improve cycling safety in the United States" and "bicycle infrastructure can indeed help improve cycling safety and increase cycling levels."

Marshall and Ferenchak (2019) even suggest that places with high rates of bike usage "are not only safer for bicyclists but for all road users." "Improving bike infrastructure with more protected/separated bike facilities is significantly associated with fewer fatalities and better road safety outcomes for all road users", they write, but their "results suggest that more bicyclists on the road is not as important as the infrastructure we build for them."

Other authors have found significant positive associations between the provision of a connected bikeway network and increased bike usage (Nelson and Allen 1997; Dill and Carr 2003; Buehler and Dill 2016; Buehler and Pucher 2012), particularly for women (Furth 2008; Garrard, Rose, and Lo 2008; Prati 2018; Le et al. 2019; Garrard, Handy, and Dill 2012). Naturally, how far away that bikeway is also matters; in a study of bike commuting in Montréal and Vancouver, "one-kilometer closer proximity [to a bikeway] was associated with four times higher cycling commute mode share" (Teschke, Chinn, and Brauer 2017).

Creating bike infrastructure in a brand new place is relatively easy, but many existing cities can't just add another ten feet of blacktop between the street and sidewalk to ride on. So how do cities create more space for people biking in dense, urbanized areas that are already built out? This report will compare several places where bicycle mode-share is increasing, in the US and around the world, in an attempt to determine what policy and infrastructure changes have been made in those locations that induced that increase.

2 What cities *are* expanding their cycling modeshare? How?

> "All the people who cycled in 2005 were 'cyclists'. . . . The infrastructure needs to be made for those who are not cyclists." —Manuel Calvo[1]

"The provisioning of a network of safe bicycling infrastructure is a critical policy element in bringing about a large-scale mode shift toward cycling" (Tucker and Manaugh 2018). Simply put, places that have separate, dedicated infrastructure for people riding bikes have more people riding bikes, around the world and in the United States (Furth 2012).

1. Sustainability consultant and architect of the *Plan de la Bicicleta de Sevilla* "on Sevilla's 2007–2011 bike boom" at the PlacesForBikes conference, https://twitter.com/PlacesForBikes/status/991656135102029824

Perhaps the best-known examples of places that have substantial proportions of their populations riding bikes on a regular basis are the Northern European cities, particularly Amsterdam (and the Netherlands in general) and Copenhagen, Denmark. As Furth (2012) notes, "In many European countries, including the Netherlands, Germany, Denmark, and Sweden, cyclists' need for separation from fast, heavy traffic is considered a fundamental principle of road safety."

2.1 Canadian Cities

North American cities' construction of separated bike infrastructure has often been inspired by the Northern European experience. Davis, California, became a "city of bicycles" after "a community leader's half-year stay in the Netherlands in the 1960s"; Montréal, Québec, built 15 miles of two-way cycletrack in the 1980s after "a city official's visit to Amsterdam" (Furth 2012).

> "Even controlling for population size, Canadian metropolitan areas have bike shares of work trips about three times higher than American metropolitan areas. . . . Differences in transport and land use policies play an important role in explaining the higher share of bike trips in Canada. To some extent, they are the same policy differences that explain higher levels of transit use and walking in Canada." (Pucher and Buehler 2007)

For starters, across Canada, cities are denser and land uses are mixed, making commute distances shorter and more bikeable; gasoline (and the cost of owning and operating a vehicle overall) is more expensive, so there are fewer vehicles in use; and "car parking in Canada is less available and more expensive than in the United States" (Pucher and Buehler 2007). However, it is also the case that "Canadian cities average almost three

times as many kilometres of bike paths and lanes per capita as the American cities sampled (46 km vs. 18 km)."

Of particular note, Montréal and Québec City residents ride bikes for 1.3% of work trips, despite having significantly colder weather than even places like Toronto (Pucher and Buehler 2005, 2006, 2007). The province of Québec has had a policy of increasing bike riding and cycling safety since 1995, and spent at least $269 million building the province's bikeway network out from 778 km in 1992 to almost 7,000 km in 2004 (Pucher and Buehler 2006). Montréal alone, as of 2004, had 210 km of separate, off-street bike paths, and another 95 km of bike lanes; Québec City had 220 km of separate paths and 121 km of bike lane (Pucher and Buehler 2006).

Calgary, Alberta, is another very-cold-weather city with substantial and increasing cycling mode-share. Although a 2009 survey of potential bike commuters at University of Calgary found that the "three most commonly indicated barriers to beginning to commute by bicycle were: I do not know a safe route, I feel unsafe riding on the road, and there is a lack of secure parking on campus" (Twaddle and Hall 2009), downtown Calgary more than doubled the number of people arriving by bicycle between 1996 and 2015 (Mitanis 2016). In 2015, the city installed a 6.5 km network of cycletracks in the Downtown area as a pilot project (Andersen 2015; Glowacz 2016). The space was created by removing on-street parking or travel lanes from streets—approximately 2% of downtown lanes were repurposed by the project (Glowacz 2016).

Within three months, weekday bike counts on the new cycletracks were nearly double counts in the same places before the cycle tracks opened, and not only the *number* of riders changed, but also the *who* of riders. While "Dutch, German, and Danish women cycle as often as men", only "29% of daily bike commuters in Canada were women", and 24% in the US (Pucher, Buehler, and Seinen 2011). In Calgary, the number was even lower—the proportion of riders who were women was 20% at Downtown locations and

22% city-wide before the downtown cycletracks were built—but rose to 27% immediately after the installation (Andersen 2016) and 30% by the end of the 18-month pilot (City of Calgary 2018).

After 18 months, Downtown ridership was up 40% since installation, with ridership on the particular routes that had become cycletracks having tripled—on one route, 8 Avenue west of 3 Street SW, ridership increased to 31% of daily on-street trips (Glowacz 2016). By the end of the pilot program, despite the increases, illegal riding on sidewalks had dropped from 16% to 2% (Glowacz 2016; City of Calgary 2018). The pilot was declared a success and the lanes made permanent at the end of 2016, and the next summer nearby (and even colder) Edmonton began installing its own 7.8-km bikeway network (Goffin 2017).

2.2 Seville

Beginning in 2004, the city of Seville, in Spain, created a network of cycle-tracks alongside roads, between the parking lane and sidewal. While previously the city had had "only sparse and unconnected bike paths", they built 77 km of bike paths in the 18 months from August 2006 to December 2007; a further 43 km was built between June 2009 and June 2010, and by 2015 the bikeway network "reached. . . 164 km (including recreational and pedestrian-shared paths), which makes it 12% of the total road length in the city"(Marqués et al. 2015). As the city built out its cycletrack network, the proportion of people who bike in the city of Sevilla went from "negligible" to over 5%—already more than most American cities—in under 10 years (Marqués, Hernández-Herrador, and Calvo-Salazar 2014; Marqués et al. 2015), and the city was already being compared to Amsterdam by at least one travel writer.[2] The average daily bicycle traffic count at one point on the system

2. Neild, Barry. "Is Seville Now Europe's Best City for Cycling?" *CNN Travel*, February 19, 2015. https://www.cnn.com/travel/article/seville-cycling-cnngo/index.html.

rose more than 450%, from just shy of 350 to over 1900 (Marqués et al. 2015).

While Calgary initially created its small downtown network as a pilot program because that made the project "nonbinding", theorizing that if the city didn't "get a bike lane right at first. . . it's not cripplingly expensive to do it over" (Andersen 2014), one particular innovation of the team that designed Seville's cycle-path network was to build it at sidewalk level—even though most of the new bikeways were going on space that had been bus lanes and parking spaces—because this made it "vastly more expensive" to take out again, even if the supportive government lost office (Andersen 2018).

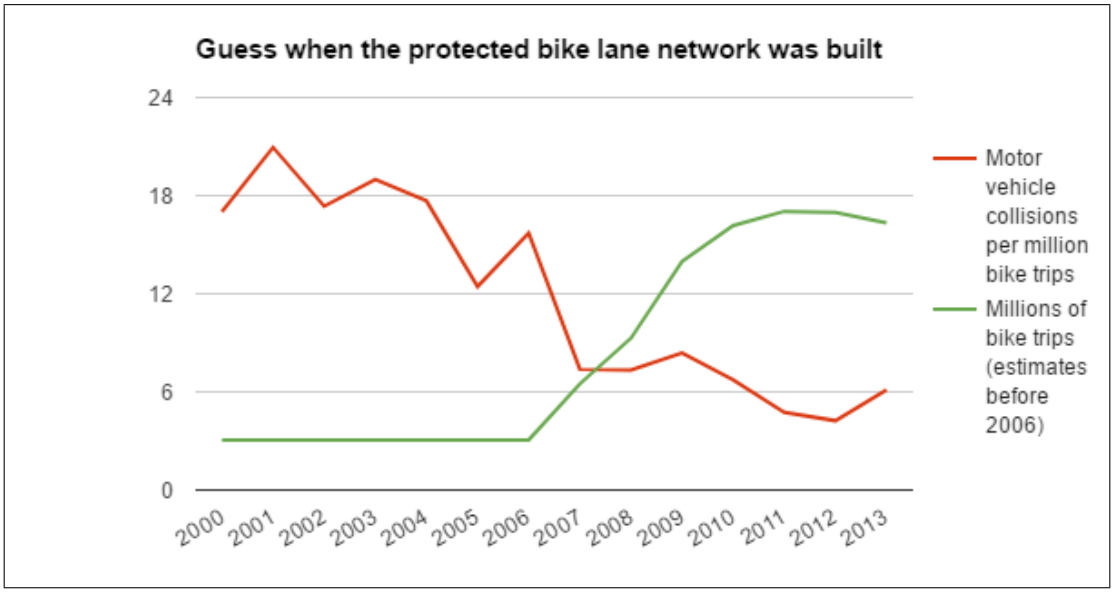

Figure 1: As Seville built out its bikeway network, "Two things started happening. . . almost immediately: the number of bike trips soared and the risk of a bike trip plummeted" (Andersen 2017).

In both Calgary and Seville, the governments initially considered building out their bikeways piecemeal. As an advocate told People for Bikes's Michael Andersen, " 'Originally what was being pitched is they were going to build two cycle tracks per year. Mayor Nenshi and a couple of the councillors. . . said it's not going to be a true test unless the whole network is up in one go' " (Andersen 2014). Seville's experience demonstrates this was the correct choice: after the network was built out, Marqués and Hernández-

Herrador (2017) found that "the implementation of the network. . . directly caused the big drop [in] risk"—"connecting the bikeways making a network had a big impact on cycling safety by itself" (Figure 1). While adding in the total length of all bikeway built improved the model, the fact of the existence of a connected network was found to be the single best explanation of the change in the danger posed to people riding bikes (Marqués and Hernández-Herrador 2017; Andersen 2017).

2.3 Elsewhere

Seville still stands alone among Spanish cities in having a network of protected bike lanes. "Other places have built bike lanes, notably Barcelona, but these are not fully segregated and the cycling share remains lower", though, given Seville's often quite hot weather, "if you build *the right* bike lanes, it appears, people will want to use them" (Walker 2015, emphasis added).

Bogotá, Colombia, has long been famous for the weekly *Ciclovía*, when parts of major roads across the city are closed to cars and thousands if not millions of residents come out to walk and ride bikes in the roads, but until recently, non-recreational cycling has been rare—"Except for Sundays, cars still rule the road" (Jenkins 2015). Between 1995 and 2003, however, mayors Antanas Mockus and Enrique Peñalosa built over 300 kilometers of bikeways, mostly as sidepaths or paths in the medians of large roads (Rodriguez-Valencia et al. 2019); daily cycling in the city increased from 0.58 percent to 4 percent and traffic fatalities dropped 50% (Jenkins 2015; Despacio 2008). As in Calgary, the proportion of riders who were female also rose, to 28.85% (Rodriguez-Valencia et al. 2019).

In November, 2019, the Australian city of Melbourne announced it would spend AU$1.6 million (about US$1.1 million) to build a protected intersection and update traffic signals to allow people walking and riding bikes to get a start crossing ahead of drivers, as part of a larger upgrade project to add protected bike lanes at another intersection and on

several nearby roads. The head of Australian bike advocacy organization Bicycle Network told Melbourne newspaper *The Age* that "only 16 per cent of bike riders are comfortable going through a normal intersection, but with separated infrastructure for cyclists that number rises to 70 per cent of recreational riders" (McMillan 2019); according to a survey conducted by the Melbourne city council, "only 22 per cent of people who would consider cycling in [city center] felt confident to do so with just painted bike lanes, compared to 83 per cent who would ride if there was some form of physical separation from cars" (Jacks and Lucas 2019).

A long list of collaborators at Portland State University and Alta Planning studied new protected bikeways in five cities across the United States and found that "ridership increased [by] +21% – +171% within one year of building the protected lanes"; while ridership across the cities was rising, the gains shown on these routes "appear to be greater than [the] overall increases in bicycle commuting in each city" (Monsere et al. 2014). As John Pucher told People For Bikes in response to (Marqués and Hernández-Herrador 2017), "'Simply racking up total bikeway mileage by putting down stripes for unprotected bike lanes is obviously cheaper. But it does not attract nearly as much new cycling'" (Andersen 2017).

3 Conclusion

> "If you build it, they will come." — *Field of Dreams*, paraphrased (Levinson 2018)

Hunt and Abraham (2007) found, among other things, that people are less willing to ride when the trip takes longer—and that riding in traffic *feels* four times longer than the same objective amount of time spent riding in a designated bike lane. Thus, to get more people to ride, it is important to make it possible for more people to live closer to where

they will ride to—but, all else being equal, giving people their own place to ride, away from traffic, will make the ride seem shorter, and that may be enough to make people more willing to do the ride.

Providing more dedicated, protected infrastructure for people riding bikes, in a connected network of bikeways, leads to more people riding bikes. In the context of highway-building, this phenomenon is increasingly known as "induced demand" and campaigned against, but if it is assumed that people riding bikes is a good thing—and, as noted on page 1, it is policy in many places that it is—then induced cycling demand is a thing which should be supported.

Increased usage is positively associated with safety, known as the "safety in numbers effect", as coined by Jacobsen (2003) and discussed by Elvik and Bjørnskau (2017), Fyhri et al. (2017), and Marqués and Hernández-Herrador (2017), among others. Marqués and Hernández-Herrador (2017) in particular found that, while the creation of a protected bikeway network improved safety, this improved safety is a better explanation for the increase in cycling than the existence of the network itself—and that the increased riding then also improved safety. This seems to suggest that creating protected bikeway infrastructure could kickstart a positive feedback loop: More infrastructure, more riders; more riders, more safety; more safety, more riders. . . they'll need more infrastructure. . . .

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