Cycling use and attitudes towards cycling in Halifax Regional Municipality and the Region of Waterloo

by

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I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

The purpose of this thesis is to explore bicycle use and attitudes towards cycling through case study analyses in Halifax Regional Municipality and the Region of Waterloo. There are two main sections of analyses; the first investigates factors that have been shown by previous research to be associated with cycling behavior for each of the study areas, and the second focuses on the results of a bicycle survey administered for the purpose of this research. The statistical analysis in Part 1 applies Fisher's Exact Test to reveal statistically significant associations in the survey data. These two sections of analysis are compared and the following conclusions offered:

1. Cycling use is likely associated with city size, density, weather, topography, age, and gender.

2. Cycling trip purpose in Halifax is associated with weather; in Waterloo, trip purpose is associated with weather, gender, and employment.

3. Cycling use in Waterloo is associated with weather, age, gender, employment, and income.

4. There is strong evidence that the provision of bicycle infrastructure has a strong association with bicycle use.

In the context of increasing bicycle use, the principal finding is the association between the provision of bicycle infrastructure and increased cycling use. In Waterloo, where the rate of cycling use is higher than in Halifax, there is approximately twice the total number of kilometres of on-street bicycle routes and respondents reported living significantly closer to bike paths, lanes, or trails. In Halifax, where cycling use is less common, respondents expressed much more concern regarding inadequate cycling infrastructure and an overall dissatisfaction with the quality of cycling facilities.

These findings reaffirm the previous research suggesting that the provision of more bicycle lanes, paths, route signage, and parking facilities is associated with higher rates of bicycle use among the general public.

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Separately, I must also acknowledge the editorial help of my father. Not all of the many paragraphs between these covers are electrifying, so thanks for your thoroughness.

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Chapter 1: Introduction

1.1 Justification of Research

More use of active transportation, including cycling, can help combat two major threats to quality of life in our communities: poor health and ongoing dependence on the private automobile.

As health issues are discussed within the transportation, urban planning, and health literature, these issues – and potential solutions – are beginning to be evaluated in the public agenda based on our dependence on private automobiles and the related built environments in which we live and work. Saelens et al. (2003) posit that although it has been established that greater use of cycling and walking can significantly improve individuals' long-term health, there is a general lack of understanding among health and physical activity professionals of the important relationships that exist between levels of active transportation and our built environment. However, Pucher et al. (2010) have recently noted that governments and health organizations are more often advocating the use of cycling as a way of improving health and reducing "…air pollution, carbon emissions, congestion, noise, traffic dangers, and other harmful impacts of car use." (p. S107)

Most levels of Canadian and American governments have not made the investments that will be necessary to make easier a significantly greater use of alternative modes, yet many governments have been increasing funding for walking and cycling, especially since the 1990s (Pucher et al., 1999; Xing et al., 2010). Also explored in this thesis, policies at the provincial and municipal levels relating to road safety, urban form, and transportation demand management are now formulated with the objective of increasing the use of bicycle travel.

Recent evidence has shown that investments in cycling infrastructure tends to generate worthwhile results; in reference to several studies looking into determinants of cycling, Pucher et al. (2010) affirm that "countries and cities with high levels of bicycling and good safety rates tend to have extensive infrastructure, as well as pro-bicycle policies and programs, whereas those with low bicycling rates and poor safety records generally have done much less." (p. S107)

To address auto-dependency and the general public's deteriorating physical health, Canadian cities will need to plan for alternative modes of transportation and it is likely that this need will increase over the next decade and after. This thesis contributes to a transition towards greater cycling use in a Canadian context by furthering our understanding of factors associated with cycling and by working to understand the public's attitudes towards cycling in their communities.

1.2 Introduction to Literature

Until a relatively recent surge of interest in the field of human-powered modes, transportation research has largely been concerned with vehicular travel (Saelens et al., 2003). Since some 83 percent of trips (movement from an origin to a desired destination) are short, and occur relatively close to home, non-motorized modes of transportation is an area of research that demands more attention (USDOT Federal Highway Administration, 1997 & Saelens et al., 2003). For example, Sallis et al. (2004) contend, "…increased attention to active transportation could contribute to solutions to a variety of transportation problems, whether the primary motivation is to enhance public health or improve transportation. More walking and cycling for transportation could produce benefits related to traffic congestion, demand for parking, as well as air pollution…" (p. 263)

Thousands of articles discuss many aspects of cycling[1] related to safety (Pucher & Dijkstra, 2000; Jacobsen, 2003), health (Petritsch et al., 2008; Sallis et al., 2004), policy

[1] For example, a Google Scholar title search for 'bicycle' returns 24,500 English language titles.

(Pucher & Buehler, 2006; Rietveld & Daniel, 2004), infrastructure (Dill & Carr, 2003; Providelo & Sanches, 2008); and to neighbourhood design (Rodriguez & Joo, 2004; Rawoof Pinjari et al., 2008). Cycling falls under the categories of *non-motorized transportation*, *active-transportation*, and *alternative transportation*; therefore, cycling-related research is often grouped and studied in combination with walking and other human-powered forms of transportation.

While research based on the public's use and attitudes towards cycling has been conducted, there is a lack of peer-reviewed research that discusses the various methodologies and findings of these studies. Many cities conduct surveys of road users – cyclists included – in an attempt to understand how the public feels about various transportation issues. Better knowledge of public attitudes, combined with professional expertise, will allow governments to plan and prioritize efforts to shift our transportation systems to modes we now consider 'alternative'.

There have been a number of recent surveys on cycling or active transportation in Canada (see Appendix 1 for a list of recent cycling surveys in Canadian cities). Surveys have been conducted recently in Calgary, Mississauga, Guelph and Nanaimo, and more are likely underway in other Canadian cities. Their methodologies and the quality of the efforts vary greatly. Some surveys are focused on learning from the bike-riding public, and some are concerned about the public in general; some surveys ask relatively few questions, and some can be quite lengthy. The distribution methods also vary; cycling surveys have been administered by telephone, mail-out, random-intercept, and online advertisement. These differences make it obvious that the funding allocated to these studies has also varied significantly.

1.3 Scope and Audience

Although the broad purpose of this research is to contribute understanding to enhance the transition from auto dependency to human-powered forms of transportation, it is hoped that this research will fulfill two more modest goals. One is to contribute to the research body surrounding public attitudes and cycling behaviour, and secondly, to assist municipal staff in each of the study areas to improve their understanding of cycling in their cities.

1.4 Research Objectives

The two main objectives of this thesis are to first understand factors that relate to a) cycling use and b) cyclist type and second, to understand the general public's attitudes and preferences towards cycling. Halifax Regional Municipality (HRM) and the Region of Waterloo are the case study regions where cycling surveys were conducted in 2009. As will be discussed in Chapter 3, the surveys were targeted to the general public (both non-cyclists and cyclists) and include questions about cycling habits, attitudes towards cycling, and socio-demographics.

1.5 Thesis Organization

A review of literature relating to cycling-use (Chapter 2) is followed by a description of the methodology employed in the present research (Chapter 3).Chapter 4 is an analysis of physical and social characteristics of Halifax and Waterloo and Chapter 5is an analysis of the survey results gathered for Halifax Regional Municipality and the Region of Waterloo. Chapter 6is a discussion of the main findings of the research and conclusion and recommendations are presented in Chapter 7.

Chapter 2: Literature Review

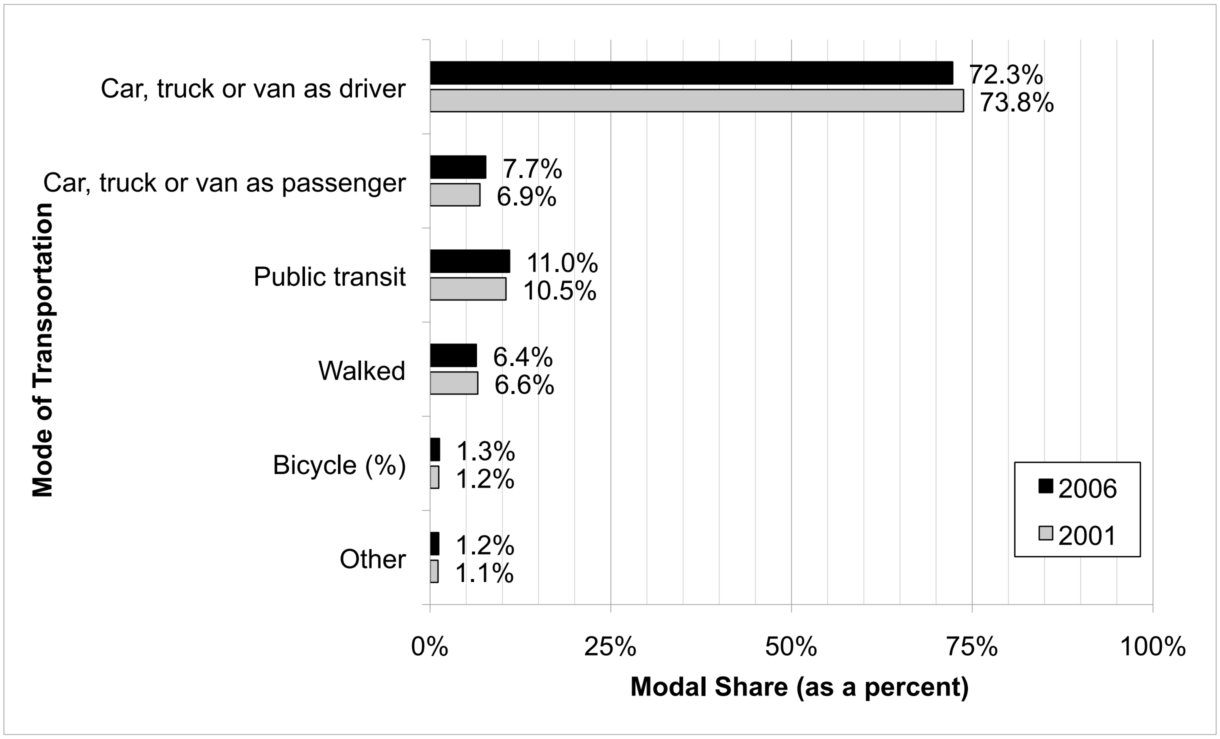
2.1 Focus of the Literature Review

Cycling is currently being researched from various angles and at many levels, in part, owing to a growing interest and awareness of the benefits of active transportation. Academics, professionals, and students, with backgrounds as varied as health, engineering, and urban planning are studying cycling, both as a form of transportation and important recreation activity. This chapter takes a broad look at cycling in Canada, and a more specific look at existing research into the determinants of cycling-use. A short discussion of research into public attitudes is also provided.

2.2 Cycling Use in Canada

Cycling is currently the fourth most common mode of commuting transportation in Canada, behind the automobile, transit, and walking (Figure 2.1). The percent of commuters driving their cars has decreased by 1.5 percent between 2001 and 2006. Increases in public transit use (0.5 percent) and automobile use by passengers (0.8 percent) likely explain the percent decrease in mode share for automobile drivers. Relatively few Canadians – only 1.3 percent – use a bicycle as their primary mode of travel to or from work. According to the Canadian Census, Nova Scotia and Ontario – the provinces wherein lie the two study areas analysed later in this thesis – have bicycle mode shares of 0.7 percent and 1.2 percent, respectively (Statistics Canada, 2008b).

Figure 2.1: Modal Share for Canadians' commute to work for 2001 and 2006 (Statistics Canada, 2008a)



Although it is used marginally in comparison with other modes, Pucher and Buelher (2006) contend that across Canada bicycle use among commuters has been on the increase since 1996. In 1996, 2001, and 2006, the Statistics Canada commute-to-work mode share shows that commuting by bicycle has increased steadily from 1.1 percent to 1.2 percent to 1.3 percent. Meanwhile, cycling levels in the United States have been decreasing (0.6 percent in 1980, 0.4 percent in 1990, and 0.4 percent in 2000) and are already considerably lower than levels in Canada (Table 2.1). Although journey to work cycling data is important to evaluate, and allows an easy comparison between jurisdictions, it is unfortunate that non-work and recreational cycling-use statistics have not been studied on a national scale in either the United States or Canada (Pucher & Buelher, 2006) since cycling is often used for non-work trips.

Table 2.1: Modal share for the worktrip in Canada and USA, 2000/2001 (from Pucher & Buelher, 2006, p. 266)

Transport mode	United States (%)	Canada (%)
Auto	87.9	80.7
Transit	4.7	10.5
Bicycle	0.4	1.2
Walk	2.9	6.6
Other	4.1	1.0
Total	100.0	100.0

As the mode share data suggest, and as confirmed by cycling research, cycling is marginally used (Pucher and Buelher, 2006) for commuting. Although there are substantial variations between provinces and cities within provinces, as a mode of transportation, bicycling is well back in the shadows, and is consistently a less popular mode than walking.

The mode share data for cycling stands in contrast with the levels of user satisfaction. According to data from the 2005 General Social Survey carried out by Statistics Canada, commuters on bicycles are those most likely to enjoy their trip to work. Specifically, the probability of a worker enjoying his or her commute was 59 percent for cyclists, 46 percent for walkers, 37 percent for auto users, and 28 percent for public transit users. Additionally, 19 percent of cyclists identified their commute to work as being the most pleasant part of their day; the same was true for only 2 percent of auto users (Statistics Canada, 2006).

Why then, do so few Canadians cycle? Easy answers would likely include bad weather, poor fitness or age, and the inconvenience of using what is seen as a marginal form of transportation. Research helps us understand the factors that influence cycling and are explored herein.

2.3 Safety and Cycling

Although exceptions exist, our cities have largely been planned in such a way that maximizes the accommodation and flow of private automobiles. Therefore, many potential users of non-motorized transportation modes are reluctant to exercise their preferences because of uncertainties over personal safety and fears of collision with larger and faster vehicles. This safety dilemma can be compared to the trend among some automobile drivers to drive larger models because they feel that large vehicles are safer in collisions (Thomas & Walton, 2008); in so deciding they ignore the fact that heavier models are more harmful to all road users in the case of a collision (Wenzel & Ross as cited in Thomas & Walton, 2008). If auto users drove smaller cars everyone would be safer and the same is true if everyone began cycling more. As Pucher and Buelher (2006) note, "Safer cycling encourages more people to cycle, and as more people cycle, there are more cycling facilities, more cycling training, and more consideration by motorists of cyclists, all making cycling safer." (p. 288)

In a comparison of walking and cycling levels with pedestrian and cyclist death resulting from collisions with motor-vehicles, Jacobsen (2003) has shown that the likelihood of a vehicle-related death involving a pedestrian or cyclist is reduced in areas with greater levels of walking and cycling. Jacobsen attributes this finding to driver behavior: "…the most plausible explanation for the improving safety of people walking and bicycling as their numbers increase is behavior modification by motorists when they expect or experience people walking and bicycling." (p. 208)

This dilemma has prompted research dedicated to understanding threats to the use of non-motorized modes and suggests methods of providing safer non-motorized options. An index, termed 'walkability[2],' is often used to describe how pedestrian friendly a particular

[2] Improved walkability has been shown to have a significant association between more walking and cycling activity, lower body mass index (BMI), and lower hypertension (Tomalty & Haider, 2009, as cited in Litman, 2009)

neighbourhood, corridor, or city may be. As part of a survey-based study that measured walkability in South and Southeast Asian and American cities, Krambeck et al. (2009) identified three primary determinants of walkability: convenience and attractiveness, policy support, and safety and security. These results are not surprising and likely apply to all modes of transportation – cycling included. Research emerging from a number of different fields, including public health and urban planning, has expressed concerns that the communities that we have built, and are still developing, have environments where cycling or walking can be dangerous activities (Litman, 2003; Sallis et al., 2004).

Consistent with the walkability index (Krambeck et al., 2009), urban mediums where cycling and pedestrian activity are both safe and successful seem to occur in jurisdictions where policy objectives are focused on creating such environments. Xing et al. (2010) suggest that a perception of safety among cyclists can lead to increasing use. In their survey of cyclists in six small US cities, they found that respondents' agreement with the statement, "most bicyclists appear to have little regard for their personal safety" is positively correlated with miles cycled for utilitarian purposes.

Between 2002 and 2005 the average number of cyclist fatalities per 100 million kilometers cycled in Germany, Denmark, and the Netherlands were 1.7, 1.5 and 1.1, respectively, whereas the United States experienced 5.8 fatalities per 100 million kilometers cycled (Pucher & Buelher, 2008). Transport Canada (as cited in Tay & Li, p. 1, 2007), reported that 28.6 percent of total motor vehicle related accidents in 2004 involved pedestrians or bicyclists – a disproportionately high share considering pedestrians and cyclists made up only 7.7 percent of commuters in 2006.

Germany, Denmark, and the Netherlands, which all tend to have more compact and diverse urban land use patterns, are often noted within the literature as being leaders in non-motorized urban transportation. Environments within which lower vehicle-miles are needed to travel to common destinations reduce the risk of injury and also increase the likelihood and possibility of greater use of active modes of transportation (Younger et al., 2008).Further, considered among the safest countries within which to cycle, less than one percent of adult cyclists in the Netherlands wear helmets – another indication of high safety levels and proper cycling infrastructure (Dutch Bicycling Federation, 2006; Dutch Ministry of Transport, 2006).

In an attempt to provide policy makers with a better understanding of the elements that contribute to the severity of injuries cyclists sustain, Eluru et al. (2008) have determined that the following variables affect cyclist injury severity: user age; speed limit of roadway; location of crash (with respect to the right-of-way); and time of day. They determined that the elderly are more injury prone, that higher speed limits lead to higher injury severity levels, that crashes at signalized intersections are less severe than those elsewhere, and that darkness, or a lack of daylight, leads to higher injury severity (p. 20).

Safety literature often highlights the effects on children of the availability of non-motorized modes of transportation. Poor planning and policy approaches, present and past, have had a substantial effect on the mobility of children, often more than for adults. Wilkinson (1997) notes that, "walking and bicycling have traditionally been the primary modes of independent transport for children, although if current trends in highways design and use continue, most children may soon find themselves prohibited from bicycling by their parents out of concern for their safety." (p. 92) Local interest groups, citizen advocacy groups, and government agencies are attempting to promote safe routes to school for young Canadians and Americans. Studies are also being conducted with the specific goal of determining design criteria to retain and attract young users to non-motorized modes. For example, the following criteria have been identified as being essential considerations: grade (slope) of routes, how direct routes are (a measure of connectivity), and the number of obstacles that might inhibit continued flow (such as intersections or stop signs) (Furth, 2008).

The challenges of encouraging cycling in our cities remain enormous. For children and adults cyclists alike, interaction with motor-vehicles poses a serious risk to one's safety. So long as the general public and many transportation experts continue to primarily accommodate the private automobile (AASHTO as cited in Laplante & McCann, 2008), these challenges and safety risks are unlikely to disappear in the short-term.

2.4 Influences on Cycling Behaviour

Cycling researchers have endeavoured to improve our understanding of what variables affect cycling, and to what extent. Factors affecting the popularity of cycling are diverse and include geography, demographics and policy support, among others. As an example, Pucher et al. (1999) identified the following factors as those that affect cycling trends in North America: public attitudes and cultural differences; public image; city size and density; cost of car use and public transport; income; climate; danger; and cycling infrastructure.

The following literature review of factors affecting cycling is based on a handful of studies of cities in Canada, the United States, as well as some examples from Europe and Australia. Most of the studies are quantitative, and analyze factors using a variety of regression methods. Some are based on stated preference surveys, while others rely on census statistics. A few studies are qualitative and base analyses on focus groups and interviews of the cycling and non-cycling public. The studies reviewed herein provide a good variation in scale, data used, and methodology. In a review of research investigating bicycle-use, Hunt and Abraham (2007) categorized factors into the four broad sections. Based in part in their classification, this chapter will investigate how cycling is associated with: physical characteristics; transportation purpose and automobile use; cycling-related characteristics; and policy. A final section is a discussion of related research into public participation and public attitudes.

2.4.1 Physical characteristics.

The characteristics of the layout of a community, its climate, and topography all inherently affect individuals' choices to use bicycles. The following sections explore research into these variables.

2.4.1.1 Neighbourhood design.

A relationship between neighbourhood design and bicycling-use (as well as pedestrian-use) has been demonstrated in a variety of research and it has been concluded that the way land is developed likely has an effect on transportation choice (Sallis et al. 1998; Booth et al. 2001; Saelens et al, 2003). Research concerning non-motorized transportation as it relates to urban form has determined that land use, transportation infrastructure, and public health are closely interrelated (Sallis et al., 2004). Pucher and Buelher (2006) note that high densities and a greater mix of land use encourage cycling as a result of shorter distances between destinations and origins.

The studies that investigate how the design of our communities affects cycling use are numerous and vary greatly in scope, geographic parameters, and in approach. A common strategy used to evaluate the effect of neighbourhood design on pedestrian and cycling activity is to examine differences in walking and bicycling rates between neighbourhoods with different types of urban form (Saelens et al, 2003). This analysis is often carried out in a comparison of urban and suburban settings. Two neighbourhood characteristics often used to define the level of walkability are: proximity (a function of diversity of land use and distance); and connectivity (the directness of travel) (Frank, 2000; Saelens et al., 2003). In addition to the development of a function to measure proximity, a number of methods for evaluating the connectivity of a given neighbourhood have also been developed (Randall and Baetz, 2001; Saelens et al, 2003). Saelens et al. (2003) provide a comparison of ten peer reviewed studies that set out to measure the average number of walking and cycling trips per week in highly walkable neighbourhoods and compare them with findings from low-walkable neighbourhoods. The studies, several of which take place in the San Francisco area, generally confirm that proximity and connectivity are positively associated with the number of walking and cycling trips (Saelens et al., 2003). Many other similar studies exist, including one conducted by Joh et al. (2008) investigating the relationship between land use and travel behaviour in new urbanist communities and auto-oriented corridors in the South Bay region of Los Angeles County. Their study finds that although new urbanist mixed-use centres can be associated with greater levels of walking, there is no evidence of reduced automobile use (Joh et al, 2008).

Citizens groups and researchers are increasingly encouraging developers, engineers, and planners to design neighbourhoods that are more conducive to active modes of transportation. Two prominent such movements are *Complete Streets* initiatives and *Context Sensitive Solutions* (CSS). Complete Streets initiatives, which started gaining momentum in some cities in the Southern United States in 2003, offer alternative approaches to road design that prioritize the safe and efficient use of our roads for drivers, bicyclists, transit vehicles and users, and pedestrians of all ages and abilities (Laplante & McCann, 2008). Key elements of these approaches are traffic calming and safe pedestrian crossings. *Context Sensitive Solutions* is an approach to decision-making that evolved from a transportation design concept called Context Sensitive Design established at a 1998 conference hosted by the American Association of State Highway and Transportation Officials and the U.S. Federal Highway Administration.CSS is an approach to transportation decision-making that ensures adequate background research and stakeholder outreach and participation are applied. A new CSS approach specific to arterial roadways in the United States was developed in 2006 by the

Institute of Transportation Engineers entitled *Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities* (ITE, 2006).

Although some of these studies have revealed a clear relationship between urban form and the level of walkability or ‘bikeability’, there are limits and shortfalls in many of these studies. For example, Saelens et al. (2003) acknowledge that the studies examined in their article often lacked analyses of respondents’ socio-economic and ethnic backgrounds, and contend that these factors could be “highly influential factors in non motorized transport behavior.” (p. 87)

As Cao (2006) and Saelens et al. (2003) have shown, research into the relationship between urban form and use of non-motorized modes of transport by no means explain the relationship in its entirety. For example, the possibility that individuals who enjoy cycling chose to live in bicycle friendly neighbourhoods is often noted as limitation of this research (Cao, 2006; Nelson & Allen, 1997). This possibility is highlighted in Xing et al. (2010), who show that preference for bicycle-friendly communities is positively correlated with miles cycled for transportation and is also associated with a higher proportion of utilitarian cyclists (Xing et al., 2010).

2.4.1.2 Distance to destinations.

Like most commuters, utilitarian cyclists prefer routes with shorter distances. The USDOT Federal Highway Administration (1992) found that the primary deterrent to using the bicycle for transportation among cyclists was when trip distances were perceived to be too great. An increase in trip time for cyclists of all levels of experience and cycling comfort has a significant negative effect on the attractiveness of cycling and the type of cycling facility affects a cyclists’ willingness to spend time cycling (Hunt & Abraham, 2007). Xing et al. (2010) have confirmed this finding for small US cities; average distance to destinations is negatively associated with miles of cycling for transport. They also found that average distance to destinations is positively associated with miles of recreational cycling.

2.4.1.3 Topography.

Although topography is not commonly mentioned as an influence on cycling, in their analysis of different levels of cycling in Dutch municipalities, Rietveld and Daniel (2004) found that a 'hilly' city can have the effect of decreasing bicycle use by as much as 74 percent. Specifically, their model, which measured the influence of 26 factors relating to city characteristics, meteorological conditions, policy consequences, and policy efforts, found that topography held the strongest association with cycling use: an r value of = -0.61.

2.4.1.4 Weather.

Respondents in a handful of US cycling-use surveys conducted prior to 1992 ranked weather as the primary deterrent to cycling, followed by traffic safety (USDOT Federal Highway Administration, 1992). Other primary deterrents include road conditions, inadequate parking, and that cycling is too slow. A negative association between percent commuting by bicycle and days of rain has also been noted in Dill and Carr (2003).

The designation of weather as the main deterrent to cycling should not be surprising. Adverse weather conditions pose a threat to cyclists' safety, since their own ability (and other road users' abilities) to see and maintain control of steering can be compromised. More importantly, perhaps, adverse weather conditions decrease cyclists' comfort and enjoyment levels. Too much rain, snow, heat, humidity, cold, or wind can all affect cyclists' cleanliness and travel time. Cyclists' levels of comfort or enjoyment can be affected and that, in turn, has a great impact on cycling use. In an effort to explain higher rates of cycling in Canada than the US, Pucher and Buelher (2006) found statistically significant evidence that less cycling occurs in cities with more precipitation.

2.4.2 Transportation purpose and automobile use.

Research has shown that cycling behaviour is associated with factors relating to automobile usage and the purpose for which individuals are traveling. These topics will be explored hereunder.

2.4.2.1 Automobile use and cost.

In an attempt to explain why Canadians tend to cycle more than Americans, Pucher and Buelher (2006) found that lower gas prices and affordability of auto ownership in the US had significant impacts. For example, they note that the average annual cost of owning a car in the US in 2005 was 27 percent lower than in Canada and that between 1990 and 2003 gas prices in the US were 50 percent lower than in Canada. Dill and Carr (2003) found a positive association between the percentage of people commuting by bicycle and cost of gasoline and found a negative association between cycling use and vehicle ownership (Dill & Carr, 2003).With regards to automobile ownership, Pucher and Buelher (2006) found that in 2002, Canadians had 41 percent more cars and light trucks per capita than American citizens (p.270).Rietveld and Daniel (2004), in their Dutch study, found that an increase of 1 car per capita in a city could reduce cycling mode share by as much as 26 percent. Although such an increase is unlikely, the authors have shown the significant impact auto use has on cycling levels. When individuals do not have access to a car (either because they don’t own one, because the car they own isn’t in working order, or when someone else in the household has priority use), the United Kingdom Department of Transport (1985) concluded that individuals sometimes begin cycling as a result.

Xing et al (2010) found that cyclists' enjoyment while driving motor vehicles in small US cities is negatively associated with weekly miles cycled for utilitarian purposes and is negatively associated with the proportion of cyclists who cycle for utilitarian purposes. They also found a positive association between effort to limit driving and weekly miles of utilitarian bicycling. Effort to limit driving also correlates positively with the proportion of cyclists who cycle for utilitarian purposes (Xing et al., 2010).

2.4.2.2 Trip purpose and reasons for cycling.

Individuals' reasons for cycling and the purpose of their trips can sometimes be related, but not always. For instance, a recreational cyclist's leisurely journey from home and back is definitely a result of a demand for recreation, which can both be considered a reason for cycling and a trip purpose. However, the purpose of an individual's bike ride to the grocery store is to fulfill a need for shopping-related transportation; the reasons they chose to cycle could include lack of access to an automobile or public transit, gas prices, or environmental or health reasons.

Pucher et al. (1999) summarize bicycling by trip purpose as it was reported in the United States Nationwide Personal Transportation Survey (see Table 2.2).

Table 2.2: Bicycle trip purpose as a percent in the U.S. for 1996 (as cited in Pucher et al., 2009)

Trip purpose	1995
Work commuting	9.0%
Shopping	12.7%
Personal business	12.5%
Social or recreational	57.0%
School	8.8%

Based on the information obtained in the NPTS, it is clear that social or recreational needs claim the majority of cyclists' trip purposes. In their study of bicycling behavior in Seattle, Washington, Moudon et al. (2005) confirmed that a strong majority of bicycle use is for recreational purposes and refer to other studies which have revealed this trend (Center for Disease Control and Prevention, 1996; National Personal Transportation Survey Statistics Canada, 1998–99 - as cited in Moudon et al., 2005). Evidence from a Portland, Oregon attitude survey confirmed that although very few cyclists ride to work, school, or for other utilitarian purposes, over 80 percent of respondents believe that the bicycle is an appropriate mode of transportation to fulfill those transportation needs (as cited in USDOT Federal Highway Administration, 1992).

A number of factors are contributing to increasing interest in active transportation. These include, rising fuel costs, interests in physical health, and concerns over air quality and the state of our natural environment. However, in the USDOT Federal Highway Administration's 1992 review of cycling surveys, it was concluded that exercise was the leading influence on individuals' decisions to cycle. Most surveys results they reviewed found 'enjoyment' to be the next significant influence, followed by 'environment' and 'cost savings,' both of which appeared as the third most important influence the surveys examined (USDOT Federal Highway Administration, 1992).

While these findings make it clear that most cyclists are cycling for recreation, they also confirm that share of commuters who cycle to work in Canada as reported in the census – slightly more than one percent of all commuters – likely represents only a small portion of all cyclists.

2.4.3 Socio-economic characteristics.

Most cycling-related research touches on the choice to use cycling being associated with demographic variables, including age, gender, education, and others. The sections below delve into some of the findings.

2.4.3.1 Age.

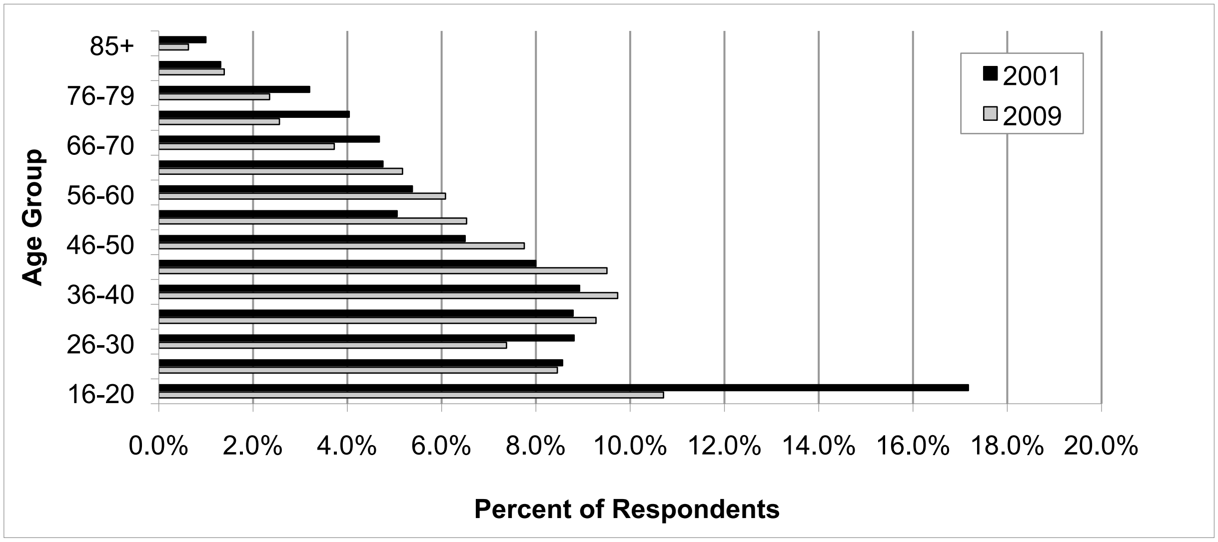
Age has an important effect on cycling-use. Cycling use appears to be high during youth, lower during adulthood, and lower still after the age of 45 (USDOT Federal Highway Administration, 1992). A rapid decline in use occurs both at 25-30 years and again towards 45 years. The United Kingdom Department of Transport (1985), in focus groups and depth interviews, revealed that many Londoners began cycling at age 7 or 8 and, in hindsight, saw it as an important step in growing up. However, when the youth became teens, cycling was often regarded as a childish activity; young men would start wanting motorized means of transport and young women would often look towards their male friends for getting around. A similar reluctance among teenagers was noted in Cavill and Watkins (2007); a 15 year-old girl in their study speaking about using a bicycle proclaimed, "I just wouldn't…[I'd] get laughed at…'cause it's a bike." (p. 412) In adult life, cycling is regarded largely as being incompatible with family and work (United Kingdom Department of Transport, 1985). Although their measure of utilitarian cycling lacks statistical significance, Xing et al. (2010) found that age is positively associated with miles cycled for recreation.

Although particular only to the United States, Pucher et al. (1999) report most-conclusively about the association between age and cycling use in their analysis of the 1995 US Nationwide Personal Transportation Survey; Table 2.3 shows a negative association between the percent of all trips completed by bicycle and age. The 2001 and 2009 United States National Household Travel Surveys also confirm that age is inversely correlated with bicycle use (Figure 2.2). This trend is also reported by Xing et al. (2010), with increases in activity for middle aged groups (comparing 2009 to 2001) while troubling declines for youth age groups.

Table 2.3: Percent of trips using bicycle by age group

Age	1995
5-15	3.3%
16-24	1.0%
25-39	0.5%
40-64	0.3%
65 and over	0.2%

Figure 2.2: Percent of respondents per age group (aged 16 and up) who used a bicycle within the week prior to taking the survey (USDOT Federal Highway Administration, 2001 & 2009)



2.4.3.2 Gender.

Cycling is more common among men than among women, especially when considering utilitarian cycling (USDOT Federal Highway Administration, 1992). Of 13 cycling surveys reviewed by The USDOT Federal Highway Administration (1992), only one reported more female users. Dill and Carr's analysis of 43 large US cities found that 82 percent of bicycle commuters are male, when men represent only 54 percent of commuters using all transport modes (2003).

The United Kingdom Department of Transport (1985) noted, "Although a variety of reasons was stated by women to explain why they did not cycle, this group was more likely than the men to stress such reason as fear or danger, or timidity towards cycling in general, and to emphasize more the effort or general discomforts involved." (p. 15) In their study it was also apparent that most participants did not feel as though cycling fit with mid-1980s fashion trends and that cycling had low sex appeal. As one respondent stated, "Can't impress the women on a pushbike…… well I mean a pushbike, I mean what's impressive about a pushbike? I mean, nothing, it's a toy, isn't it, it's a toy." (p. 5) The rejection of cycling is also strongly influenced by gender, especially for young people. Cavill and Watkins (2007) note that the perception among young females in North Liverpool, England is that cycling is just not an option, whereas those females find cycling quite acceptable for young males.

2.4.3.3 Education.

Based on the results of a survey in six small US cities, a cyclists' level of education is positively associated with weekly miles of utilitarian cycling, but not for recreational cycling (Xing et al., 2010). Among cyclists, level of education is also positively associated with proportion of utilitarian cycling-use (Xing et al., 2010). Aside from the study carried out by Xing et al. (2010), level of education has not been identified as a significant determinant of cycling neither for recreational nor for utilitarian reasons. This could indicate that the variable carries more weight in smaller cities. Rietveld and Daniel (2004), in their study of cycling use differences in Dutch municipalities found that the presence of a vocational school (for students aged 16-20) in a city has an effect of increasing the cycling mode share by 7.4 percent.

2.4.3.4 Income.

In general, research analyzing how income affects commuting cycling use has consistently found that as income increases, the percentage of bicycle use decreases. Among existing cyclists in small US cities, higher annual income is associated with a lower proportion of utilitarian cycling (Xing et al., 2010). For large US cities, Pucher et al. (1999) report that bicycle modal share among households earning less than $15,000 US is three times higher (1.6 percent) than for households earning more than $80,000 US (0.5 percent) and attribute this trend to the likelihood that households with lower incomes are less likely to own a car and are more likely to live in urban areas with higher densities where trips tend to be more bikeable due to greater variety of land use. The United Kingdom Department of Transport (1985) noted that the affordability of the bicycle was one of the main practical benefits: “Some of these people had re-started cycling specifically for that reason: on finding themselves unemployed they said they had the time available and no money for [another mode of] transport. Either they then grew to like cycling and stressed other benefits in addition, or they continued to cycle ‘just for the money’.” (p. 14)

The United States Department of Transportation Federal Highway Administration also confirmed a negative association between income and use in their review of cycling surveys (1992). However, their study also made note of a poll that showed an increase in use among the highest income groups, and also referred to a 1991 study that found no statistical relationship between bicycle commuting and household income (USDOT Federal Highway Administration, 1992, p. 16).

Although Dill and Carr (2003) did not find a significant correlation between bicycle commuting and income, they did find a positive association between percent commuting by bicycle and percentage of workers employed in farming, fishing, and forestry. Although these findings are not definitely related to income, an association could be assumed owing to moderate incomes typical of these industries. Interestingly, Dill and Carr’s study of 43 large US cities also found that bicycle commuters had lower incomes than vehicle commuters, which suggests a negative correlation between income and cycling use.

2.4.3.5 Image.

Cycling differs from other forms of transportation in several ways. Most significantly, it is used marginally; for adult transportation in most jurisdictions in North America, the bicycle is used one or fewer times out of a hundred trips. As such, there is often a lack of designated facilities for bicycle use and cyclists are often found mixing with and competing for space with other road users. Unlike other conventional modes of transportation – other than walking – cycling also requires physical exertion. It is perhaps owing to these characteristics of cycling that it is viewed as odd by non-cyclists. In fact, according to respondents in small US cities, stronger perception that cycling is a normal activity among cyclists is associated with a higher proportion of utilitarian cycling-use in different communities and is associated with more miles cycled for utilitarian purposes.

Cavill and Watkins (2007), in a series of group interviews in North Liverpool, England, noted strong feelings among youth about the image of cycling – that it was seen as "…simply not appropriate for them or for their peer group – especially young girls." (p. 411). However, it was noted among youth that cycling could be accepted if it was fun and if you owned "good gear," "shades," and rode a bike with "your own designs" (p. 411).

O'Connor and Brown (2010) noted in their qualitative study of serious leisure cyclists in Australia that many cyclists felt as though fellow road users classified them as 'an out group' and this was exemplified by their many accounts of being victims of verbal and physical abuse.

2.4.4 Cycling infrastructure.

The type of facility available for cycling has been shown to have an important impact on cycling use. And although a variety of other factors affect cycling use, it seems logical that the quality of available cycling facilities should have a strong impact on cycling use. This logic is affirmed in research and has also been shown as a common perception among the general public. For example, a 1990 survey of 700 employed New Yorkers found that 49 percent of them would commute to work by bike if they had secure parking and showers at work, and a safe route to ride upon (Komanoff as cited in Komanoff, 1997). A 1991 Seattle bicycle survey (cited in USDOT Federal Highway Administration, 1992) found that 67 percent of respondents – who were a mixture of cyclists and non-cyclists – believed that the most important policy option to increase bicycling is to expand and improve bicycle facilities (next most important were education for cyclists and motorists and enforcement of bicycle traffic laws). For municipal officials, such surveys can be helpful input in prioritizing transportation demand management efforts. The following paragraphs discuss research that delves into more specific aspects of bicycle-related infrastructure.

2.4.4.1 Route types.

Like pedestrians, cyclists use a range of transportation routes, including sidewalks, trails, streets with or without bicycle lanes, and road shoulders. Each type of route can be classified based on a variety of factors, such as exclusivity to cyclists and surface type. For example, some trails can accommodate pedestrians, cyclists, roller skaters, skateboarders, and all-terrain vehicles, and can have a surface of pavement, concrete, crushed gravel, bark-mulch, or bare ground. Route type preference varies among cyclists based various factors, including level of experience, perceived level of safety, and trip purpose. A common debate among cyclists is whether or not cyclists are served best by using bikeways that are exclusive of traffic, or by integrating with traffic in order to train other road users to respect their space. For example, Hunt & Abraham (2007) found that cyclists largely prefer cycling in designated bicycle lanes over options where dealing with road traffic and pedestrians are involved, but that this feeling was less significant among cyclists who had higher levels of cycling comfort and experience. A property rights-based argument is also common among cycling advocates, who claim that cyclists have an equal right to use space on most roads because most local roads are largely funded through municipal property taxes (Komanoff, 1997; Litman, 2009).

However, most feel as though additional and improved bicycle lanes are necessary in order to attract new bicycle riders.

The American Association of State Highway and Transportation Officials (AASHTO) have defined 2 classes of bikeways: Class 1 facilities are bike paths or shared use paths physically separated from motorized vehicular traffic; and Class 2 facilities are on-street bicycle lanes designated for the preferential or exclusive use of bicyclists by striping, signing, and pavement markings (as cited in Dill & Carr, 2003).

It has been proven, though, that the existence of bicycle pathways that separate bicyclists from motorists, including grade-separated and designated travel lanes has a strong relationship with bicycle use. Nelson and Allen (1997), studying 18 US cities of different sizes, determined that each mile of bikeway per 100,000 residents, holding other factors constant, is associated with a 0.069 percent increase in bicycle commuting. Their final regression model had an R^2 value of 0.825 and included bikeway mileage, rain days, and percentage of college students using bicycles. However, as they acknowledged, their research does not prove a cause-effect relationship between bike lanes and bicycle commuting. Instead, their research confirms that cities with a high number of on-street bicycle lanes also have a relatively high bicycle modal share, which suggests a cause-effect relationship. Following up on Nelson and Allen's study, Dill and Carr (2003) confirmed their findings: the number of Class 2 bike lanes per square mile proved to have a high association with bicycle commuting. Dill and Carr (2003) observe that the association between bicycle commuting and Class 2 facilities is likely higher than the association between bicycle commuting and Class 1 facilities because of the design characteristics and nature of Class 1 facilities: "…many bike paths are built in parks and greenbelts, intended for recreational cyclists, do not connect to major employment locations." (p. 121)

2.4.4.2 Cyclist-motor vehicle interaction.

The second category of factors affecting cycling use developed by Hunt and Abraham (2007), *non-cycle traffic characteristics*, pertains most to cyclists-motor vehicle interaction.

Cyclists and automobiles and other motorized traffic typically operate safely without conflict; however, when motorists and cyclists do not respect one another's space it can be very dangerous. Owing to differing levels of protection, cyclists and pedestrians are far more vulnerable when collisions with motorized vehicles occur. As a result, the level of safety for cyclists is top of mind for both cyclists and non-cyclists.

In a 1992 review of cycling-related surveys in North America, The USDOT Federal Highway Administration determined that traffic safety is the second most influential deterrent to cycling for the general public behind bad weather; for cyclists, level of danger is the second most significant deterrent, behind trip distance.

The United Kingdom Department of Transport (1985) noted in a qualitative study that the dangers of cycling are discussed more by non-cyclists than cyclists, and those perceived dangers are such that they often deter non-cyclists from even considering cycling at all. In a group discussion, one female participant noted: "There's a lot more men than women (cyclists). Fear – that would be the main reason for not riding a bike on the road. I'd be scared out of my life. I wouldn't attempt it. And I think that applies to most women, lots of women, you know." (p. 16) Another individual in the same study noted that commercial trucks were especially frightening because of their effect cyclists' stability.

This common perception of fear and lack of safety while cycling, because of the need to interact with motor vehicles, is an argument for more bike paths or shared use paths that are separated from vehicular traffic. Hunt and Abraham (2007) note that, generally, cyclists have much less desire to cycle in mixed traffic than they do in a designated bike lane and that this feeling is heightened for cyclists who have low levels of cycling comfort and experience; however, they noted that older cyclists "had less of an aversion to riding in mixed traffic." (p. 465) As well, Hunt and Abraham note that mixing with pedestrians is also largely undesirable for cyclists – perhaps owing to potential dangers of collisions or the need to reduce speed (2007). This feeling is heightened among groups of cyclists who cycle with high and moderate levels of comfort.

Komanoff (1997), in a discussion of impediments to cycling, concludes that, "…by far the greatest barrier to increased bicycle use is fear of physical harm from motorists or motor vehicles." (p. 9) Komanoff argues that fear – more so than other deterrents such as bicycle theft or personal image – explains why so few Americans can cycle regularly for transportation. He lists six common forms of cycling-related fear (1997, p. 9):

- fear of injury or death from cycling;
- similar fears felt and expressed by family members, friends, etc.;
- stress from having to defend one's right-of-way on the street;
- fear of intentional harassment from motorists;
- inability to experience the intrinsic exhilaration of cycling on account of the attention demands of traffic; and
- awareness that motorists know they can break the law without being called to account.

Acknowledging that the probability that a cycling trip will end in fatality is approximately seven times greater than it is for an automobile trip, Komanoff (1997) partially attributes the lack of perceived safety of bicycling to the reporting of cycling accidents; "…cyclist fatalities are blamed on the supposed intrinsic perils of cycling rather than on driver misconduct or cycle-hostile traffic engineering." (p. 10) He also alleges that societal perception of cycling safety is likely much more negative than the actual level of safety.

It appears as though many non-cyclists' perceived level of risk often outweighs any benefits they might realize from cycling. Hunt and Abraham (2007) suggest that a cyclists' level of experience is negatively associated with their perception of risk – a trend also noted in O'Connor and Brown (2010). In a discussion about cycling and road infrastructure, an elder respondent from North Liverpool, England noted, "…I think the roads are dangerous… they're not made, are they, for the volume of traffic? You're all right on the cycle lane, you know if you have a cycle lane, but it's when you come to lights or a roundabout…" (Cavill & Watkins, 2007, p. 412)

Xing et al. (2010) have found that, among cyclists, the perception of safety while cycling is positively associated with proportion cycling for utilitarian purposes and with weekly miles cycles for transportation and recreation. This finding suggests that a cyclist who feels safe is more likely to use their bicycle for practical purposes, such as going to work or running errands.

For cyclists and non-cyclists alike, it is clear that perceived level of safety bears heavily on their cycling-use. This trend helps to explain the high priority placed on developing bicycle routes that help protect cyclists from motor vehicle traffic.

An exception should be noted, though, in this discussion of challenges of mixing cycling and other road traffic. Although it would appear, based on the research, that cyclists largely see themselves as victims and in need of better protection, there are some cyclists who – whether acting defensively or as a way of asserting their presence –can be considered aggressors on the road. In O'Connor and Brown's (2010) qualitative study of experienced recreational cyclists in Australia, one respondent discussed how cyclists take reactionary measures when car drivers are in the wrong: "…all of the people that I ride with have road rage instances often, it's full on… They're always having problems…and they [fellow cyclists] go off 50 times worse than I do in regards to road rage…we chase cars down, I bang on roofs. Usually if I go down the bike lane and if there's a car in the bike lane, I grab their mirror… so that they think they've hit me." (p. 55) Respondents also admitted that some cyclists' habits of breaking traffic rules fuels motorists' hostility towards them.

2.4.4.3 Comfort and enjoyment while cycling.

Harkey and Reinfurt (1998) developed the Bicycle Compatibility Index (BCI) as a way of classifying different roadways according to their suitability for cycling. To determine the level of service for cyclists on a given facility type, their model incorporates the following variables, depending on their applicability: presence of a bike lane or paved shoulder, the width of the bicycle lane or shoulder, curb lane width, curb lane volume, the volume of other vehicle lanes, speed of traffic, presence of a parking lane, the type of roadside development, as well as truck volumes, parking time limits, and right turn volume. As mentioned in their 1998 Implementation Manual, the BCI "can be used by bicycle coordinators, transportation planners, traffic engineers, and others to evaluate the capability of specific roadways to accommodate both motorists and bicyclists." (1998, p. 2) The BCI has the potential to reduce cyclists' interaction with vehicles, reduce overall levels of fear, increase cyclists' level of enjoyment, and could also encourage choice more riders.

According to Cavill and Watkins (2007), comfort and enjoyment while cycling can relate to a variety of factors, including bicycle-friendly design, fitness level, and level of separation from motor-vehicle traffic. It has been suggested that the importance of enjoyment and comfort is greatest among older age groups. A case study in Edmonton (Nelson and Allen,

1997) determined that although all groups of cyclists prefer designated bicycle lanes to scenarios where mixing with motor vehicles and pedestrians is involved, cyclists with higher levels of comfort are much more indifferent to facility types.

In their survey of six small US cities, Xing et al. (2010) determined that the level of enjoyment while cycling is approximately equal among those who ride for utilitarian and for recreational purposes, and that enjoyment levels are positively correlated with weekly miles bicycled. Comfort level is positively associated with weekly miles cycled for utilitarian purposes and with the proportion of cyclists cycling for utilitarian purposes (Xing et al., 2010).

2.4.4.4 Bicycle parking.

Approaches to bicycle parking vary greatly and, like route types, cyclists have long debated the merits and shortfalls of different designs. For example, in a 1991 parking survey conducted by the City of Toronto (2001), respondents living in multi-unit residential apartments were asked to state where they typically park their bikes, and where they would like to park them if better facilities were available (see Table 2.4).

Table 2.4: Existing and preferred locations for bicycle parking for Torontonians living in multi-unit residential buildings (City of Toronto Bike plan: 2001)

Location	Where Cyclists Want to Park	Where Cyclists Park Now
Locked bike room	40%	9%
Outside bike racks	26%	4%
Inside apartment / on balcony	11%	62%
Bicycle locker	4%	0%
Personal storage locker	3%	7%
Parking meter, fence, etc.	0%	9%
Elsewhere	0%	3%

Survey answers would likely be different for residents in single-family dwellings or for employment or downtown destinations, but it is interesting to note that only four percent of respondents appear to have been satisfied enough to use outside bike racks. In 1984, the City of Toronto began the installation of post-and-ring bicycle parking stands and has since installed over 6,800 of them. Although such facilities are touted as a good bicycle facility improvement initiative, some advocates argue that basic bike racks fall short of providing adequate protection from the threats of weather and theft.

The desire to have secure bicycle parking facilities varies according to the respondent's bicycle price and age. Excepting cyclists with the most expensive types of bicycles, secure parking becomes more attractive as bicycle price increases and younger cyclists place greater value in secure parking than older cyclists (Hunt and Abraham, 2007). According to Hunt and Abraham (2007), "the addition of secure parking has the same effect on utility as a decrease of 26.5 minutes in the time spent on a roadway in mixed traffic," (p. 463). Their finding implies that a strong feeling of the importance of parking facilities and a lack of importance placed on distance exists among cyclists.

2.4.4.5 Bicycle theft.

Section 2.4.4.4 (page 31) presented evidence that the provision of safe and secure bicycle parking has a significant impact on bicycle use. It is fair to assume that the importance placed on effective bicycle parking is related to the assumption that good parking facilities increase convenience and deter theft. However, among some youth, bicycle theft is not only relevant to bicycle parking. Cavill and Watkins (2007) found that a major deterrent to cycling among some North Liverpool youth was having their bicycles stolen from them. Their concerns related to their peers; as the authors write: "There were very few stories of bikes being stolen from a bike rack by an unknown thief. Instead, there were many tales of bikes being taken by someone on the street who was known by the bike owner – a peer or maybe even a friend – and who has asked them to 'Give us a go on your bike'." (p. 411)

Although the importance of good bicycle parking is noted often in the literature as being a determinant of cycling-use, aside from the above, no evidence is presented directly concerning theft as a deterrent. This would suggest that, for the most part, there is little concern over bicycle theft when adequate parking is available.

2.4.4.6 Showers.

Showers are less important facilities than safe bicycle routes and secure bicycle parking (Hunt and Abraham, 2007; USDOT Federal Highway Administration, 1992). While showers are often cited as a factor that would encourage cycling for commuters since physical demands of cycling and less than ideal weather can generate sweat, dirt, and moist clothing, there seems to be no substantial evidence in the literature that the provision of showers at destinations has a strong association with cycling use. Only Hunt and Abraham (2007) have presented some indication that cyclists with higher levels of cycling-experience place a higher value on the availability of showers at destinations.

2.4.5 Policy.

2.4.5.1 Policy support.

Many of the factors identified above are interwoven with policy decisions. For example, the research discussed in section 2.4.2.1 (page 16) shows that higher gasoline prices affect transportation mode choice; differences in gas price are related to policy decisions on taxation. As Pucher and Buelher (2006) note, the highest gas prices are in Europe, where cycling rates are much higher than in North America; in Canada, where gas prices are higher than the US, again cycling rates are almost double American percentages. Some research has identified that public policy initiatives can alleviate most of the deterrences that dampen cycling use (Dill & Carr, 2003; Pucher & Buelher, 2006).

Pucher and Buelher's (2006) research on the differing cycling rates in the United States and Canada (and to some extent in Europe) points to the following public policy-related factors as being determinants of cycling use:

- cycling safety;
- urban density and trip distance; and
- car availability and the costs of owning and operating a vehicle.

With respect to specific cycling policies, Pucher and Buelher (2006) compared efforts made in Canada and the US in regards to the development of bikeways and bicycle parking facilities. They note that Canadian cities had an average of almost three times as many kilometers of bikeways (45.7 kilometres) than in the US (17.4 kilometres). The authors also note that most large Canadian cities require developers to provide bicycle parking in their municipal zoning by-laws, which is not the case in most US cities. The City of Chicago's bike rack installation programme is noted as being the most aggressive in the US with a total of 9200 bike racks in 2006, whereas Toronto and Ottawa were noted as the leading Canadian examples (15,000 and 10,000 bike racks installed). The authors' overall impression is that "most Canadian cities make a concerted effort to provide safe and convenient bike parking." and that, "with a few exceptions, the American cities… did not make bike parking a high priority." (p. 274).

Pucher and Buelher (2006) also note that although the US federal Government has made substantial headway in recent years in creating forward-looking cycling policy and increasing cycling and pedestrian funding, success has been limited owing to state control over the allocation of transportation funding. For example, a 1990 policy requiring states to produce 20-year and 2-year transportation plans that consider walking and cycling needs was adhered to by only 29 states and the District of Columbia. Pucher and Buelher (2006) point to the limited role played by the Canadian government in influencing provincial transportation spending and make mention of recent independent successes in the provinces of Quebec and British Columbia.

Pucher and Buelher (2006) also mention that the few examples of Canadian and US efforts to educate road users and children about cycling pale in comparison to Germany, Denmark, and the Netherlands, where fourth-graders are required to take a course and pass a police administered test on cycling safety. Rietveld and Daniel (2004), in a study of determinants to cycling use in Dutch municipalities, found that the successful implementation of local government bicycle initiatives has a strong positive association ($r = 0.33$) with cycling use.

2.4.5.2. Encouragement to cycle.

The USDOT Federal Highway Administration's 1992 review of cycling-related surveys makes note of an alternative method aimed at gathering a better understanding of respondents' reasons for not cycling – asking them what factors would encourage more use. Surveys by Bicycling Magazine (1991) and surveys in Davis, California, and in New York and Seattle are highlighted. The USDOT Federal Highway Administration's review shows that, most commonly, respondents feel as though no specific improvements will encourage them to cycle more. Otherwise, with some variance, safer bicycle routes were mentioned as being a key incentive. In Davis, California – a city known for having relatively more bicycle lanes – 12 percent chose 'safer routes' and in Seattle, 41 percent reported 'safer routes' as being an improvement that would encourage them to cycle more. In New York only 1 percent chose 'safer routes' as an incentive; however, twenty-eight percent of New Yorkers reported that a combination of 'safer routes', 'shower facilities,' and 'improved bicycle parking' would encourage them to cycle more (USDOT Federal Highway Administration, 1992).

The US Federal Highway Administration also made note of a 1981 survey conducted by the United States Federal Highway Administration that asked respondents to choose their preference of four scenarios that would help encourage greater use of alternative transportation (1992). The choices were provision of improved bicycle and pedestrian facilities, implementation of a congestion charge, policy to encourage compact land use, and increased fuel prices. Respondents felt that 'compact land use' would encourage both cycling to work and cycling for other utilitarian purposes (following, in order of descending popularity were improved bicycle facilities, congestion charge, and fuel price increases) (USDOT Federal Highway Administration, 1992, p. 24).

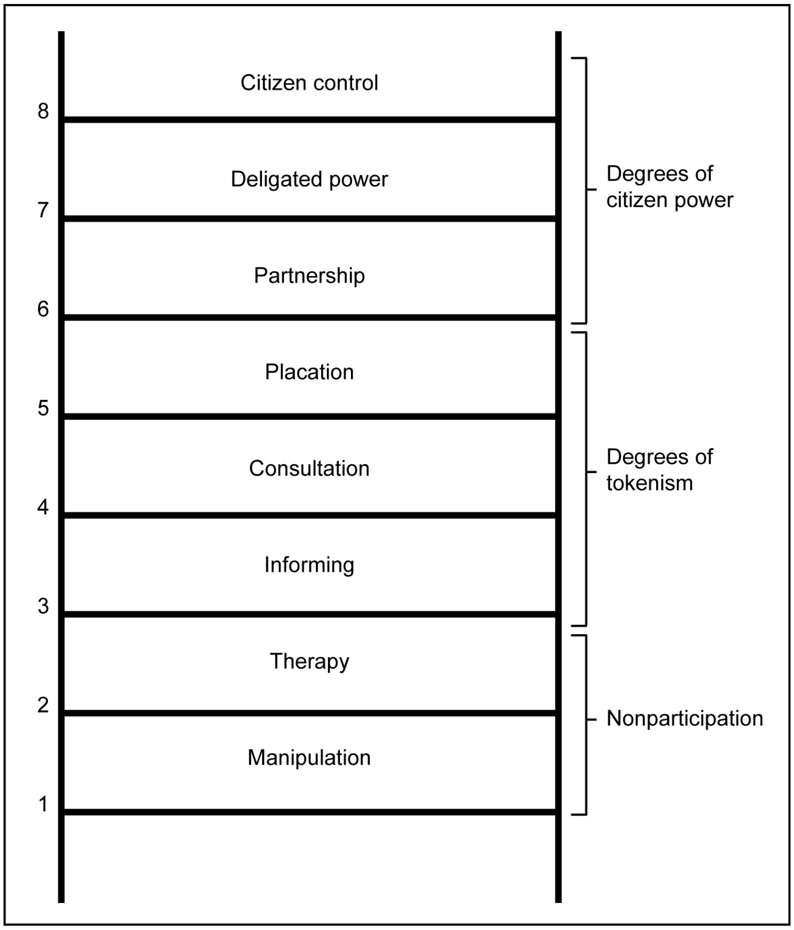
2.5 Public Participation and Public Attitudes

Planning and development decisions in Canada are made with varying levels of public participation. In part, this is because the importance of public participation and the value of public attitudes, compared with the value of professional opinion and scientific study, continue to be debated (Crompton et al., 1981, King et al., 1998). The purpose of public participation is to inform decision makers of public preferences, to help educate the public, and to appease public concerns; however, it can also slow the decision-making process and, in some cases, it has little effect. In the field of transportation, for example, some hold the opinion that engineers are adequately equipped with professional experience, forecasting tools, and other scientific methods, and need not rely on the advice or opinion of interested citizens. Others feel that local knowledge and public opinion should be gauged and thoroughly considered when decisions affecting road-users are made.

While members of the public feel increasingly entitled to engage in the decision making process (King et al., 1998), decision-makers are not always in agreement. A 1981 survey of recreation and park administrators in Texas investigated attitudes towards public participation and revealed that administrators are generally supportive of the public's involvement (Crompton et al, 1981). However, the authors mentioned a commonly held public perception that administrators often place their own interests ahead of the general public's. As noted by King et al. (1998), "…although many public administrators view close relationships with citizens as both necessary and desirable, most of them do not actively seek public involvement. If they do seek it, they do not use public input in making administrative decisions (as indicated by a 1989 study conducted by the Kettering Foundation Toward Authentic Participation in Public Administration). These administrators believe that greater citizen participation increases inefficiency because participation creates delays and increases red tape." (p. 319)

Arnstein's Ladder of Citizen Participation (1969) describes varying levels of public participation (Figure 2.3). The lower rungs represent non-participatory public involvement whereby power holders educate participants but are not interested in their opinion; rungs farther up the ladder represent participation methods which increasingly weigh the public's opinion. Rungs six and seven progress from levels of participation that ensure common citizens' opinions will affect decision-making to the theoretical example whereby citizens retain complete managerial and decision-making control (Arnstein, 1969).

Figure 2.3: Arnstein's ladder of citizen participation (adapted from Arnstein, 1969, p. 217)



Attention has been drawn to the ultimate usefulness of public opinion and preference surveys as instruments for policy development. The USDOT Federal Highway Administration (1992) and Dill and Carr (2003) note that while members of the public occasionally support an initiative at the public participation stage, overestimations of public support are common. As reported by the USDOT Federal Highway Administration, "high levels of abstract support for cycling belie the fact that, in most places, only a small minority choose to use a bicycle for transportation on anything resembling a regular basis." (1992, p. 17) Dill and Carr (2003) also warn that, "the results of [preference or attitudinal] surveys…are influenced by the wording of the questions, and they reveal only what people might do, rather than what they actually do." (p.116)Nevertheless, according to a study conducted by King et al. (1998), administrators, activists, and citizens alike, agree that public participation is both necessary and desirable.

Participants agreed that more frequent meaningful partnerships that produce evidence of the public's influence are essential to collaboration. Although public attitude surveys lack effectiveness when they are the sole method of public participation and are not repeated to monitor change, surveys have a great capacity to collect meaningful information from the public.

While some cycling-use studies incorporate individuals' attitudes and opinions (Cavill & Watkins, 2007; United Kingdom Department of Transport, 1985), most found in the literature are based upon stated-preference surveys or statistical analyses of determinants of cycling-use. Such studies are helpful contributors to our understanding of cycling-use and can help to clarify cyclists' preferences for different types of facilities, but research into public attitude and opinion is often lacking – especially for non-cyclists.

Attitudinal surveys of the general public, which are most closely applicable to Arnstein's 'consultation' rung, offer professionals an opportunity to hear public opinion and give the public a chance to be heard. By directly surveying the general public about their attitudes towards cycling, and their reasons for cycling or for choosing not to cycle, a researcher can assist municipal officials and staff learn how to prioritize efforts in transportation demand management to reflect the public's desire. The obvious limitation (as expressed by Arnstein, 1969) is that such methods afford no assurance to the public that decision-makers will consider their attitudes.

The present thesis is based on a survey of the public that endeavours to collect cycling-use data and gauge public attitudes towards cycling in two mid-sized Canadian cities, Halifax Regional Municipality and The Region of Waterloo. As mentioned, the intention of the survey in Halifax is to provide a starting point from which subsequent data collection can be used to gauge change in cycling behaviour. In Waterloo, the survey is a follow up to a 2002 study commissioned by the municipal government.

2.6 Summary

The above review of current research into determinants of bicycle use shows the wide variety of factors that affect cycling. The importance of each factor varies from study to study and from one geographic place to another. Although those factors are commonly agreed to influence cycling-use, there is no consensus in the research as to the relative influence of each. It is likely the case that, as The USDOT Federal Highway Administration (1992) contends, “no single improvement will be sufficient to attract all potential bicycle commuters to cycle, and that some sort of integrated approach is the best bet for stimulating mode shifts.” (p. 23) While the methodologies employed in cycling-use research vary both in terms of approach and of the variables analysed, Chapter 2 confirms that several key factors are responsible, in part, for varying levels of cycling use in different cities and regions: the physical environment (city size and density, topography, and weather); transportation-related factors (public transit use, and automobile use, ownership); socio-economics (income, age, gender, and education); infrastructure-related factors (cyclist safety, and provision of bicycle routes and parking facilities); cycling-related policies, and public attitudes towards cycling.

Each of the above factors is related to cycling in some respect, and therefore it is worthwhile to discuss how these relate to the objectives of this thesis. As mentioned in sections 1.3 and 1.4 (page 4), the objectives of this thesis are to understand factors that relate to cycling use and cyclist type and second, to understand the general public’s attitudes and preferences towards cycling. More broadly, these objectives were chosen to contribute to research aimed at transitioning from auto dependency to healthier and more environmentally appropriate modes of transportation. As such, this thesis explores how cycling is associated with: a) factors which can be modified by changing public policy and through infrastructure projects, such as those addressing public attitudes and the provision of infrastructure; and b)other factors, such as socio-economics, topography, and weather. And, since the former of these types of factors can be practically affected by government programmes and related research, these factors will occupy the majority of the concluding discussion of this thesis. More specifically, public attitudes, policy, and the provision of infrastructure will be highlighted.

The general findings provided in Chapter 2 serve as a framework for the analyses carried out in this thesis, as illustrated in Table 3.1 (page 52) and as discussed further in the ensuing chapter. Part 1 of the analysis (Chapter 4) looks into many of the above-mentioned variables as they relate to the Halifax and Waterloo study areas to reveal differences between the two in terms of their relative conduciveness to cycling use. Basic statistics are compared for each study area as well as more in-depth analyses of residential density and of topography. Part 2 of the analysis (Chapter 5) looks into similar information generated from cycling-use and attitude surveys of the general public in each of the study areas. Part 2 also provides more insight into the public's attitudes towards cycling in their communities in order to paint a clearer understanding of the public's opinion of the quality of infrastructure, common concerns, and ideas for improving cycling in their communities. Parts 1 and 2 are discussed together in Chapter 6.

Chapter 3: Methodology

3.1 Mixed Methods Approach

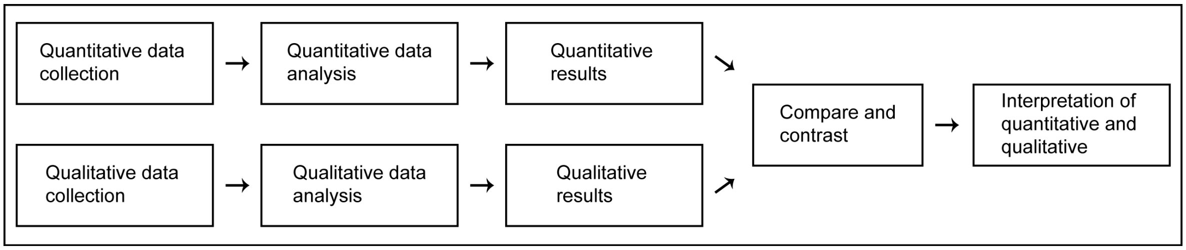
This thesis involves two sections of analysis. The first (hereinafter referred to as 'Part 1' of the analysis) is an investigation into characteristics that have been identified in previous research as having an effect on cycling, undertaken for each study area. The second section (hereinafter referred to as 'Part 2' of the analysis) is the analysis of information collected in a survey instrument that consists solely of pre-determined questions.

Part 1 of the analysis involves the collection of existing documents and information regarding the physical and social characteristics of each study area, and employs a mix of qualitative and quantitative approaches. Part 2 uses various statistical analyses of the survey input variables which is considered a quantitative methodology. As such, the overall nature of the research employed can be considered a mixed-methods approach (Creswell, 2007).

3.1.2 Triangulation.

According to Creswell (2007), triangulation design "is used when a researcher wants to directly compare and contrast quantitative statistical results with qualitative findings or to validate or expand quantitative results with qualitative data." (p. 63) Although Part 1 of the analysis employed in this thesis uses a combination of quantitative and qualitative methods, the overall research approach can be classified as a type of triangulation design since the two sections of analysis are carried out separately, and then merged in discussion. The approach used can be further classified as a 'convergence model' of triangulation described by Creswell (2007) and as shown below in Figure 3.1.

Figure 3.1: Triangulation Model: Convergence type (adapted from Creswell, 2007, p.63)

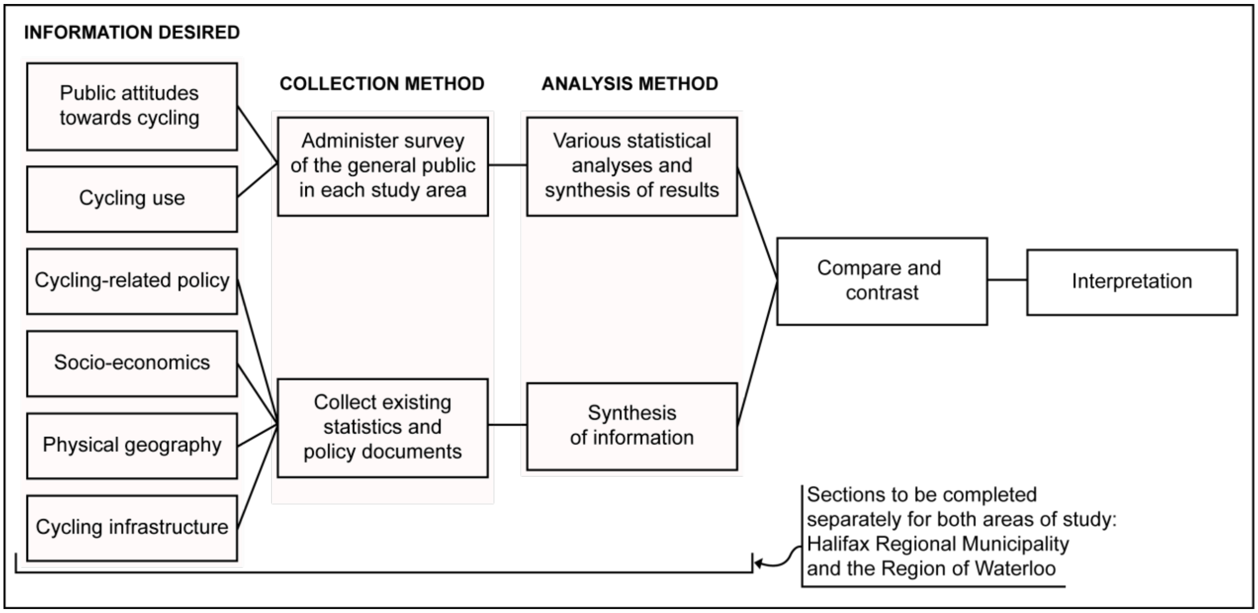


3.1.3 Case study approach.

According to Yin (as cited in Hancock & Algozzine, 2006), case study research "means conducting an empirical investigation of a contemporary phenomenon within its natural context using multiple sources of evidence." (p. 15)Hancock and Algozzine (2006) characterize the case study approach as being research that: investigates a phenomenon (e.g. an event, situation, programme, or activity); is carried out in its natural context; is bound by space and time; and is grounded in deep and varied sources of information. Hancock and Algozzine also note that although the goal of case study research can be confirmatory, it is more often exploratory in nature. The present research investigates an activity, is both exploratory and confirmatory in its objectives, and uses a variety of information sources, which are specific to one general period of time.

Figure 3.2 summarizes the research design employed; as shown, the results from each section of analysis – generated separately in each of the two study areas – are compared and interpreted with the hope of yielding conclusive findings concerning cycling use and attitudes towards cycling in each of the two study areas and in general.

Figure 3.2: Methodological framework (based on Creswell, 2007)

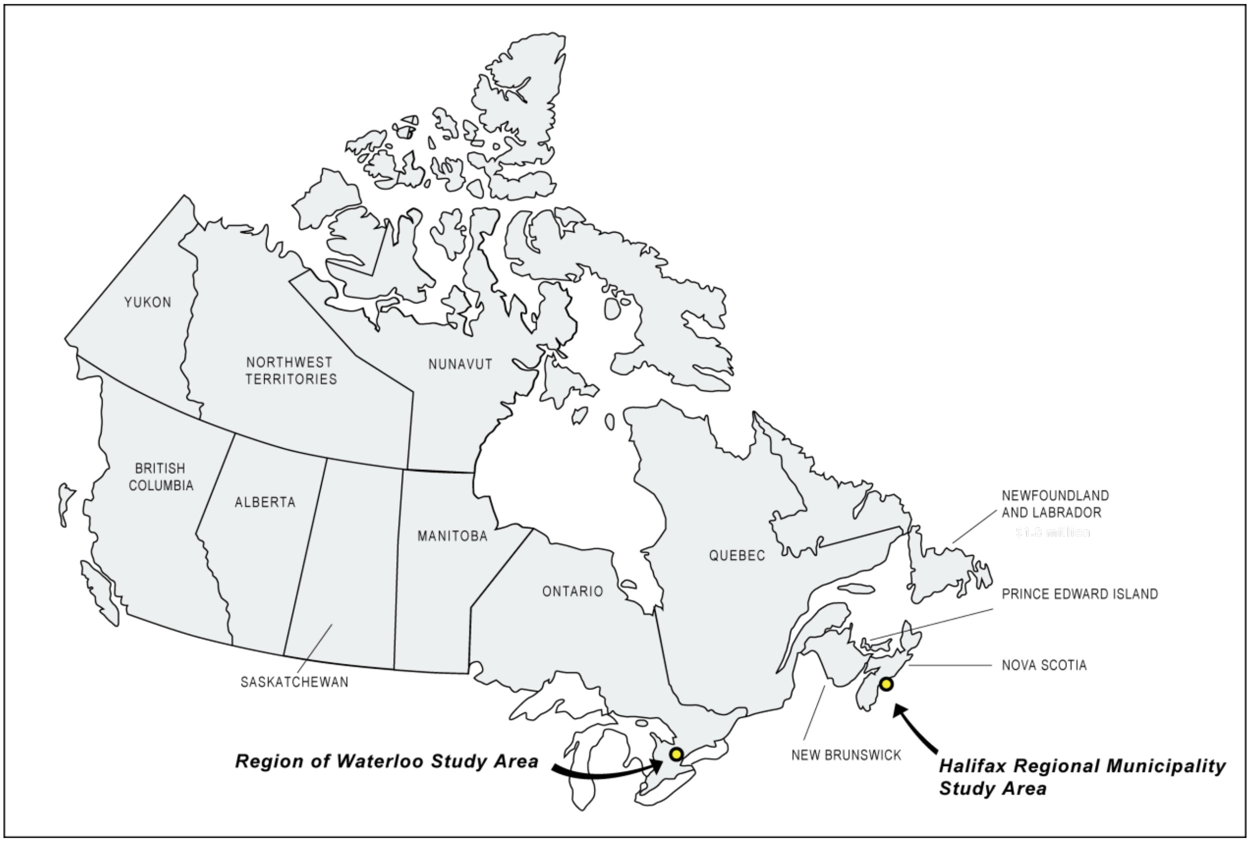


3.2 Selection of Study Areas

Two mid-sized urban areas that are geographically convenient to the researcher were chosen as case studies: the Region of Waterloo and Halifax Regional Municipality (see Figure 3.3).The Region of Waterloo and Halifax Regional Municipality were chosen in part since they are regionally quite separate and since the populations of each of the two study areas are comparable: the Region of Waterloo's 2006 population of 478,121 is similar to that of Halifax, which had a 2006 population of 372,679.

Halifax Regional Municipality and the Region of Waterloo have several notable similarities and differences. While specific characteristics of each that might help to explain bicycle use or the public's attitudes towards cycling will be discussed in Chapter 4, the following will consider initially-realized similarities and differences with respect to density and size.

Figure 3.3: Location of study areas



The Region of Waterloo, established in 1973, includes the City of Waterloo, the City of Kitchener, the City of Cambridge, and the four townships of Wellesley, Wilmot, Woolwhich, and North Dumphries. Although the area is often referred to as Kitchener-Waterloo or ‘KW’, the most populous urban centres in the Region are the City of Kitchener, (2006 population: 204,668) and the City of Cambridge (2006 population: 120,371). The City of Waterloo had a 2006 population of 97,475, while the four outer lying townships had a combined 2006 population of 55,607.

Halifax Regional Municipality was formed in 1996 by an amalgamation of the former Cities of Halifax (1996 population of 113,910) and Dartmouth (1996 population of 65,629), the Town of Bedford (1996 population of 13,638), and the largely rural Municipality of the County of Halifax (1996 population of 149,477). These four jurisdictions make up the boundaries of both the former Halifax County and the present-day Halifax Regional Municipality.

Although the two study areas are similar in population and in that they are made up of clusters of urban centres with significant areas of lower density in their environs, key differences between the Halifax Regional Municipality and the Region of Waterloo are size and density. Halifax Regional Municipality measures 5,490.18 sq. km, while the Region of Waterloo measures only 1,368.64 sq. km (Statistics Canada, 2007a and 2007b). Therefore, while the populations of each of the municipalities are similar, their average densities are not: HRM had a 2006 overall population density of 67.9 people per square kilometre, whereas the Region of Waterloo had a 2006overall population density of 349.3 people per square kilometre – over five times the population density of HRM. This difference influenced how the two municipal regions were considered when defining each of the study areas for the distribution of the survey.

3.2.1 Definition of study areas for survey distribution.

An initial focus of this thesis was to compare cycling use and attitudes towards cycling in urban parts of the study areas with suburban parts. And although this thesis does analyse cycling use and cyclist type based on residential density using the methodologies described below, the level of analysis devoted to density was reduced. Nevertheless, the approach used to analyse density spatially in each study area was also a logical method for defining the study areas.

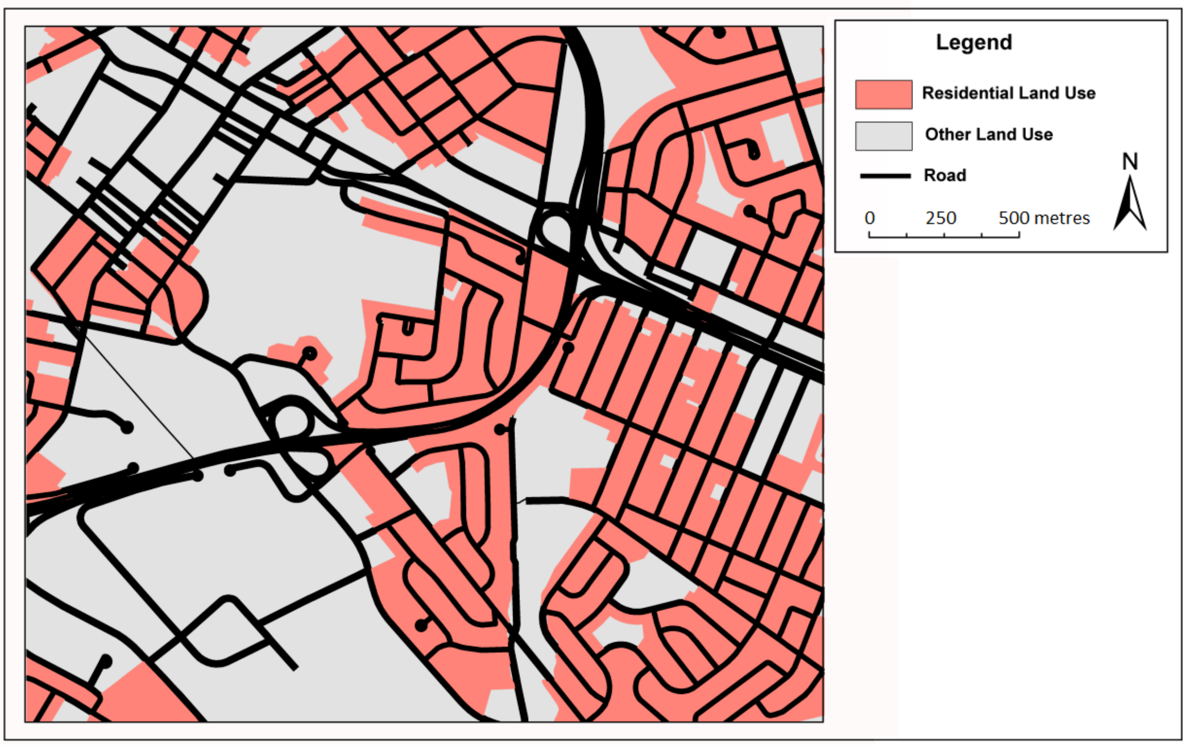
The division of each study area into urban and suburban categories was based on dwelling-unit density at the census tract level. When dividing the study areas into urban and suburban categories, it was revealed that Halifax Regional Municipality had significant tracts of land that had very low dwelling-unit densities relative to the lowest dwelling-unit densities in the Region of Waterloo.

Census tracts with the lowest average dwelling-unit densities below 5.0dwelling-units per hectare – all of which occur in HRM – were excluded from the survey as were the predominately rural Townships of Wellesley, Wilmot, Woolwhich, and North Dumphries in the Region of Waterloo. The elimination of low-density and mainly rural areas benefits the study in two ways: the total area and overall density in each of the study areas became much more similar and it allowed the thesis to be focused more on suburban and urban areas as opposed to rural locales. Although a study of cycling use and public attitudes towards cycling in rural areas is worthwhile, it seems logical to study rural issues separately since cycling behaviour and attitudes are likely to be separate, in many instances.

In Halifax Regional Municipality, the adjustment eliminated most of the overall region, since large areas within its boundaries are uninhabited or have very low densities. The adjusted boundary for the Halifax Regional Municipality measures 74.5 square kilometers (7450.5 hectares), has an overall dwelling unit density of 12.1 dwelling units per hectare, 90,104 dwelling units, and a 2006 population of 183,261. The adjusted area of survey distribution in the Region of Waterloo measures 90.3 square kilometers (9031.4 ha), has an overall dwelling unit density of 18.5 dwelling units per hectare, 166,738 dwelling units, and a population of 420,623.

When the definition of urban and suburban areas in Halifax Regional Municipality and the Region of Waterloo were carried out it was realized that that process could be quite involved; based on other research the categorization of suburban and urban areas of cities can require analyses of several variables. These variables can combine density (either population density or dwelling-unit density), period of development (often, in the North American context, the post war period is deemed suburban), measures of accessibility (such as street connectivity and walkability), distance from the urban core, and land use (Bunting & Filion, 1999). However, since the purpose of differentiating between suburban and urban areas of the study areas in this thesis is simply to enable a basic comparison, a simple method was chosen. It was determined that the calculation of dwelling-unit density at the census tract level could reveal, generally, which were predominantly made up of urban-type and suburban-type development. To strengthen this analysis and further simplify it only residential uses of land were considered in the calculation of dwelling-unit density. Figure 3.4 is a representation of the spatial distribution of residential land in an urban area in the City of Kitchener. The calculation of density using dwelling-units per hectare of residential land ensured that neighbourhood design would be favoured in the differentiation between 'urban' and 'suburban' parts of each study area. The exclusion of other land uses from the density calculation enabled a much more precise evaluation of density in residential areas. For example, if dwelling-unit density was calculated based on total land area, a census tract located near the urban core with a large portion of industrial or commercial land and a small area of residential land might return a density that would indicate suburban-type development, when the residential portions should, in fact, be considered urban in nature.

Figure 3.4:Example of the residential land use data used in the density calculation



The numeric categorization was based on an overall mean dwelling-unit density of census tracts (in both study areas) of 20.76 dwelling units per hectare. The two categories of tracts were labeled 'higher density' and 'lower density'.

As mentioned above, census tracts with fewer than 5.0 dwelling units per hectare were excluded from the study. In total, 40 census tracts, having a total area of 5847.1 square kilometers, were excluded from the study area in Halifax Regional Municipality. The only tracts excluded from the Region of Waterloo study area were those situated outside of the Cities of Waterloo, Kitchener, or Cambridge, as well as the census tract shown in grey towards the north-centre of the City of Waterloo (Figure 3.6, below). This tract is largely commercial and industrial in nature and had a 2006 population of only 25.

The boundaries of each of the two study areas and the distribution of 'higher density' and 'lower density' tracts are shown in Figure 3.5 (Halifax Regional Municipality) and Figure 3.6 (the Region of Waterloo). A table summarizing the dwelling-unit densities for each of the tracts included in the study is provided as Appendix 2.

While the case study areas are substantially refined for Part 2 of the analysis, the survey portion, Part 1 of the analysis involves the original boundaries of the Region of Waterloo and the Halifax Regional Municipality where policies or programmes exist that pertain to those areas entirely. Policies and characteristics that are specific to rural areas will not be considered in Part 1 of the analysis.

Figure 3.5: Dwelling unit density (Halifax Regional Municipality study area)

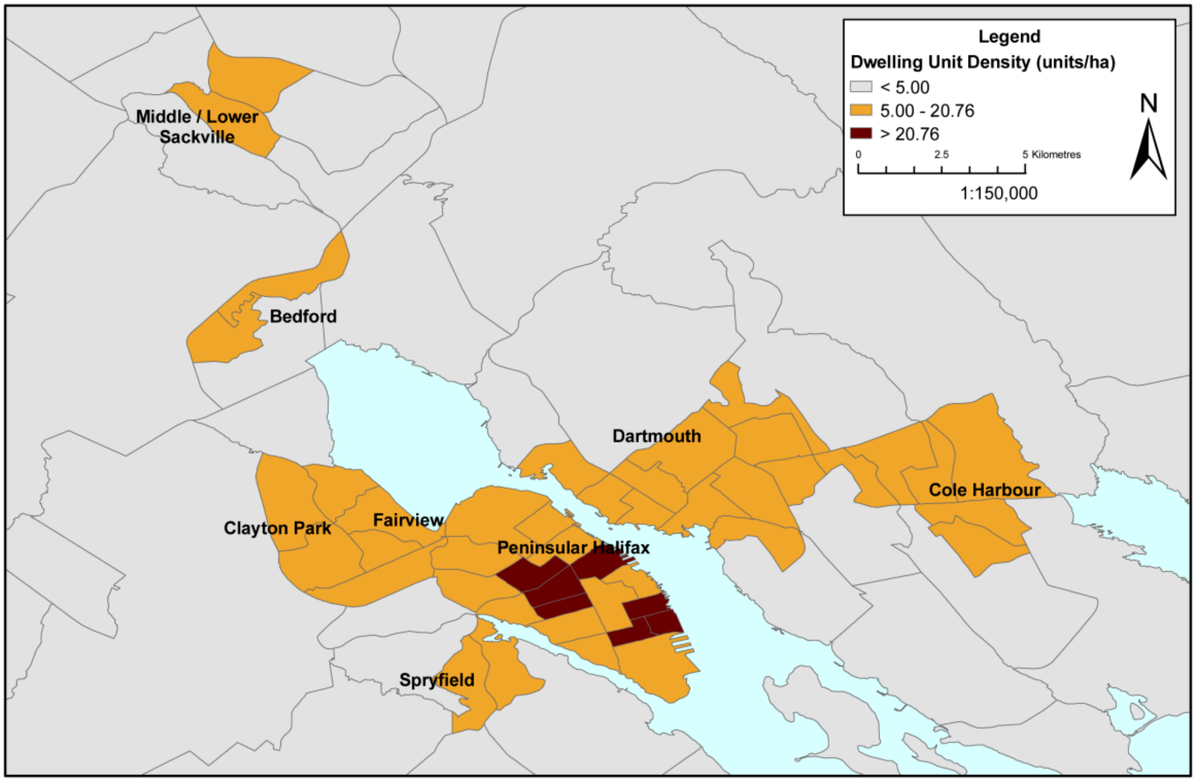
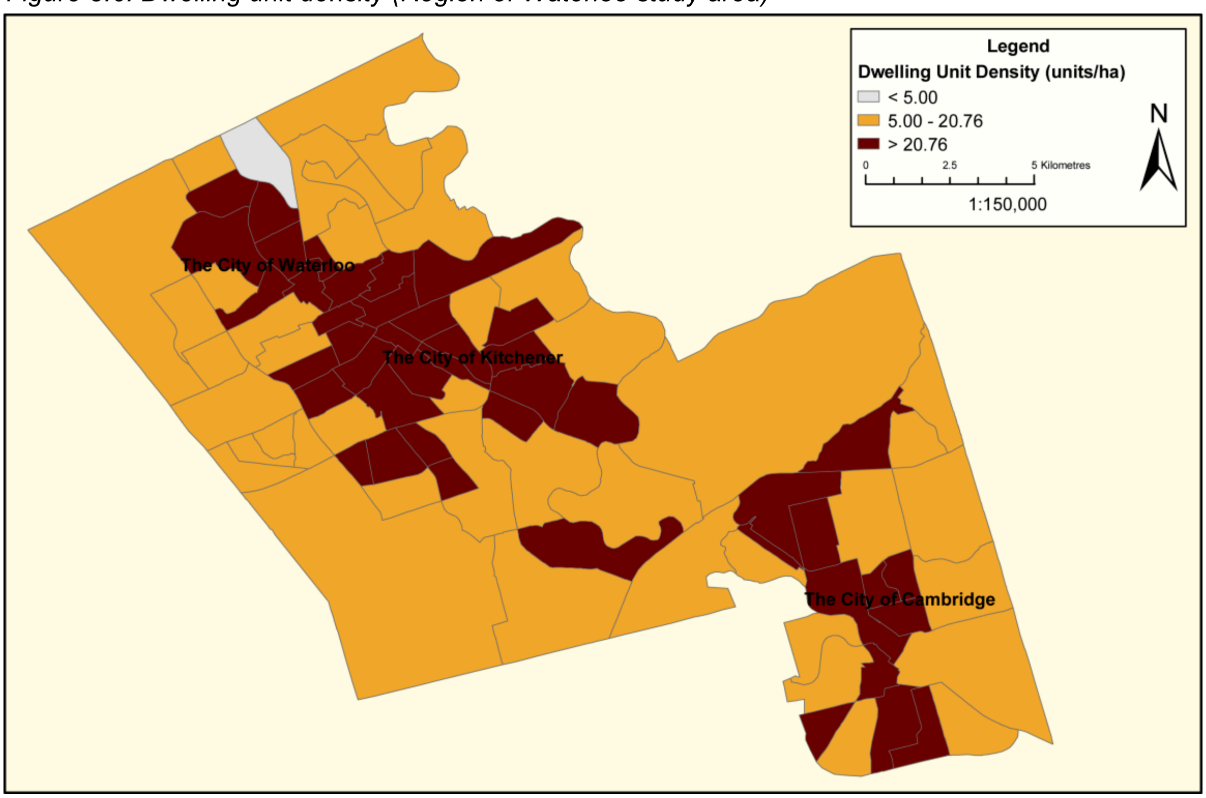


Figure 3.6: Dwelling unit density (Region of Waterloo study area)



3.3 Part 1 of the Analysis: Policies and Characteristics of the Study Areas

The objective of Part 1 of the analysis is to become familiar with aspects of each of the two study areas that could influence the public's attitudes towards cycling and their cycling use. Factors to be considered in Part 1 of the analysis were chosen based on the findings from previous cycling use research and are shown in Table 3.1. Table 3.1 also indicates how the various factors typically affect bicycle use, either positively (+) or negatively (-), according to the research.

The sources used to collect information for each of the variables are various and are noted in Chapter 4 where appropriate. The sources are primarily secondary in nature (i.e. already collected and synthesized) and include: policy documents, Statistics Canada data, data readily available from the local governments of the municipalities considered in the study, and other sources as necessary. The variables are analysed in separate subsections and are compared in summary in section 4.14 (page 100). Cycling-related policies at the provincial, regional, and local government levels are reviewed, including provincial transportation acts, regional land-use planning strategies, community plans, land-use by-laws, and other relevant municipal by-laws.

Patton and Sawicki (1993) established a standard for basic policy analysis that is comprised of six main steps: "problem definition, determination of evaluation criteria, identification of alternatives, evaluation of alternatives, comparison of alternatives, and assessment of outcomes." (p. 52) Although their prescribed approach applies best to the formulation and evaluation of new or alternative policy than it does to the analysis of existing policy content, the first two steps of their approach are relevant to the present thesis.

Table 3.1: Factors explored in Part 1 of the analysis

Factor		How factors tends to relate to cycling use	Research
Physical characteristics			
City size	+ / -	(+) Cycling use tends to be greater in mid-sized cities. (-) When cities are too small or too large, cycling tends to be less convenient.	Pucher et al, 1999; Pucher & Buelher, 2006
Density	+ / -	(+) Cycling use tends to be higher among denser communities; however (-) cities with exceptionally high densities tend to have lower cycling-use than cities with moderately high densities.	Pucher & Buelher, 2006
Weather	+ / -	Cycling use tends to be greater in cities with (-) low precipitation, (-) low wind speed, and (+) warm air temperatures.	Pucher et al, 1999; USDOT FHA, 1992; Dill & Carr, 2003; Pucher & Buelher, 2006
Topography	-	Cycling use tends to be greater in cities with low topographic variance.	Rietveld & Daniel, 2004
Transportation purpose and automobile use			
Automobile use	-	Cycling use tends to be greater in cities with low automobile use.	Pucher et al, 1999
Public transit use	+	Cycling use tends to be greater in cities with high transit ridership.	Pucher et al, 1999
Cost of owning automobile	+	Cycling use tends to be greater in places where the costs of owning an automobile is high.	Pucher et al, 1999; Pucher & Buelher, 2006; Dill & Carr, 2003
No. of autos per capita	-	Cycling use tends to be greater in places with a low number of autos per capita.	Rietveld & Daniel, 2004
Socio-economic characteristics			
Income	+ / -	(+) Cycling use tends to be greater when income is low; however, (-) among much higher income groups cycling-use tends to be greater as well.	Pucher et al, 1999; Xing et al, 2000; Finch & Morgan, 1985; USDOT FHA, 1992
Age	+ / -	Cycling use tends to be (-) low for young children, (+) high for younger adults, and (-) low for older adults and seniors.	Finch & Morgan, 1985; Xing et al, 2010; Pucher et al, 1999
Gender		Cycling use tends to be greater among males.	USDOT FHA, 1992; Dill & Carr, 2003; Finch & Morgan, 1985
Education	+	Cycling use tends to be greater in cities with post-secondary educational institutions and greater (for utilitarian trip purposes) when level of education is increased.	Xing et al, 2010, Rietveld & Daniel, 2004
Cycling infrastructure			
Fatalities / Injuries	-	Cycling use tends to be greater in cities places with lower rates of cyclist fatalities and injuries.	Pucher et al, 1999
Cycling infrastructure	+	Cycling use tends to be greater in cities with more extensive bicycle route networks.	Pucher et al, 1999; Hunt & Abraham, 2007; Nelson & Allen, 1997; Dill & Carr, 2003
Policy			
Policies directly and indirectly affecting cycling are explored	+	Cycling use tends to be greater in cities with more cycling-supportive policies, planning tools, and legislation.	Pucher & Buelher, 2006; Dill & Carr, 2003

Note: the (+/-) symbols summarize how factors typically relate to cycling use (additional clarification is also provided to the right of each symbol)

The analysis of existing policies affecting cycling is approached with a general interest in increasing cycling among the general population. As such, the analysis is focused on content that affects alternative transportation and bicycle and related infrastructure. In applying Patton and Sawicki (1993), the 'problem' steering the analysis carried out in Chapter 4 is a need for increased levels of cycling. There are no specific criteria used in the evaluation of the existing policies. Instead, the consideration of policy is primarily concerned with the identification of policy specific to cycling and on the general effectiveness of these policies. Existing policies that are identified will not be evaluated in terms of cost, administrative ease, legality, political acceptability, or otherwise, as discussed in Patton and Sawicki (1993).

3.4 Part 2 of the Analysis: 'Bike Study' Survey

The following paragraphs describe why a survey was chosen as a method and how it was designed and implemented. The method of analysis is also discussed.

3.4.1 Survey design.

3.4.1.1 Data collection.

Cycling use can be studied by analyzing existing secondary data, conducting observational studies, or by directly asking individuals or households about their bicycle use. The study of attitudes towards cycling is possible if such data already exists, or, if not, by soliciting information from a population through a survey or through individual or group interviews.

There are several reasons why the present research was based on survey data. One is the nature of the data that was desired; since the priority of this study was to interpret information about the general public's cycling use and attitudes, a survey was an appropriate method of collecting data. Further, the consideration of non-cyclists' attitudes and understanding non-cyclists' rationale for not cycling was an essential component of the study[3]. If the research was based on data collected through observation or using data from existing studies, data concerning non-cyclists would have been much more difficult to obtain. As well, although focus groups and interviews have been used in the past in order to generate cycling-related information about both cyclists and non-cyclists (Cavill & Watkins, 2007; United Kingdom Department of Transport, 1985), these methods require a large level of commitment from interviewees and, therefore, have a strong likelihood of eliciting bias which can result in a poorly representative sample of the target population.

Another reason for using a survey was the existence of a previously conducted survey in the Region of Waterloo. In 2002 the Region of Waterloo commissioned Decima Research Inc. and Marshall Macklin and Monaghan to conduct a quantitative study of cycling attitudes and use (Decima & MMM, 2002). The study was based on a random telephone survey of Waterloo Region residents aged 15 and older. The target population for the 2002 study was stratified based on the population in each of the seven areas sampled: the cities of Cambridge, Kitchener, and Waterloo; and the townships of North Dumfries, Wellesley, Wilmot, and Woolwich.

[3]Although this has not been pointed out in cycling-use literature, it is the author's opinion that well-organized cycling advocacy groups have a disproportionately strong influence on cycling-related issues facing municipalities and local governments. And while such groups should be credited for pressuring governments to make decisions that have positive impacts, it is quite possible that the results favour existing cyclists more so that potential cyclists. Thus is the primary logic for including non-cyclists in cycling-use and cycling attitude studies such as the present.

3.4.1.2 Survey content.

As the previous survey created an opportunity to repeat and compare change in attitudes and use over time, the survey design employed in the present thesis was based on the 2002 design. Although there are some small differences in content, the survey questions were largely identical (questions and response for the Halifax and Waterloo surveys are provided in Appendices 3 and 4).The survey has four main sections: household cycling ownership and use; individual participants' use; participants' attitudes towards a variety of cycling-related issues; and basic demographic information.

3.4.1.3 Survey administration and distribution.

Two separate survey distribution methods were used, both employing multistage procedures (Creswell, 2007): the main effort was carried out by telephone and the other was carried out by regular mail. Both methods involved advertising the survey to potential participants and directing them to complete an online survey at their convenience. As an incentive, potential participants who were contacted were offered a chance at winning one of four fifty-dollar prize packages donated by local businesses if they completed the survey. Although the telephone interview scripts varied depending on the type of response from the interviewee, the basic strategy was to inform the first point of contact about the survey and invite them to participate online at their convenience (a sample of a script used is provided in Appendix 5).The telephone numbers dialed were picked randomly from the stratified random samples using a CATI (Computer Assisted Telephone Interviewing) system at the University of Waterloo's Survey Research Centre.

The telephone and mail-out distribution methods were similar in approach. For the mail-out, a letter was mailed to a household drawn from the same stratified random sample used in the telephone distribution; it was hoped that the first point of contact would read the letter, visit the website, and complete the survey. Appendix 6 is a copy of the mail-out letter used to recruit respondents.

A random list of addresses and phone numbers, stratified according to the number of dwelling units per census tract in each of the study areas, were obtained from a sampling services firm. A team of ten students conducted the telephone interviews on two consecutive Saturdays in the fall of 2008 and the mail-outs were distributed in the spring of 2009.

The first survey distribution effort – carried out by telephone – yielded response rates of 3.19 percent in Halifax Regional Municipality and 4.23 percent in the Region of Waterloo. And although 4291recruitment attempts were made in both study areas combined, a large portion of these was unsuccessful. Table 3.2 is a summary of the final telephone dispositions.

Table 3.2: Dispositions for survey distribution by telephone

Outcome	Frequency	Percent
Answering Machine	1794	44%
Refusal	836	21%
NIS Fax Business	487	12%
Complete	466	11%
No Answer	275	7%
Break Off	248	6%
Other	185	5%

The second survey distribution approach was an alternative used, in part, to gage the likely response rate from a second phase of surveys. However, only 8 of 100 mail-outs were successful in the Region of Waterloo and only 7 of 100 were successful in the Halifax Regional Municipality. Although the resultant response rate for the two study areas – 7.5 percent – was significantly higher than the response rate generated for the telephone distribution method – 3.29 percent, owing to time and financial restrictions no further survey advertisements were mailed.

In total, two hundred letters were distributed and 4291 telephone numbers were attempted, for an overall 4491 attempts. It is also worthwhile noting that the response in the Region of Waterloo was considerably higher than for Halifax Regional Municipality – a difference of 25.4 percent (or 20 completed surveys). At least in part, this could be attributed to the fact that the study was being introduced as a University of Waterloo research endeavour; it can be assumed that those most familiar with the University are somewhat more likely to participate. Table 3.3 is a summary of the response rate for each of the two study areas and combined.

Table 3.3: Survey response rate

Attempted	Waterloo	Halifax	Total
Telephone	2149	2142	4291
Mail-out	100	100	200
Total	2249	2242	4491
Response			
Telephone	80	61	141
Mail-out	8	7	15
Total	88	68	156
Response Rate			
Telephone	3.72%	2.85%	3.29%
Mail-out	8.00%	7.00%	7.50%
Total	3.91%	3.03%	3.47%

The goal of both of the survey distribution methods was to encourage the recipient to visit the study's website, which was hosted at <www.bikestudy.ca>. As required by the Office of Research Ethics, potential respondents were invited to read a short information letter, which offered them some information about the study and made them aware that their participation was voluntary. To make the survey more attractive to potential participants it was given the names of *Bike Study Halifax* and *Bike Study Waterloo*. Appendix 7 is a screenshot from the website participants were encouraged to visit. After reading the information letter respondents could then select the appropriate link for their geographic locations whereupon they would be redirected to the survey, which was hosted online by <surveymonkey.com>.

Refer to Appendix 8 for a copy of the letter of approval obtained from the University of Waterloo's Office of Research Ethics.

3.4.1.4 Data used in the design of survey.

The administration and analysis of the Bike Study survey required data from a variety of sources. Data were used to define the specific study areas within each municipality and to determine the number of potential respondents within each census tract. As mentioned, the specific delineation of the two study areas was based on a dwelling-unit density calculation based on census tract statistics and residential land use data. Land-use zoning mapping for the City of Cambridge, the City of Kitchener, and the City of Waterloo were acquired through the University of Waterloo's University Map Library. These three separate data sets were joined in order to provide information specific to the Region of Waterloo study area. Land-use data for Halifax Regional Municipality were recently developed by a space-time activity research project (STAR Project) at Saint Mary's University and were made available through the Maritime Provinces Spatial Analysis Research Centre at Saint Mary's University. The land use data for each of the study areas were combined with dwelling-unit counts from the 2006 Census and census tract shapefiles developed for use in a geographic information system, in order to separate each of the two study areas into 'higher density' and 'lower density' categories as discussed in section 3.2.1 (page 46) .

3.4.2 Analysis of survey results.

3.4.2.1 Categorization of respondent types.

A non-cyclist should be described as someone who never cycles; a recreational cyclist should be described as someone who cycles at least occasionally for recreation (not with the intention of satisfying a transportation demand); and a utilitarian cyclist should be described as someone who cycles at least occasionally to satisfy a transportation demand. However, when these categories are used, a substantial overlap tends to exist between recreational and utilitarian cyclists, since most utilitarian cyclists also cycle for recreation. As such, in an effort to reveal measurable differences between types of cyclists, respondents in cycling studies are often categorized as follows: those who never cycle (non-cyclists);those who cycle *only* for recreation (recreational cyclists); and those who cycle for utilitarian purposes (utilitarian cyclists) (Hunt & Abraham, 2007; Pucher & Buehler, 2005).

Respondent categories and definitions used in the Waterloo Region Cycling Survey (2002) were specifically chosen for this study for the sake of consistency; in order to enable comparison between the two sets of results. Each respondent type is defined below for the purposes of this study:

Utilitarian Cyclists: those who ride a bicycle for utilitarian purposes such as going to work or school, running errands, going shopping or visiting friends. Utilitarian cyclists may also ride a bicycle for recreation or fitness purposes, but they are classified hierarchically as utilitarian.

Recreational Cyclists: those who ride a bicycle for recreation or fitness purposes. Recreational cyclists do not ride a bicycle for utilitarian purposes. It should be noted that wherever cyclist comparisons are made throughout this report, recreational cyclists are those who cycle for recreational purposes only.

Non-Cyclists: those who do not ride a bicycle at all.

For Part 2 of the analysis, survey respondents were categorized separately into groups based on whether or not they use bicycles and, if so, for what purposes [response variable:

type of cyclist]; and how much they use their bicycles, regardless of trip purpose [response variable: bicycle use]. Each of these response variables was arranged into three categories[4]:

Type of cyclist: utilitarian cyclists, recreational cyclists, and non-cyclists

Bicycle use: higher cycling-use, lower cycling-use, and no cycling-use

While many researchers chose to analyse cycling habits based on only one of these variables, analysis of both enables comparisons with a greater number of studies. Further, while it might initially seem most important to understand what factors relate to high amounts of bicycle use, if researchers are concerned with increasing utilitarian cycling, then purpose of use (type of cyclist) must be incorporated. The explanatory variables, those which may or may not relate to 'type of cyclist' or 'bicycle use', including demographic variables, geography, and attitudes towards cycling, were nearly entirely collected as either nominal or ordinal data. Survey questions which yielded interval or ratio response data were converted to categorical for the purposes of this analysis.

3.4.3 Statistical approach: Fisher's Exact Test.

Contingency analysis is used to measure either 'goodness of fit' or the 'independence' of frequencies of two categorical variables. 'Independence' tests measure whether or not an observed set of data is related to another observed set of data. While the chi-square method is often used to explore independence, Fisher's exact test can be a more accurate method of determining significance when sample sizes are small or when frequency distributions are rather unbalanced. And, although Fisher's Exact Test historically has been applied only in situations with 2x2 contingency tables (one degree of freedom), modern statistical software allows the algorithm to be applied to contingency tables with more rows and columns. This

[4]Both of these response variables are assumed to be non-parametric, since they are organized nominally and are not expected to have a normal distribution.

method was employed for the present analysis. Refer to Appendix 9 (page 193) for a legend explaining how the survey results were re-categorized into categorical variables suitable for contingency analysis.

In contingency analysis, the null hypothesis is that there is no association between the variables being tested, and if rejected, we can conclude that the "variables are not statistically independent, but related to one another in some nonrandom fashion." (Chapman McGrew, Jr. & Monroe, 2000, p. 169) A significance level of $p \leq 0.050$ (equal to or greater than 95 percent) was chosen to analyse the results: where $p \leq 0.050$, the null hypothesis is rejected and the result is deemed significant A significant result indicates that the differences observed in the sample data, as an estimate of the association between the two categorical variables, is unlikely (as expressed by the p-value) to have occurred by chance, if we hold the null hypothesis to be true.

Chapter 4: Part 1 of the Analysis, Policies and Characteristics of the Study Areas

The review of research related to cycling use in Chapter 2 has confirmed that several variables can affect the public's use of cycling. No definitive explanation of why individuals choose to cycle or why they choose not to has been formulated and it is unlikely that such a conclusion will be made owing to the number of variables involved in transportation mode choice. Nevertheless, the research has shown that certain variables are positively associated with cycling use. These variables, identified previously in Table 3.1 (page 42), will be explored for each of the two study areas, and compared where possible.

While some data are available at the census tract level and enable more geographically precise analysis, much of the data available are relevant to broader geographic areas. Where necessary, data specific to the regional level or the provincial level will be used instead to provide indications of trends.

4.1 City Size and Density

According to Pucher et al. (1999), "Small, compact cities are more amenable to cycling since more destinations are accessible within a short bike ride, motor traffic volumes are lower, and there are less likely to be obstacles such as expressways and bridges." (p. 646) It is difficult to know if Pucher et al. (1999) were referring to population density, residential density, employment density, commercial density, or a combination of these. For this study, residential density – based on the number of dwellings per hectare of residential land in each census tract – was calculated for each of the study areas defined in Section 3.2.1 (page 46).

While greater density is generally associated with higher levels of cycling, it is important to note that areas with very high densities typically do not have greater cycling-use than those with medium densities. This can be attributed to the relative convenience of cycling and to the provision of other modes of transportation; as Rietveld and Daniel (2004) describe, “the use of the bicycle is low in low density areas, as in such areas there might be fewer opportunities to make short trips. Then it reaches a maximum in medium density areas, and falls again, as might be expected, in high density areas, where public transport is well provided so that it is a competitor to the bicycle.” (p. 536) Since Halifax and Waterloo have no large areas with very high overall land use densities, it can generally be accepted that the higher density parts of both study areas are more conducive to cycling than parts of each study area with low densities.

The overall dwelling-unit density for Waterloo and Halifax were 23.61, and 15.59 units per hectare, respectively. The Waterloo study area measures 74.5 square kilometers (7450.5 hectares) and the Halifax study area covers 90.3 square kilometers (9031.4 hectares)[5].

Employment density – a function of the number of jobs per unit area of land – could be equally important to residential density in a consideration of overall density, especially when the topic of interest involves transportation since many trips are from home to work or vise-versa. However, the number of jobs per census tract is not a readily available statistic; instead, a less robust statistic incorporating the number of residents in each census tract employed in the census metropolitan area (CMA) was used as an indication of employment density in each study area. The employed labour force 15 years and over who worked in the CMA in which they reside was 11.86 employees per hectare in the Waterloo study area and was 11.08 employees per hectare in the Halifax study area (Statistics Canada, 2007a and 2007b). The primary limitation to using data for residents employed in a geographic area to determine employment density is that it excludes employees in the area who reside outside of the

[5] The study areas exclude parts of each Regional Municipality with dwelling-unit densities below 5.0 units per hectare, as discussed in greater detail in Section 3.2.1 (page 46).

census tracts in question. Nevertheless, it can be assumed that the statistic is, at the very least, suggestive of the overall employment density for the study areas.

The above considerations of residential density and suggestions of employment density reveal that the Waterloo study area has a greater overall density than the Halifax study area. Considering the lack of lands with very high densities in either study area, this section of analysis suggests that the Waterloo study area is likely more conducive to cycling than the Halifax study area, in terms of city size and density.

4.2 Weather

To obtain a general understanding of the climate and weather patterns for each study area, basic temperature, precipitation, and wind speed data were obtained from Environment Canada (n.d.). Climate data were obtained for up to ten years prior to 2008 in order to calculate average values for each study area. A more detailed analysis of temperature, precipitation, and wind speeds would have considered the range and variability of values for each study area and their impact on cycling; however, the simple analysis of averages provides a helpful comparison in the context of this work.

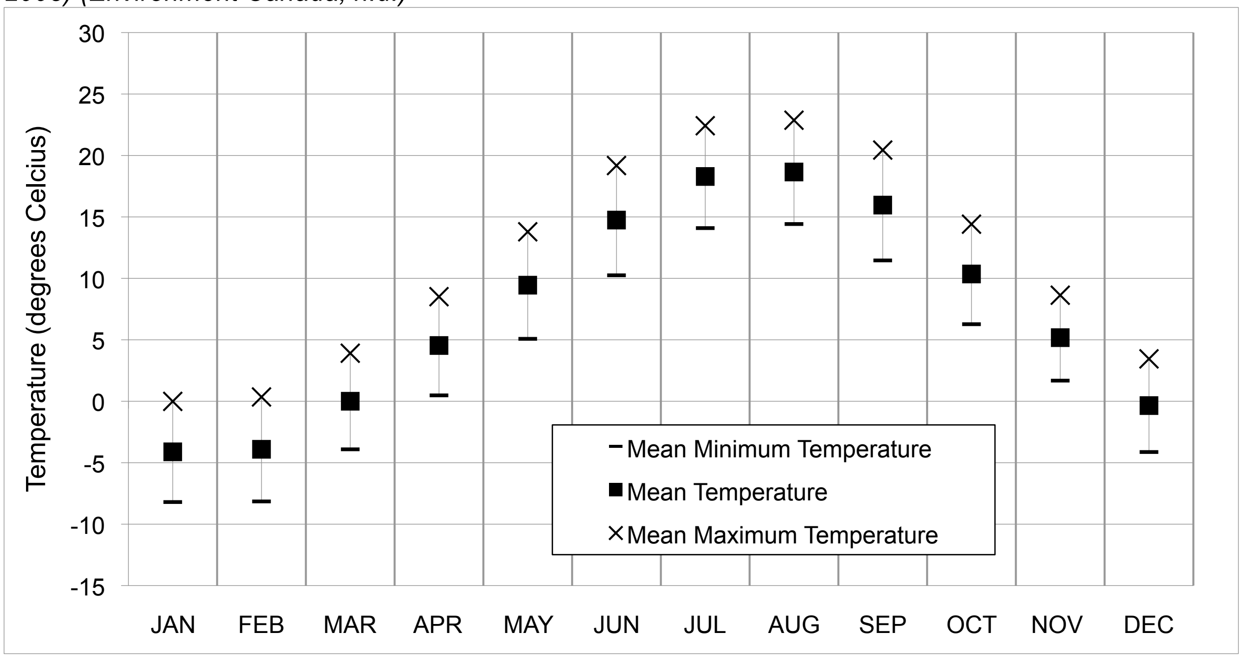
4.2.1 Temperature.

Figures 4.1a and 4.1b show the differences in mean temperature[6] throughout the year in Halifax and in Waterloo. While Halifax has higher mean temperatures than Waterloo by one or two degrees during the winter months, the reverse is true in the spring and summer. On average, from April to October, mean temperatures in Waterloo are an average of 2.1 degrees

[6] All temperature values are given in degrees Celsius.

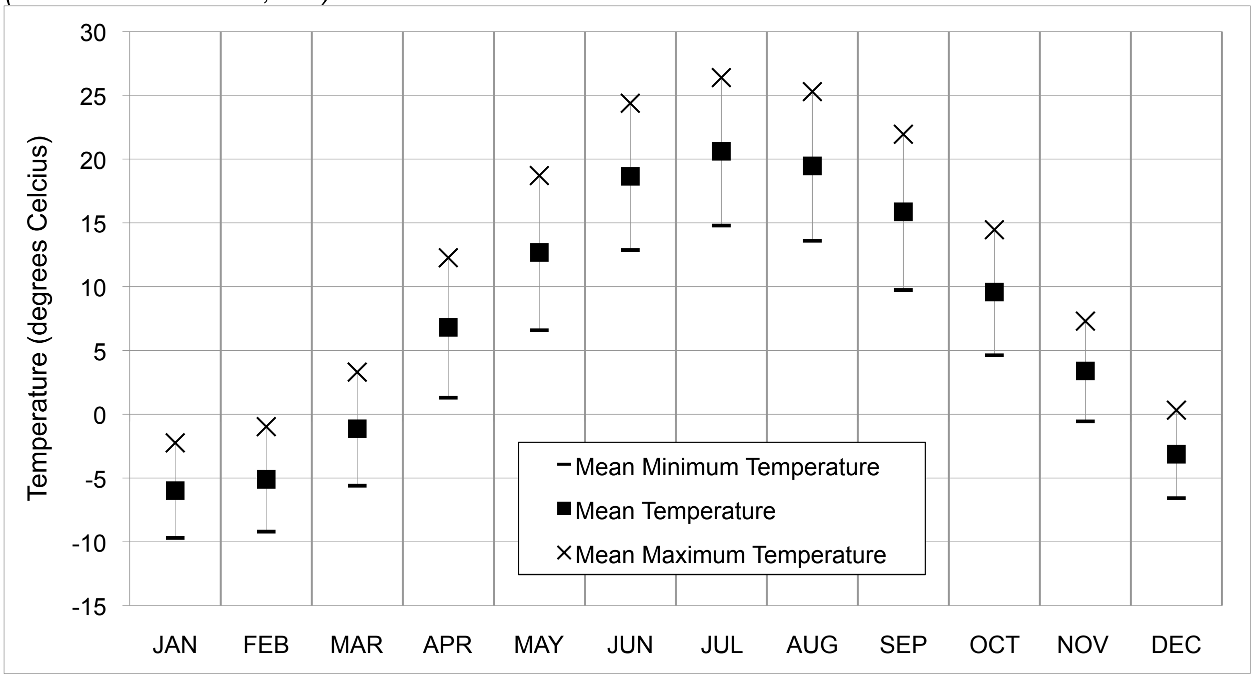
warmer than in Halifax. The figures also suggest that the temperatures from September to November vary minimally between the two study areas.

Figure 4.1a: Average temperature by month, Halifax Regional Municipality (10 year average, 1999-2008) (Environment Canada, n.d.)



Note: 1999 - 2006 temperatures based on data from weather station 'Shearwater A' with an elevation of 50.9m; 2007 - 2008 temperatures based on weather station 'Shearwater Auto' with an elevation of 53.0m.

Figure 4.1b: Average temperature by month, Region of Waterloo (10 year average, 1999-2008) (Environment Canada, n.d.)

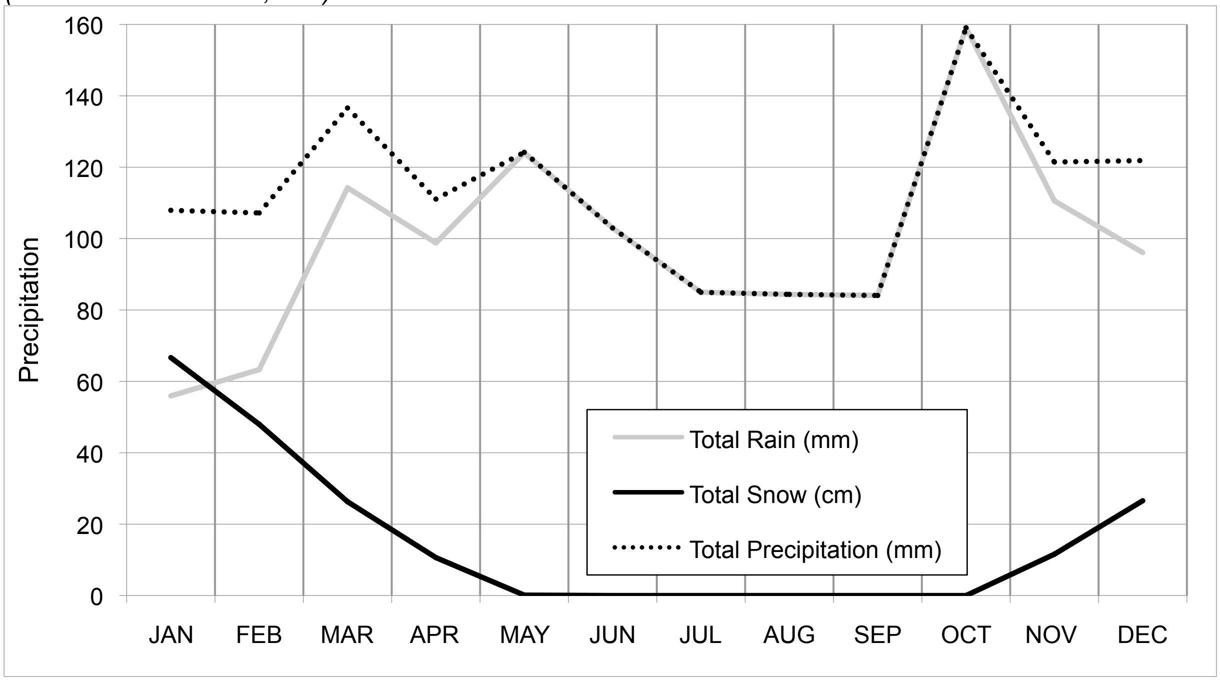


Note: January 1999 - October 2002 temperatures based on data from weather station 'Waterloo Wellington A' with an elevation of 317.0m; November 2002 - December 2002 temperatures based on data from weather station 'Region of Waterloo International Airport' with an elevation of 321.3m; 2003 – 2008 temperatures based on data from weather station 'Roseville' with an elevation of 328.0m.

4.2.2 Precipitation.

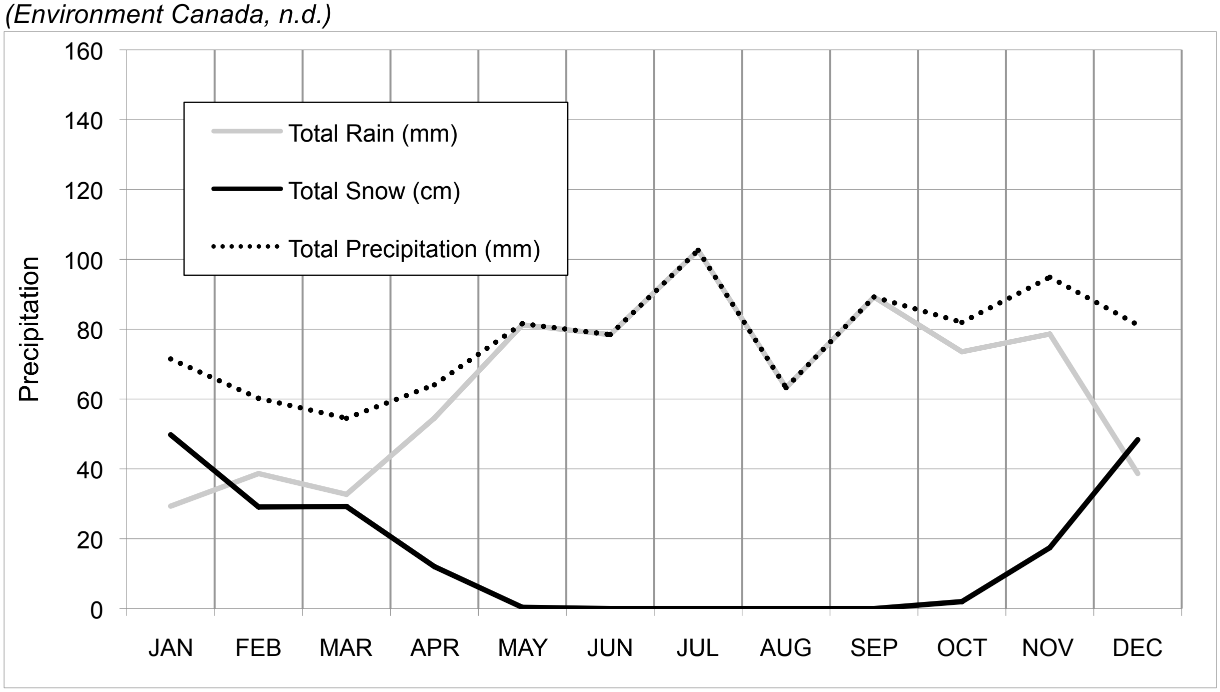
There is a greater average monthly amount of precipitation in Halifax than in Waterloo (Figures 4.2a and 4.2b). There was a monthly average of 112.1 mm of precipitation was calculated for Halifax, whereas there was only 76.9mm of precipitation in Waterloo – a difference of 35.2mm. While this general difference exists for both rain and snow, a few exceptions should be noted: July and September tend to be rainier in Waterloo than in Halifax and more snow tends to fall in Waterloo in the month of December.

Figure 4.2a: Average precipitation by month, Halifax Regional Municipality (8 year average, 1999-2006) (Environment Canada, n.d.)



Note: 1999 - 2006 precipitation data based on weather station 'Shearwater A' with an elevation of 50.9m.

Figure 4.2b: Average precipitation by month, Region of Waterloo (10 year average, 1999-2008) (Environment Canada, n.d.)

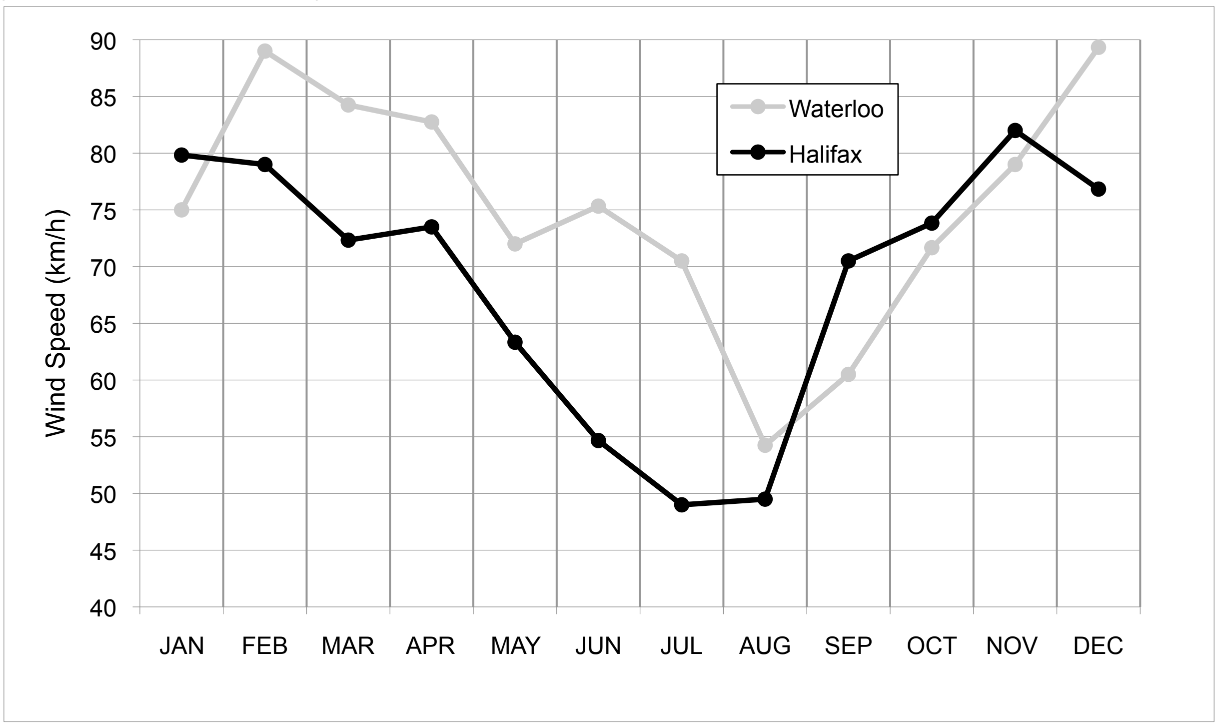


Note: 1999 - October 2002 temperatures based on data from weather station ‘Waterloo Wellington A’ with an elevation of 317.0m; November 2002 – 2008 temperatures based on data from weather station ‘Roseville’ with an elevation of 328.0m. Exception: total precipitation for November and December 2002 are based on data from weather station ‘Region of Waterloo International Airport’ with an elevation of 321.3m.

4.2.3 Wind speed.

Based on the data presented in Figure 4.3, which shows the monthly average speed of daily maximum gusts of wind in Halifax and Waterloo, it would appear that the maximum wind speeds between February and August are greater for Waterloo than in Halifax. Otherwise, wind speed is similar for the two study areas. The annual average maximum wind speed (based on the monthly averages) is 68.7 kilometres per hour in Halifax and 75.3 kilometres per hour in Waterloo.

Figure 4.3: Average speed of maximum gust, Halifax Regional Municipality and Region of Waterloo (Environment Canada, n.d.)



Note: Halifax Regional Municipality data (1999 – 2004) based on weather station 'Shearwater A' with an elevation of 50.9m. Region of Waterloo data (1999 – October 2002) based on weather station ‘Waterloo Wellington A’ with an elevation of 317.0m.

4.2.4 Overall weather.

Although cycling might be more favourable with regards to temperature during the winter months in Halifax, and overall in terms of wind speed, Waterloo tends to be warmer than Halifax from April to October; as a product, likely more conducive overall to cycling. Waterloo also experiences significantly lower annual precipitation than Halifax.

Rietveld and Daniel (2004) suggest that because preventative efforts can help mitigate the influence of rain on cycling more so than wind, wind has more of an influence on cycling use. However, it is important to weigh the differing costs of each of the two conditions: cycling in wind can take considerable physical effort, but cycling with rain can also involve more physics effort and can also compromise comfort, cleanliness and can affect the value of a bicycle and increase maintenance costs – especially if bicycle parking is not adequately sheltered from the elements. As such, unless there is a substantial difference in wind speed between two jurisdictions, it is likely that precipitation is a more critical variable. In a consideration of the average weather conditions in each of the two study areas, is likely that the weather in Waterloo is more favourable to cycling than it is in Halifax.

4.3 Topography

Rietveld and Daniel found that topography has the strongest association with cycling use out of all of the 26 factors they analysed. For this study, a simple method was used to calculate average percent slope in Halifax and Waterloo to gather an understanding of topographic variation. In a Geographic Information System, a 1000m grid of points was drawn over each of the study areas and an average slope was calculated based on the standard deviation of the elevations of all of the points. Figures 4.4a and 4.4b show the variation in slope as well as the grids used for each study area. The average slope for the Waterloo study area was 2.55 percent; in the Halifax study area the average slope was 2.67 percent – indicating that the average slope is greater in the Halifax study area.

Figure 4.4b shows that significant portions of land with large amounts of slope occur in primary employment areas (the central business district in Halifax, the Port of Halifax, and the Halifax Dockyards) as well as the Armdale Roundabout area, which is a major confluence of roads connecting suburban Halifax to the more urban Peninsula Halifax. While a significant portion of land with large amounts of slope in the Waterloo study area also seems to occur along a major transportation corridor in parts of South Kitchener and the northwest parts of the City of Cambridge, much of the most significant topographic variation in the Waterloo study area occurs in areas which can be considered peripheral in terms of land use activity.

Figure 4.4a: Region of Waterloo study area slope calculation method

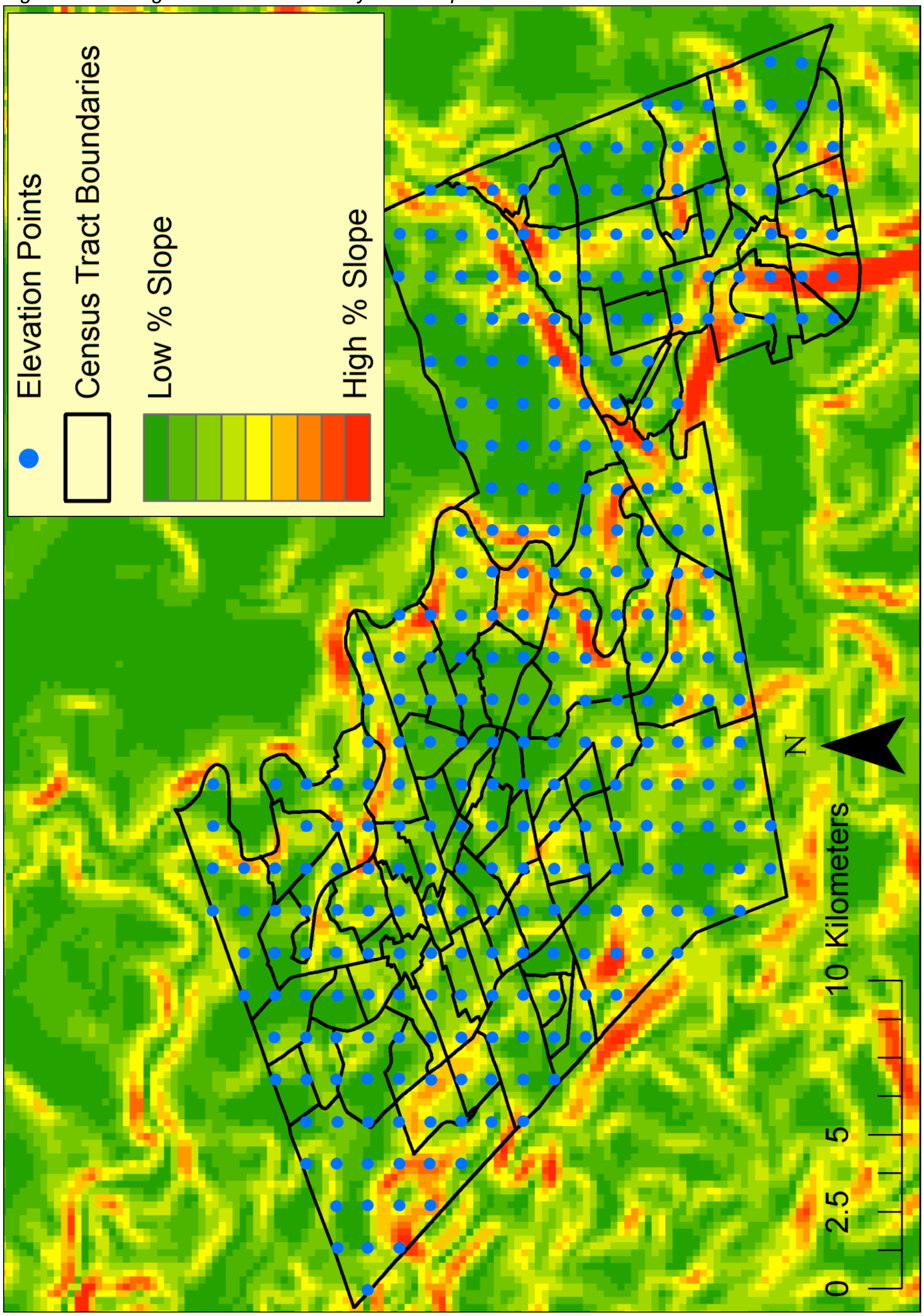
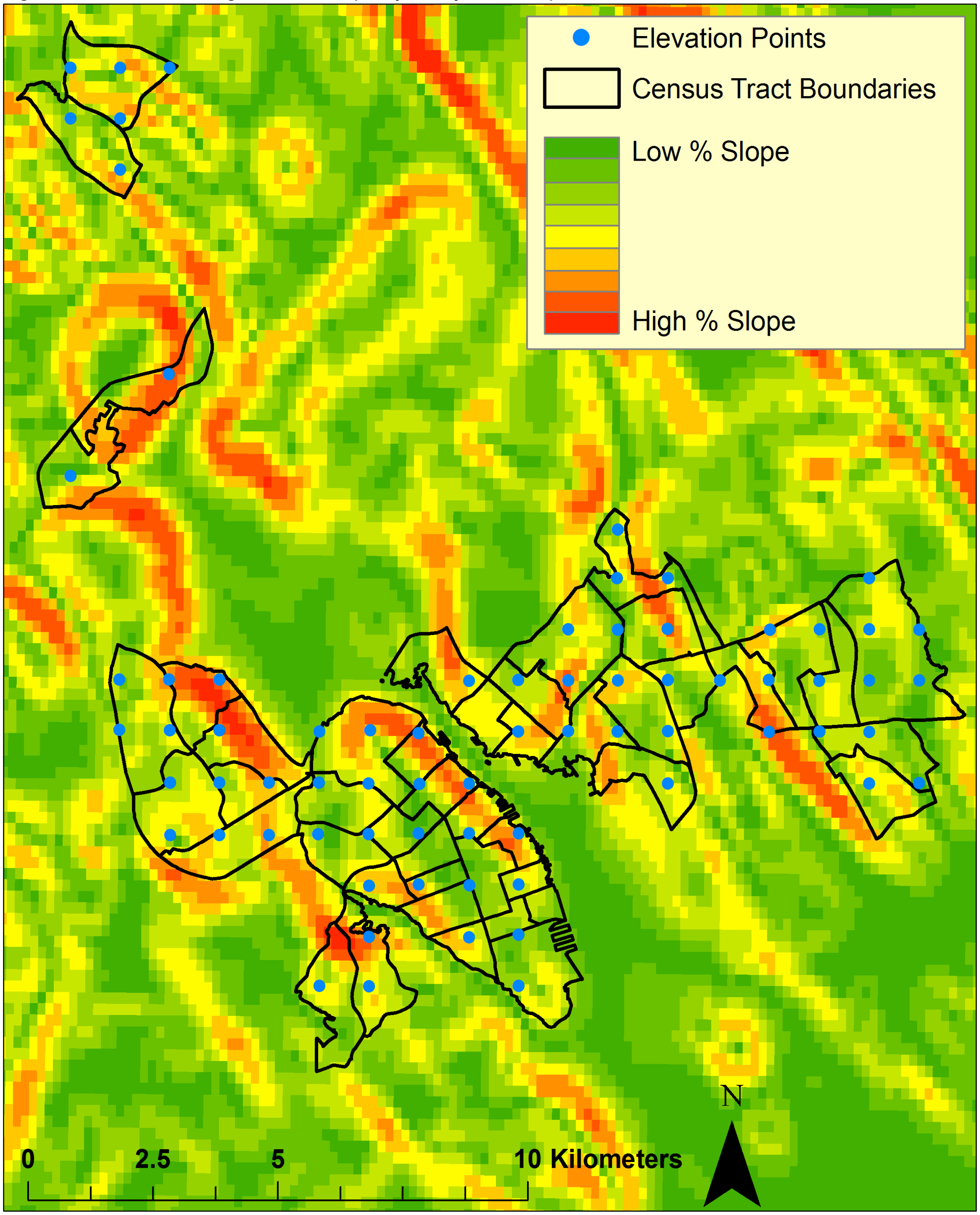


Figure 4.4b: Halifax Regional Municipality study area slope calculation method



As mentioned in Chapter 3, Rietveld and Daniel (2004) found that a ‘hilly’ city can have the effect of decreasing bicycle use by as much as 74 percent in a municipality. Although the difference in slope between Halifax and Waterloo is only 0.12 percent, the difference suggests that the terrain in Waterloo somewhat more hospitable for cyclists. A more in-depth analysis of the differences in slope between Halifax and Waterloo would include an evaluation of variability in slope. For example, it is possible that a few large differences in elevation in either of the study areas (acting as outliers) might distort a potentially lower average.

4.4 Automobile and Public Transit Use

Jurisdictions with high levels of automobile use tend to be places with low levels of cycling, while jurisdictions with high transit use tend to be places where car ownership is less necessary, resulting in higher levels of cycling (Pucher et al, 1999).

Statistics Canada data for the Region of Waterloo and Halifax Regional Municipality in 2006 show that 88 percent of employed residents over the age of 15 in Waterloo Region commute to work in a car, truck, or van as either a driver or a passenger, while 75.8 percent use a car, truck, or van in Halifax Regional Municipality (Table 4.1) (Statistics Canada, 2007a and 2007b). Statistics Canada journey to work data for 2006 suggest that 11.9 percent of employees in Halifax Regional Municipality use transit to get to work, while only 4.6 percent of Waterloo Region employees use transit (2007a and 2007b). More accurate transit data for 2008 obtained from the Canadian Urban Transit Association confirms the disparity in transit use. In 2008, ridership per capita[7] in Halifax Regional Municipality was 62.52, whereas in Waterloo Region ridership per capita was 37.45m (T. Siu, personal communication, October 13, 2010).

[7] Ridership per capita provides a general comparison of public transit use between transit agencies; it is calculated by dividing the total annual ridership by the population of the service area.

Table 4.1: Mode of transportation to work, employed labour force, 2006 (Statistics Canada, 2007a and 2007b)

	Region of Waterloo	Halifax Regional Municipality
Car, truck, van, as driver or passenger	87.98%	75.76%
Public transit	4.55%	11.87%
Walked or bicycled	6.67%	11.08%
All other modes	0.80%	1.29%

Automobile use and public transit ridership data suggest that residents of Halifax Regional Municipality are more dependent upon alternative modes. Based on these findings, residents of Halifax Regional Municipality are somewhat more likely to use bicycles for transportation[8].

4.5 Cost of Owning an Automobile

The Canadian Automobile Association separates the costs of driving a car into two categories, ownership costs and operating costs (Canadian Automobile Association, 2008). Ownership costs include the cost of the automobile, taxes, registration, and insurance, while operating costs include fuel costs and the cost of maintenance. The costs below were estimated based on the ownership of a 2008 Honda Civic, the top-selling vehicle for 2008 in Canada (Leblanc, 2008).

[8] The differing levels of walking and bicycling in Halifax and Waterloo in Table 4.1 are worthy of acknowledgement. While it is impossible to understand how cycling use varies based on this mode share data, since walking and cycling are grouped, the percentage difference is at least suggestive of higher rates of cycling in Waterloo. It is important to note, however, that these data only reflect commutes to work for active members of the workforce. A comparison of bicycle use based on the findings of the Bike Study surveys is provided in section 5.2 (page 109).

4.5.1 Gasoline prices and average driving distance.

MJ Ervin and Associates, "the pre-eminent gasoline price collection agency in Canada" (Dahl, 2008), compiles gas price data for many cities across Canada. While they do not collect data for the Waterloo Region, data averages for London and Hamilton can be compared with data for Halifax as an indication of regional price difference. The 2008 average retail cost of gasoline for London and Hamilton was $1.100 per litre; in Halifax the price was $1.178 per litre – a difference of $0.078 (MJ Ervin, 2010). This price difference is reaffirmed by data for Ontario and the Atlantic Provinces. The average retail cost of gasoline for 2008 was $0.079 less in Ontario ($1.101) than it was in Atlantic Provinces ($1.180) (MJ Ervin, 2010).

Data from the 2008 Canadian Vehicle Survey (Statistics Canada, 2009) reveals that the average annual distance driven per light passenger automobile in Ontario is 15,833 kilometres; while the distance in Nova Scotia is 16,476 kilometres. Although these numbers likely vary within each province depending upon a number of factors, including urban or rural situation and upon a driver's broader geographic location, these figures offer a helpful indication of an average difference between the two study areas.

Money spent on gasoline can vary substantially, depending upon variables such as type of vehicle, geography, driving habits, nature of the routes driven, and vehicle maintenance. Using the estimated mileage for the 2008 Honda Civic[9] as an example for both study areas, and assuming for the sake of comparison that 60 percent of the distance driven takes place in the city and 40 percent of the driving occurs on the highway, the estimated annual fuel cost for a vehicle in Halifax is $1602.76, whereas it is $1438.24 in Waterloo – a difference of $164.52.

[9]The 2008 Honda Civic has an estimated fuel mileage of 9.41 litres per 100 kilometres in the city and 6.53 litres per 100 kilometres on the highway litres per kilometer (U.S. Department of Energy, n.d.).

4.5.2 Cost of automobile insurance.

For Halifax and Waterloo, average insurance premiums were estimated for a 2008 Honda Civic, operated by a middle-aged driver with a clean driving record. Based on on-line quotes from several insurance providers in each municipality, it would appear as though drivers in the Waterloo Region ($1471.17) pay an average of $78.26 more per year than drivers in Halifax ($1392.91).

4.5.3 Cost of vehicle registration.

Lightweight passenger vehicles must be validated annually in Ontario at a cost of $74.00; an additional biannual cost of $35.00 applies to have the car tested for emissions standards. These requirements represent an annual cost of $91.50. In Nova Scotia, a biannual registration cost, equal annually to $99.71, means Nova Scotia drivers pay $8.21 more per year than drivers in Ontario.

4.5.4 Total variable cost.

Although several cost variables are quite similar for car owners in Halifax and Waterloo, including automobile price, sales taxes, and cost of maintenance, the variable costs make driving in Halifax slightly more expensive than driving in Waterloo. For gas, registration, and insurance, the average owner of a 2008 Honda Civic will spend approximately $3095.38 per year in Halifax, whereas the same driver will spend approximately $3000.91 per year in Waterloo Region.

Although research has indicated that the costs of owning and operating a vehicle are generally related to cycling use, in order to understand whether or not the average cost difference between Waterloo and Halifax is substantial enough to influence an individual's mode choice, it would be necessary to consider the relative effect of cost margins in mode choice decision-making, in general, and as they differ between study areas. Nevertheless, this relatively simple analysis suggests that with respect to the estimated average costs of owning and operating automobiles, alternative modes of transportation, including cycling, could be slightly more appealing to individuals in Waterloo than for individuals in Halifax, since automobile costs are very slightly higher in Nova Scotia.

4.6 Number of Autos per Capita

The number of registered lightweight passenger automobiles in Nova Scotia and Ontario, considered with 2008 population estimations, reveals that Nova Scotia had approximately 0.58 autos per capita, while Ontario had approximately 0.56 autos per capita. Since more precise statistics were not available for the study areas, it is difficult to conclude that a significant difference in automobile ownership exists.

4.7 Income

Table 4.2 shows that residents of the Region of Waterloo who are 15 years of age and over and earn an income, have a higher median income, both after tax and before, than the same group in Halifax Regional Municipality (Statistics Canada, 2007a and 2007b). More specifically, median income before tax is 7.6 percent greater in the Region of Waterloo; after tax, the percent difference is 7.5 percent, owing to a slightly lower tax rate in Halifax Regional Municipality.

Table 4.2: Median income, before and after tax, 2006 (Statistics Canada, 2007a and 2007b)

	Region of Waterloo	Halifax Regional Municipality
Median income ($)	29,449	27,198
Median income after tax ($)	26,187	24,216

As discussed in Chapter 2, research has shown that income tends to have a negative association with cycling use (USDOT Federal Highway Administration, 1992; Dill and Carr, 2003)[10]. This has been explained, in part, as a function of one's ability to afford access to the use of an automobile (Rietveld and Daniel, 2004; Pucher et al., 1999). As such, it can generally be inferred that owing to a higher median income in Waterloo Region, it is more likely for residents of Halifax Regional Municipality to use modes other than the automobile for transportation, including cycling.

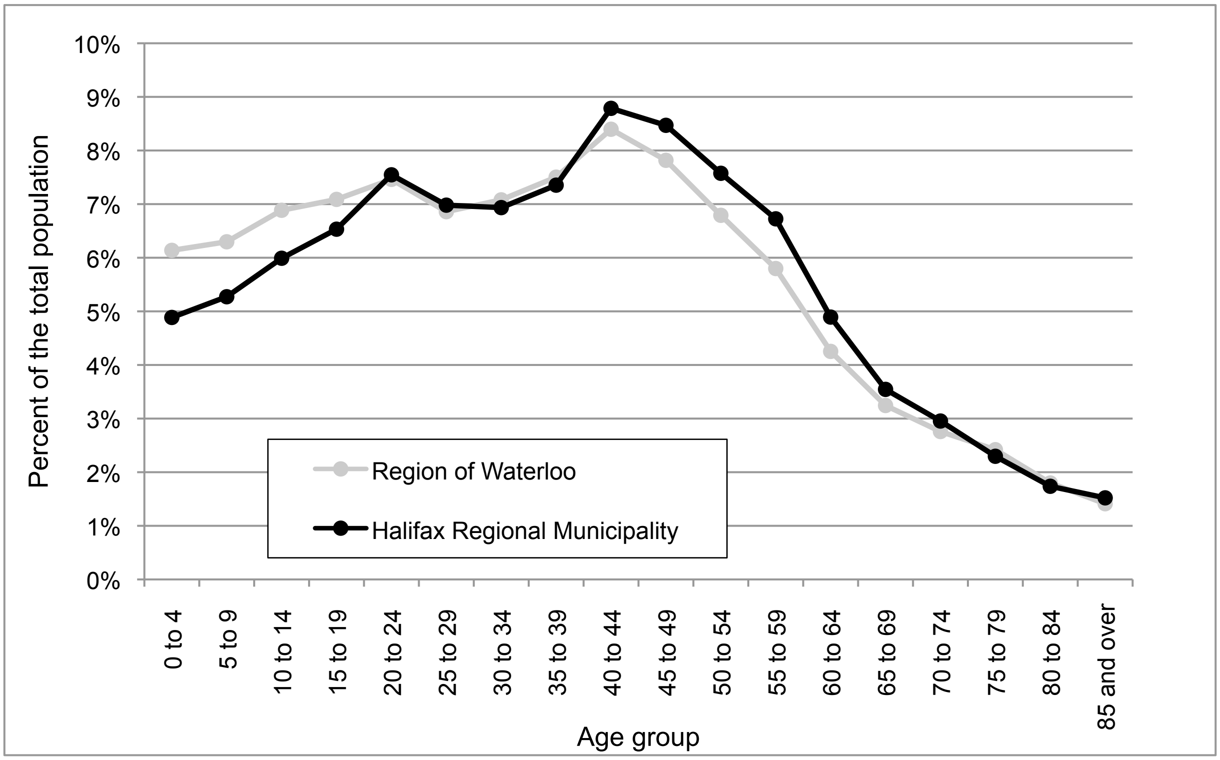
4.8 Age

Cycling use has been shown to have at least somewhat of a negative association with age. As shown in Figure 4.5, the percentage of population aged 0 to 20 and 45 to 70 was greater in the Region of Waterloo than it was in Halifax, whereas the percentage of population within the age groups between 20 and 44 and between 75 and over are much more similar. These percentages confirm that there is a higher percentage of children and teenagers in the Region of Waterloo than in Halifax Regional Municipality and that there is a higher percentage of middle-aged adults in Halifax Regional Municipality than in the Region of Waterloo. The suggestion that the overall population in Halifax Regional Municipality is older than in the Region of Waterloo can be confirmed by evaluating median age. Median age in Halifax

[10] And while this trend is generally applicable, research has also identified somewhat elevated levels of cycling among the highest income groups (see section 2.4.3.4 on page 22).

Regional Municipality, as reported in the 2006 census was 39.0, whereas it was 36.4 in the Region of Waterloo (Statistics Canada, 2007a and 2007b).

Figure 4.5: Age, as a percentage of the total population, 2006 (Statistics Canada, 2007a and 2007b)

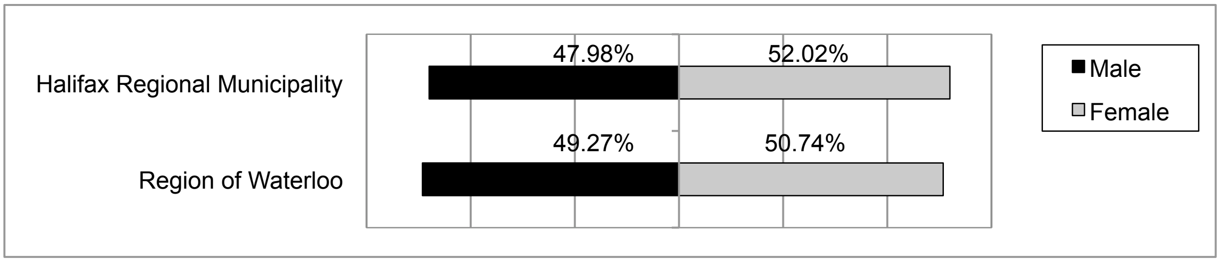


Therefore, in a consideration of age, it can be concluded that cycling use is more likely to be greater in Waterloo Region than in Halifax.

4.9 Gender

In 2006, the ratio of men to women in the Region of Waterloo was greater than it was in Halifax Regional Municipality, as shown in Figure 4.6. Since cycling use has been shown to be greater among men than for women, it can be gathered that based on gender alone cycling use is likely to be greater in the Region of Waterloo than in Halifax Regional Municipality.

Figure 4.6: Gender, as a percentage of the total population, 2006 (Statistics Canada, 2007a and 2007b)



4.10 Education

Cycling use is at least somewhat related to the presence of a university or vocational college (Rietveld and Daniel, 2004). Waterloo Region and Halifax Regional Municipality are both home to large populations of post-secondary students. In Waterloo Region, there were a total of 14,259 students enrolled full-time at the University of Waterloo and Wilfred Laurier University in 2008; for the same year in Halifax Regional Municipality there were 18,090 students enrolled full-time at the Atlantic School of Theology, Dalhousie University, Mount Saint Vincent University, the Nova Scotia College of Art and Design, Saint Mary's University, and the University of King's College[11] (Table 4.3).

Waterloo Region had a 2008 university enrollment of 12.0 per capita, whereas in Halifax Regional Municipality there was a university enrollment of 17.3 per capita. According to Rietveld and Daniel (2004) these data favour greater cycling-use in Halifax Regional Municipality.

[11] Enrollment statistics were obtained from the Association of Colleges and Universities of Canada (C. Lachance, personal communication, November 3, 2010); 2008 Population Estimates were based on the Census Metropolitan Areas (Statistics Canada, 2008a).

Table 4.3: 2008 University enrolment per capita (C. Lachance, personal communication, November 3, 2010)

	Enrollment	Population	Per Capita
Halifax Regional Municipality	18090	388300	17.3
Region of Waterloo	14259	476400	12.0

4.11 Safety

Since statistics concerning fatalities and serious injuries are not available for the specific study areas, provincial averages of fatalities and serious injuries were analysed to provide an indication of differences in the overall level of safety between Halifax and Waterloo.

Between 1998 and 2008 in Nova Scotia, cyclists represented 1.39 percent of the 936 total fatal collisions; in Ontario, cyclists represented 2.47 percent of the 8219 total fatal collisions. Of the total collisions resulting in serious injury in Nova Scotia between 2002 and 2006, cyclists were victims of 1.61 percent of 1611 collisions. In Ontario, between 1998 and 2007, cyclists sustained major injuries in 3.55 percent of the 39,411 collisions resulting in major injuries.

Taking into consideration both the average number of collisions in each province and the number of vehicle-kilometres travelled (vkt) in 2008, it can be calculated that although the overall likelihood of a fatal collision (all vehicle types) in Nova Scotia (1:104,367,141 vkt) is greater per vkt than in Ontario (1:138,240,297 vkt), the likelihood that a cyclist is the victim of a fatal collision is 25.5 percent greater in Ontario than in Nova Scotia. The same inversion is true for collisions resulting in serious injuries; the overall likelihood of a collision resulting in a serious injury (all vehicle types) in Nova Scotia is 1:27,562,384 vkt, and 1:28,829,438 vkt in Ontario, while the likelihood that a cyclist is seriously injured in a collision is 52.4 percent greater in Ontario.

It can be gathered that cyclists' involvement in collisions resulting in either serious injury or fatality is greater in Ontario than it is in Nova Scotia per vehicle kilometre travelled. In turn, this suggests that cyclists in Halifax are less likely to be seriously injured or killed than those in Waterloo[12].

4.12 Cycling Infrastructure

A simple quantitative comparison of cycling routes between jurisdictions can be troublesome, owing to differences in city size, variety of classification methods employed, and inconsistent monitoring. It was coincidental that both the Region of Waterloo and Halifax Regional Municipality produced bicycle facility mapping using 2008 data; otherwise, precise data specific to on and off-road facilities would likely have been difficult to obtain. According to measurements from maps produced by each of the governments, the Region of Waterloo study area had approximately 109.7 kilometres of bike routes in 2008 (20.1 off-road, 89.6 on-road) (Region of Waterloo, 2004), while the Halifax study area had approximately 49.3 kilometres of routes (6.8 km off-road, 42.5 km on-road) (Halifax Regional Municipality, 2009). However, these figures must only be considered rough estimates. The Halifax Regional Municipality website claims that there were approximately 70.4 kilometres of on and off-road bicycle lanes in 2008, while information on the Region of Waterloo website estimates there to be approximately 270 kilometres of bicycle routes in the Region for the same year. Although differences based on the adjusted boundaries of each of the study areas are to be expected, it would appear that there are disparities which are unaccounted for. Some of the differences could be explained by the date the distances were calculated in 2008 or to the inclusion of different facility types (multi-use trails, on-road routes, off-road paths, or wide curb lanes).

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[12] It should be noted that the provincial collision data may not accurately reflect trends in each of the study areas, since the quality of transportation infrastructure can vary significantly.

As a result, a conclusion regarding the differences in the total distance of bicycle routes is limited to the general observation that the Waterloo study area appears to have had a much more extensive network of on-road and off-road bicycle facilities than Halifax in 2008, based on estimates of the total distance of bicycle routes as well as the size and density of the study areas[13].

Although measuring the overall length of a bicycle route network is an important component in an evaluation of its quality or effectiveness, it is important to acknowledge that several other variables would contribute to a better assessment of the level of infrastructure difference between Halifax and Waterloo, including: the overall connectivity of the route segments, how well the routes satisfy trip demand (between popular origins and destinations); surface maintenance; interaction with other traffic; and number of barriers or intersections along route segments, and signage. Such an analysis would ideally be carried out on a case study or comprehensive scale and is not within the scope of the present thesis.

4.13 Policies

Rietveld and Daniels (2004) use the term 'policy efforts' to describe, "…the actions and… the results of the actions taken by local authorities in order to improve the ease of cycling and to encourage the use of the bicycle as a means of transport." (p. 540) Rietveld and Daniels (2004) and other researchers (Pucher and Buelher, 2006; Dill and Carr, 2003) have carried out detailed bicycle policy reviews that investigate a variety of specific factors, such as: the number of stops or turns off imposed on cyclists per unit distance; the number of times cyclists have to ride one behind the other; vibration related to surface texture; the

[13] Had more precise figures been available for the total distance of bicycle routes for the two study areas, a more accurate statistic based on population density and total distance of vehicle roadways might have been helpful. However, since the input variables were limited to rough estimations, general observation remains the most practical method of analysis.

percentage of the trips for which riding a bicycle is faster than riding a car; residents' satisfaction levels with municipality bicycle policies; quality of the bicycle network and bicycle racks; vehicle parking prices; and broader factors, including the plans adopted by municipalities, higher level policy documents, and the number of employees who are fully or partially focused on bicycling or bicycle infrastructure projects.

Section 4.13 provides an overview of provincial and municipal level policies affecting cycling in Halifax and Waterloo. Existing policies that are identified will not be evaluated in terms of cost, administrative ease, legality, or political acceptability, as is often carried out in more thorough policy analysis. In keeping with the period of study for the thesis, policies adopted after 2008 will not be examined.

Cycling is affected by various policies at different levels of government in Waterloo and Halifax; the following provides an overview of the cycling-related content in those policy documents.

4.13.1 Provincial transportation policies.

Certain aspects of cycling are addressed in Nova Scotia's Motor Vehicle Act (1985) and Ontario's *Highway Traffic Act* – policy documents that regulate the use of public and private highways for the safety and best interest of their users.

In both acts, provisions address bicycle lights, helmets, signaling, passing, and operation in traffic. In both provinces, cyclists may ride bicycles on any public or private highway unless indicated otherwise, are not permitted to ride on sidewalks, and must ride as far as safely possible to the right side of the road right-of-way. Paragraph 148 (4) of the Ontario *Act* requires all drivers "… in charge of a vehicle on a highway meeting a person travelling on a bicycle [to] allow the cyclist sufficient room on the roadway to pass." In Nova Scotia, a similar provision not only applicable to cyclists requires vehicle operators to allow vehicles to pass where it is safe to do so[14]. Both in Ontario and Nova Scotia, bicycles must be equipped with lights on the front and rear and with a bell or horn. Both provincial Acts contain provisions requiring adults and children to wear helmets, but also extend power to departmental Ministers to legislate exceptions to the rule; in Ontario, *Regulation 610* under the *Highway Traffic Act* exempts cyclists who are 18 years and older from wearing a helmet. All Nova Scotian cyclists must wear helmets, whereas in Ontario only cyclists under the age of 18 are required to wear helmets. Both Acts also describe the proper methods of hand-signaling for turns and for stopping, specify that cyclists are not permitted to attach themselves to other vehicles, and prohibit cyclists from riding with more people than bicycles are designed to accommodate. The Nova Scotia Act specifically prohibits cyclists from riding without hands on handlebars, without feet on pedals, and from practicing tricks or 'fancy riding' on highways.

4.13.2 Provincial planning policies.

The Ontario Planning Act (1990) and the Nova Scotia Municipal Government Act (1998) provide legislative frameworks for regional and community planning. The Planning Act (1990) dictates the contents for Official Plans for upper-tier municipalities and lower-tier municipalities and delegates power to municipalities to enable them to make planning-related decisions. Provisions relevant to cycling include those that empower municipalities to require land owners to provide parking facilities (presumably including bicycle parking) and impose conditions on subdivisions or developments related to "pedestrian pathways, bicycle pathways, and public transit rights of way…"

[14] As this thesis was being written, an amendment to the Nova Scotia Motor Vehicle Act was assented to that requires drivers to leave at least one metre of space between the vehicle and the cyclist (Bill No. 93, 2010).

The Nova Scotia Municipal Government Act (1998) provides the framework for regional and community planning, but contains no cycling-related provisions. *Regulation 101* of Nova Scotia's Act (Statements of Provincial Interest) is similar in nature to Ontario's Provincial Policy Statement (PPS) (Province of Ontario, 2005), discussed in section 4.13.3 (page 86), but does not contain any provisions relevant to cycling.

4.13.3 Ontario Provincial Policy Statement.

All planning-related decisions in Ontario must be made in accordance with the policies in Ontario's Provincial Policy Statement (Province of Ontario, 2005), several of which are relevant to cycling. The most relevant policy requires the promotion of a land-use pattern and density that "…minimize[s] the length and number of vehicle trips and support[s] the development of viable choices and plans for public transit and other alternative transportation modes, including commuter rail and bus." A housing policy commits municipalities to promote "densities for new housing which… support the use of alternative transportation modes…" Other policies in the PPS commit municipalities to work towards safe, environmentally friendly, and healthy and active communities, which "…facilitate pedestrian and non-motorized movement, including, but not limited to, walking and cycling."

4.13.4 Regional municipal planning policies.

The governance structures of the Region of Waterloo and Halifax Regional Municipality are similar. The Waterloo Region is considered an Upper-tier Municipality and planning is governed by a document called the Regional Official Plan (ROP) (1995); Lower-tier Municipalities and incorporated areas are required to develop official plans in keeping with the provisions of the ROP. Planning in Halifax is governed by the Regional Municipal Planning

Strategy (RMPS) (2006); sub-regions within the municipality have Secondary Planning Strategies in keeping with the RMPS. Planning strategies for more specific locales, such as neighbourhoods or business districts, also exist for both study areas.

The Waterloo ROP (1995) and Halifax's RMPS (2006) are compared in the following paragraphs in terms of cycling-related content.

The Waterloo ROP envisions "a greater comfort for pedestrians and cyclists" by 2016 and a number of policies support this vision. For example, future maintenance and improvement of the 'Regional Road' system must involve the consideration of the needs of cyclists. Several policies provide direction to Area Municipalities; according to the ROP, Area Municipalities are encouraged to promote non-automobile transportation including cycling, required to encourage site plans that promote cycling, and are encouraged to develop bicycle facilities in connection with transit infrastructure. In Waterloo's ROP, the Region also commits to work towards acquiring abandoned rail corridors for their possible future use as cycling routes and commits to working with the Area Municipalities to establish a structure for a cycling network.

Halifax's RMPS (2006) contains a number of policies and provisions that relate specifically to cycling and the development of cycling infrastructure. Policies in the RMPS commit the Municipality to include requirements for the provision of bicycle parking in land-use by-laws and to develop a Transportation Master Plan, which is to include functional plans addressing transportation demand management and active transportation. The RMPS also mentions the development of an Urban Design Guidelines Functional Plan, which would include elements addressing bicycle travel. Finally, the RMPS commits to including alternative transportation infrastructure projects, such as dedicated bicycle and pedestrian facilities, in future municipal road projects.

4.13.5 Municipal level planning policies and land use by-laws.

Owing to differences in the governing structure of the study areas, the contents of the municipal level planning policies differ. In the Waterloo study area there are municipal level plans for the cities of Waterloo, Kitchener, and Cambridge. Since each of these cities has its own planning department, and each employs different approaches, the contents and focus of their plans are not as uniform as those in effect in the Halifax study area. Under HRM's Regional Municipal Planning Strategy (2006) there are separate planning documents for many sub-regions. In relation to the study area defined for the present thesis, there are seven sub-regions with their own municipal plans and land use by-laws, most of which contain similarly structured provisions and content. The cycling-related contents of the plans in effect for both study areas are introduced below.

4.13.5.1 Region of Waterloo study area municipal level plans.

Three Official Plans for each of the Area Municipalities operate within the framework of the Waterloo ROP: the City of Waterloo Official Plan (1990), the City of Kitchener Official Plan (1995) and the City of Cambridge Official Plan (1997). Each will be considered separately.

One of the primary objectives of the City of Waterloo Official Plan (1990) is to develop an urban form that encourages greater use of alternative forms of transportation and reduces automobile dependency. According to the Waterloo Official Plan, commercial, institutional, recreational, mixed use, and high and medium density residential land developments should be located to facilitate access to convenient and safe cycling linkages. This Plan also contains policies that refer to the development of a Community Trail/Access Link System and others that encourage the installation of bicycle racks throughout Nodes, along Corridors, and in close proximity to transit stations. The development of a linked Open Space system of trails, including off-road bicycle paths, is separately discussed in the Parks and Open Space section of the Plan. The City of Waterloo zoning by-laws do not contain any provisions related to bicycles, apart from permitting community trails in a variety of parkland zones.

Providing a balanced transportation system that is integrated with community trail links and neighbourhood development to improve and encourage pedestrian and bicycle use is one of the principles of the City of Kitchener Official Plan (1995). Another principle is to plan community centres, nodes, corridors, and commercial campuses to provide easy access to cyclists. Transportation policies support and encourage a number of specific features: developing a bicycle route network of lanes, routes, and paths; designing roads to reduce the risk of accidents and injuries to cyclists; encouraging bicycle parking, in general and specifically at transit terminals; encouraging shower and change facilities where appropriate; and cycling education and awareness programmes. According to Kitchener's Official Plan, the City is also committed to undertaking a bicycle and pedestrian study as part of the development of a comprehensive active transportation network. The Plan also expresses support for bikeway trails, downtown pathways and bicycle racks, and the integration of cycling facilities with mixed use nodes and corridors, medium-rise residential uses, and neighbourhood mixed-use centres. Cycling-related policies for Special Policy areas and in Secondary Plans are repetitions of statements in the general provisions.

The City of Cambridge Official Plan (1997) expresses support for a bicycle-friendly trail system and enhanced transportation options for cyclists and other alternative modes. More specific support is mentioned for the acquisition of abandoned rail lines, and for cycling facilities to be integrated with Community Core Areas, Nodes, and other community services and facilities. The Plan also supports the incorporation of pedestrian and cycling features into site plan development. Additional support for cycling (sometimes in general, on occasion with specifics) is expressed in some Special Districts.

4.13.5.2 Halifax study area municipal level plans.

There were seven municipal level plans in effect in 2008 in the Halifax study area. Cycling-related elements of each are discussed below.

One of the objectives of the Bedford Municipal Planning Strategy (1996) is to develop a transportation network that encourages the movement of pedestrians and cyclists. The Plan also expresses the intention that sidewalks and bicycle routes to the 'waterfront project area' should be developed and that landscaping should be designed for appreciation by cyclists. Reference is made to the encouragement of cycling use in the Bedford South Secondary Plan, which contains discussions of cycling-friendly road design and a regional trails system. However, no policies reinforce those objectives. In the Bedford West Secondary Plan, a policy states that the design of new neighbourhood streets should accommodate cyclists in the Residential Neighbourhood designation. Bicycle storage facilities must be considered as part of developments in the Community Commercial Centre and Mixed Use Business Campus designations in Bedford West.

Transportation policies in the Municipal Planning Strategy for Dartmouth (1978) discuss the investigation and future implementation of bikeways of various route types. A policy commits council to consider pedestrian and bicycle facilities "in all contracts." Bikeways are also mentioned in discussion of a future Recreation Master Plan. The Pinecrest – Highfield Park Secondary Plan emphasizes the need to increase pedestrian access and mentions the desire to have a safe pedestrian and bicycle connection constructed between a residential community and a heavy commercial area. The Morris – Russell Lake Secondary Plan contains a rather firm policy committing the Municipality to implement bicycle facilities:

> A series of trails for pedestrians and cyclists shall be established within the secondary plan area which link residents with commercial, employment and other activity centers and to public transit facilities and, where feasible, to regional trail systems which are

> developed or planned. Without limiting the foregoing, the Municipality shall establish a multi-use trail between the secondary plan area and the Woodside Ferry Terminal.

The Downtown Dartmouth Secondary Plan (2000) endeavours to provide a balanced transportation system that includes cycling facilities. According to the Plan, future infrastructure upgrades should incorporate access for cyclists. Among the goals of a future 'Recreation and Open Space Master Plan' is the development of a bicycle-friendly environment Downtown. The Plan also commits to extending a portion of the Trans-Canada Trail to encourage bicycle travel.

The Halifax Municipal Planning Strategy (1978) contains general policies and objectives for the entire Plan area as well as five secondary level plans with more locally specific planning goals. One of the Strategy's transportation policies addresses cycling directly:

> The City should develop a program for the systematic development of bicycle, pedestrian, and skiing pathways. The initial focus of the program should be on the connection of City parks and scenic areas by such pathways. The City should attempt to supplement the options available in journey-to-work travel modes by providing bicycle pathways.

The Secondary Planning Strategies under the Halifax Municipal Planning Strategy (1978) contain a variety of provisions related to cycling. For example, the integration of bicycle facilities is a potential condition of new development in the Bedford Highway and Wentworth areas. Encouragement of cycling transportation is mentioned in the Western Common Area Plan, the Wentworth Strategy, and in the Bedford West Plan. In the Mainland South and the Peninsula North Secondary Plans, specific cycling-related projects or plans to develop projects are discussed.

In the Sackville Municipal Planning Strategy (1994), general support for the encouragement of bicycle and pedestrian access is expressed, as is the specific goal of developing pedestrian and bicycle access between the adjacent towns of Bedford and Sackville.

The Sackville Drive Secondary Plan (2002) calls for a greater emphasis on transportation demand management, including greater cycling use, and also contains policies addressing the need for specific active transportation linkages between several land use activity nodes.

There are no references to cycling or trails in the Cole Harbour / Westphal Municipal Planning Strategy (1992).

In 2006, Halifax Regional Council approved an amendment that added bicycle parking provisions and definitions to all of the land-use by laws in effect in the study area secondary plans. The provisions dictate the quantity and type of bicycle parking that must be provided as part of the development of specific types of land uses (see Table 4.4). The by-laws also describe the minimum dimensions of parking spaces and contain provisions for design, access, and site requirements.

Table 4.4: Bicycle parking requirements (Halifax study area Land Use By-Laws)

Use	Bicycle Parking Requirement
Multiple Unit Dwelling	0.5 spaces per dwelling unit 80% Class A, 20% Class B
Hotels/ Motels/Inns	1 space for every 20 rooms 80% Class A, 20% Class B Minimum 2 Class B spaces
General Retail, Trade and Service, Food Store, Shopping Centre, Restaurants	1 space per 300m² GFA 20% Class A/ 80% Class B Minimum 2 Class B spaces
General Office, Banks, Medical, Clinics, Institutional Uses, Government Buildings	1 space per 500m² GFA 50% Class A/ 50% Class B Minimum 2 Class B spaces
Auditoriums, Theatres, Stadiums, Halls	1 space for every 20 seats 20% Class A/ 80% Class B Minimum of 2 Class B spaces Maximum of 50 spaces
Schools, Colleges, Universities	1 space for every 250m² GFA 20% Class A/ 80% Class B
Recreation Facilities, Community Centres, Libraries	1 space per 200m² GFA 20% Class A/ 80% Class B Minimum of 2 Class B spaces
General Industrial Uses	1 space per 1000 m² GFA 80% Class A/ 20% Class B Minimum of 2 Class B spaces Maximum of 20 spaces
Commercial Parking Structures/Lots (>20 Motor Vehicle Spaces)	5% of motor vehicle parking provided Minimum of 2 Class B spaces Maximum of 50 spaces
Any Uses Not Specified Above	1 space per 500 m² GFA 50% Class A/ 50% Class B

4.13.6 Regional transportation plans.

Although Halifax Regional Municipality is on track to develop a Transportation Master Plan within the next several years, the Municipality does not currently refer to a Master Plan for direction. As such, only the Transportation Master Plan for the Region of Waterloo is discussed herein. It should also be noted that the cities of Waterloo and Kitchener are currently developing Transportation Master Plans of their own.

Approved in 1999, the Regional Transportation Master Plan (TMP) (1999) consists of a Regional transportation vision, a forecast of future demands, and a detailed plan to manage and accommodate anticipated demands.

The TMP is based on an 'Auto Reduction' approach focused on reducing some of the use of private autos "…through a commitment to practical Transportation Demand Management strategies." The majority of the TMP focuses on Transportation Demand Management (TDM). Of fourteen strategies to improve transportation in Waterloo Region, several are expressly relevant to cycling:

1. Hire a Transportation Demand Management Coordinator
2. Establish priority networks for improvements to bicycle and pedestrian treatments
3. Meet with area municipalities to initiate discussion for developing land use plans to support the Regional Transportation Master Plan
4. Improve TDM consideration in the site design process
5. Routinely make road projects bicycle, pedestrian and transit friendly
8. Educate the public regarding auto reduction and TDM initiatives

Although the strategies are not binding upon Council, they do influence decision-making and resource allocation. Each strategy is discussed in the TMP. Directional components and timeframes discussed for each strategy provide good indications of intention; these are provided below for the sections most relevant to cycling:

> The Region of Waterloo will appoint the TDM Coordinator who can the liaise with Federal and Provincial agencies with respect to TDM activities at the senior levels of government and can co-ordinate the activities within and among the area municipalities within the Region. (Strategy # 1)

The initial identification of a program for bicycle and pedestrian treatments should be presented to Council within six months of the appointment of the TDM Coordinator. (Strategy #2)

The review of plans for transportation implications will be immediate. The Region will prepare “check list” guidelines within six months of the appointment of the TDM Coordinator. (Strategy #3)

The Regional Transportation Division, in conjunction with the Area Municipal Planning staff, will develop site design guidelines to ensure transit, bicycling and walking provisions are incorporated into site plans. (Strategy # 4)

The Region, in consultation with the area municipalities and the transit authorities, will develop design guidelines for the incorporation of enhancement techniques for bicycle, pedestrians and transit facilities that are incorporated into roadway projects. (Strategy # 5)

The Region’s proposed TDM Co-ordinator will develop typical transportation demand management measures and contact schools, universities and community groups, to advise and educate them [about] the benefits associated with TDM. The program that is developed will also include media releases, flyers, etc. (Strategy #8)

4.13.7 Cycling plans.

Both the Halifax and Waterloo study areas approved planning documents that provide guidance for the implementation of bicycle facilities. The cities of Kitchener and Cambridge completed Bicycle Plans of their own in 2010, but these plans do not apply to the period of study.

4.13.7.1 Region of Waterloo Regional Cycling Master Plan.

In 2004 Regional Council approved the Regional Cycling Master Plan (2004). The following paragraphs provide brief summaries of noteworthy components of the Regional Cycling Master Plan, which is structured around four elements: the cycling network; design strategies; supporting initiatives; and policies.

Cycling network

The Regional Cycling Network routes were selected based on considerations of user needs and the outcomes of a route selection process. The selection process resulted in the definition and prioritization of two levels of cycling routes: the Core Network (years 1 to 10) and the Long Term Network (years 11 to 20+). The Core Network is "…based on the concept of providing continuous corridors in both east-west and north-south directions throughout the major urban centres of Cambridge, Kitchener and Waterloo," while the Long Term Network "includes those routes in the Regional Network that have not been developed as part of the Core Network." The intention of the Long Term Network is to "improve the density of the network and [expand] the network to other areas where demand is less." (p. 26)

Map 2 of the Regional Cycling Master Plan (2004), which shows the existing and approved cycling routes in Waterloo Region, is attached herein as Appendix 10.

Design strategies

A thorough guide of typical cycling facility types and designs to be applied in concert with the Regional Cycling Network are presented in this section of the Master Plan. Various route types, including bike lanes, shoulder bikeways, wide curb lanes, off-road multi-use trails, and boulevard multi-use trails are defined and discussed. Design features, such as bike lanes at intersections, bridges, and roundabouts, are also analysed.

Network support strategies

The Master Plan acknowledges that a network of bike paths and lanes needs to be accompanied by infrastructure and maintenance that complement the use of bicycles for recreation and transportation. In this section of the Plan, criteria to be considered when installing bicycle parking are highlighted, including: quality of the facility, accessibility, and protection from weather and theft. On and off-road maintenance issues are also highlighted; topics addressed include: street sweeping and debris removal, snow plowing, pothole and surface irregularities, and signs and pavement marking.

Policies

The Regional Cycling Master Plan contains a series of policies to guide staff and Council. The following are concise versions of these policies:

Cycling is to be viewed and supported as a viable and desirable mode of transportation.

The 'fundamental enforcement policy' is to educate motorists and road users about cycling-related elements from Municipal By-Laws and the Highway Traffic Act.

The Regional Cycling Network is to be phased in over time: the Core Network will be implemented within 10 years, while the Long Term Network will take 20 years.

The design of facilities will be based on the guidelines established in the Cycling Master Plan.

The maintenance, construction, and funding of the Regional Cycling Network will be shared by the Region and Area Municipalities.

The Region will support the introduction of various cycling-related initiatives by organizations working in co-operation with the Region, including safety courses and cycling promotion.

The Regional Cycling Advisory Committee will continue to exist and advise council.

Retired road and rail infrastructure will be considered for their potential incorporation into the Regional Cycling Network prior to being sold or used otherwise.

Infrastructure improvements such as bicycle-friendly grates and pothole repairs will be pursued on Regional roads.

4.13.7.2 Halifax Regional Municipality Active Transportation Functional Plan.

The Active Transportation Functional Plan (AT Plan) (2006) superseded the 2002 Halifax Regional Municipal Bicycle Plan: *Blueprint for a Bicycle Friendly HRM*.

The introductory chapters of the Active Transportation Functional Plan discuss the purpose, goals, objectives, and scope of the Plan and contain sections framing the Plan in legislation, and the current and expected conditions of the active transportation network. Chapters 4 and 5 are described below.

Chapter 4 of the Active Transportation Plan describes the Plan's recommended active transportation network. The AT Plan has the following objectives:

> Make Active Transportation modes more convenient and less risky by removing barriers to walking, cycling (including youth oriented travel) and improving connections to public transit in the Region;
>
> Provide a connected off-road and on-road AT network to visitors as a premier tourism asset;
>
> Encourage more people to walk, cycle, inline skate, etc. more often by providing them with connections to where they want to go; and
>
> Support efforts to achieve a greener and healthier Halifax Region by encouraging residents and visitors to choose Active Transportation modes and to reduce greenhouse gas emissions through decreasing dependency on the private automobile for travel, especially for short distance trips.

The Plan is based upon the establishment of a system of primary "spine" routes and secondary "community" routes and each is further categorized into facilities for pedestrians and cyclists. The route selection criteria include: risk assessment; connectivity/access; convenience; attractiveness; cost; and route alignment. Primary routes were planned to connect activity nodes, including: commercial, employment, institutional, rural communities, and residential and tourist destinations. The AT Plan describes the primary route facilities as "…primarily on-road bike (bike lanes, paved shoulder bikeways, signed-only routes) and some major 'regional' linear off-road multi-use trails." The Plan notes that higher-order facilities, such as dedicated bike lanes, will be employed for primary routes where possible, but that many arterial and collector roads cannot provide the necessary road width for such facilities. Secondary "community" bicycle routes are intended to feed into the primary routes and are sometimes less direct than the primary system. The routes are described as consisting, "…primarily of on-road bike facilities (bike lanes, paved shoulder bikeways, signed-only routes) and some major "regional" linear off-road multi-use trails," with facilities that "…consist mostly of signed-only bike routes on local residential or collector streets as well as off-road multi-use trails." A map from the AT Plan that shows proposed cycling routes and trails is provided as Appendix 11 herein.

Chapter 5 of the AT Plan describes the implementation strategy and provides recommendations to Regional Council, staff, and various Provincial government agencies. Concise versions are noted below:

1. Adopt in principle the vision, goals, objectives, and network development approach contained in the report and the companion document: planning and design guidelines, draft trail by-law.

2. Make Active Transportation modes more convenient and less risky by removing barriers to walking and cycling and improving connections to public transit.

3. Support efforts to achieve a greener and healthier Region by encouraging residents and visitors to choose Active Transportation modes as part of a commuting and fitness regime and to reduce greenhouse gas emissions through less automobile dependence.

4. Continuously monitor the AT Plan with a focus on the central goal of doubling the number of people who use AT modes.

5. Proceed with drafting a formal municipal by-law that adheres to the intent of the Draft Trail By-Law and work with the RCMP on region-wide enforcement.

6. Use the technical recommendations and the Appendix: Facility Planning, Design Guidelines and Draft Trail By-Law to implement the Active Transportation Plan.

7. The implementation schedule and phasing approach contained in the AT Plan should guide implementation.

8. Allocate three full-time equivalent [municipal staff] positions to implement the AT Plan.

9. Expand the mandate of the HRM Bikeways Advisory Committee to include Active Transportation.

10. Begin a process for the possible transfer of multi-use off-road trail facilities from community organizations where these assets form part of the AT spine network.

11. Begin discussions with land owners to secure easements, options or agreements of purchase and sale for the AT network.

An implementation schedule for the AT Plan is described in Chapter 5; a timeline is provided, which recommends reviewing and updating the plan every five years.

4.13.8 Overall policy comparison.

The comparison of cycling policy between jurisdictions is not simple, particularly when the topic is meshed by legislation. Since structure and content of the policy documents is rather similar between Halifax and Waterloo, it is difficult to identify if policy support was greater in one place, or in the other. Further, where differences exist, it is difficult to weigh policy shortfalls against each another.

While it might be assumed that Ontario's provincial cycling-related policies are stronger than Nova Scotia's, since cycling is referred to in several times in Ontario's Provincial Policies Statement, this conclusion cannot be made so directly. Nova Scotia's Motor Vehicle Act (1985) requires all of the Province's cyclists to don helmets, expressly prohibits cyclists from riding without hands on handlebars and feet on pedals, and also prohibits them from riding unsafely. These small safety provisions, when they are well enforced, have the potential to be highly effective ways of improving safety for cyclists and all road users. On the other hand, since the few bicycle-friendly policies in Ontario's PPS (Province of Ontario, 2005) must be adhered to in every jurisdiction of the Province, they could have a much greater impact than those specific safety-related provisions in Nova Scotia.

At the regional level, both Halifax's Regional Municipal Planning Strategy (2006) and the Region of Waterloo's Official Plan contain statements in support of cycling. Both jurisdictions commit to considering the incorporation of bicycle facilities into all future road improvement projects and contain a host of provisions that encourage the incorporation of bicycle facilities in various forms. However, policies that are binding upon government with words such as 'shall' or 'will' and tend to require municipalities to act are scant in both regions. The Region of Waterloo's Official Plan requires the government to work towards acquiring abandoned rail corridors for bike and pedestrian trails and to work towards the establishment of a structure for a future cycling network.

In comparison, the few binding policies in the Halifax Regional Municipality's RMPS (2006) seem to have a greater reach. The RMPS requires that provisions be added to land use by-laws that require developers and property owners to install bicycle parking facilities next to commercial, institutional and medium and high density residential developments. The RMPS also contains specific goals for the development of a Transportation Master Plan, which is to include several Functional Plans, some of which are referred to above.

At the municipal level, planning documents for both study areas contain a myriad of policies and provisions that express general support for bicycle-friendly design and encourage bicycle routes and parking facilities. Municipal level plans in effect in both study areas also contain several more specific policies that bind the municipalities to extend specific portions of trails, to carry out bike studies, and to consider the incorporation of pedestrian and cycling features into development site plans. An evaluation of which study area's cycling-related policies are more thorough or effective is not within the scope of this research; however, it appears as though the nature of the municipalities' cycling-related policies is similar.

The Transportation Master Plan (1999) for the Region of Waterloo seems to provide helpful direction for auto reduction targets and sets objectives for transportation demand management. Since Halifax has not yet developed a transportation master plan, the Region of Waterloo is likely at an advantage in this respect[15].

The bicycle plans for Halifax and Waterloo have similar objectives for the development of their route networks; both contain two separate categories of routes – a priority network and a support network – and both contain short and long term development goals. The Region of Waterloo's bicycle plan also contains an extensive section describing design guidelines for bicycle facilities, which should be helpful to planners and decision makers, although these resources are also available elsewhere and are constantly changing. Although cycling and walking are separate modes of transportation, Halifax Regional Municipality's AT Plan benefits from its consideration of both modes in one document, whereas the Waterloo Plan is exclusive to bicycling.

Perhaps the most important difference between the Halifax and the Waterloo bicycle plans is revealed in their concluding sections. The Region of Waterloo Bicycle Plan concludes with a series of policies, which upon the plan's adoption presumably have the influence of binding council to taking action, in principle, on those policies. In contrast, the Halifax Regional Municipality Active Transportation Functional Plan (2006) concludes with a series of recommendations; when adopted, presumably, councilors must only consider the recommendations made in the AT Plan.

The most notable differences in policy between the Halifax and Waterloo study areas are the binding nature of the policies in the Region of Waterloo Bicycle Plan; the cycling-related transportation policies in Ontario's *Provincial Policy Plan*; the land-use by law

[15] At the time of the writing of this thesis, the regional governments in both study areas were developing new transportation master plans.

provisions in Halifax requiring bicycle parking for a variety of land use developments; and the Motor Vehicle Act (1985) policies which require helmets for all bicyclists and prohibit cyclists from driving dangerously in Nova Scotia.

The scope of the present thesis does not include an investigation into the effectiveness of the aforementioned policies. Without such an investigation, and considering the relative similarity of bicycle policies, it is impossible to simply choose which study area has a more robust foundation of bicycle policy. As such, while there are a number of policies supporting and encouraging the growth of cycling and the safety of cyclists in each of the study areas, it can only be concluded that there are clear shortfalls in both jurisdictions.

Although the policies reviewed herein above are appropriate in an analysis combined with the Bike Study survey, which concluded in 2008, it is important to note that substantial differences in policy and infrastructure exist between the end period of study for this thesis (2008) and when it was completed. For example, in Waterloo Region, the City of Waterloo completed a draft Transportation Master Plan in 2010 which contains new goals and objectives for active transportation, the City of Kitchener completed a new Cycling Master Plan in 2010, and the City of Cambridge completed a Bikeway Network Master Plan in 2008.

As well, an evaluation of how well the goals and objectives contained within the previously developed policy documents have been addressed since the adoption of those documents is necessary in order to draw conclusions regarding which study area is more effectively addressing shortfalls in cycling. Such an analysis, including, for example, a before and after assessment of the cycling route networks in each of the study areas or a similar assessment of cycling promotion efforts, would greatly strengthen this review of cycling-related policy.

4.14 Conclusion

In relation to factors which have been shown to influence cycling, Part 1 of the analysis has revealed several differences between Halifax and Waterloo. While a consideration of these differences along with the cycling-use data for each of the study areas enables some conclusive suggestions regarding the influence of these factors on cycling in each study area, it is necessary to emphasize the relatively basic nature of these analyses. Many of the comparisons in Part 1 of the analysis are based on data averages and are limited to generally identifying which study area is better positioned with respect to the variable being analysed based on previous research. Analyses involving a greater number of study areas and, as identified throughout Chapter 4, approaches measuring the variables in greater detail, considering the range and variability of data, would provide greater strength to the findings.

The observation that the two study areas are better positioned in comparison with the other in an equal number of cycling-related variables is accurate; however, since the variables are quite different in scale and effect on cycling, and since many are not controllable variables, the question of which study areas wins more categories is not overly relevant. Instead, what Table 4.5 and, more broadly, what Chapter 4 has shown, is that there are a number of notable differences and similarities between Waterloo and Halifax in terms of cycling and cycling-related variables.

Table 4.5: Summarized results of analyses into cycling-related variables in the Halifax and Waterloo study areas

	Halifax	Waterloo
City size and Density		
Size (hectares)	9031.4	**7450.5**
Density (units / ha)	15.59	**23.61**
Weather		
Mean temperature (°C)	7.4	**7.64**
Precipitation	112.1	**76.95**
Max wind speed (km/h)	**68.69**	75.3
Topography (avg. slope %)	2.67	**2.55**
Public transit and auto use		
Transit ridership (per capita)	**62.52**	37.45
Autombile use (%)	**75.76**	87.98
Cost of owning and operating an auto (CAD $)	**3,095.38**	3,000.91
Number of autos per capita	0.58	0.56
Income (median, after tax) (CAD $)	**24,216.00**	26,187.00
Age (median)	39	**36.4**
Gender (% male)	47.98	**49.27**
Education (univ. enrollment per capita)	**17.3**	12
Safety		
1 cyclist death per (million vkt)	**7.51**	5.60
1 cyclist serious injury per (million vkt)	**1.71**	0.81
Cycling infrastructure (kilometres of bike routes)	49.3	**109.7**
Policies	undetermined	undetermined

Note: the results presented in this table are for summary purposes only; refer to the appropriate section within Chapter 4 for more accurate findings.

These results suggest that Waterloo's relatively young population with a slightly higher percentage of men could favour cycling use. Weather in Waterloo is generally better than in Halifax and the city size, density, and topography are also favourable to cycling when compared with Halifax. Waterloo also appears to have a more extensive network of bicycle routes, which could be the most important variable analysed.

In Halifax, cycling use is favoured by comparably higher public transit ridership and lower use of the private auto for commuting. The cost of owning and operating a vehicle is very slightly higher in Halifax than in Waterloo and the median income is lower – both variables support greater cycling use. Finally, the safety statistics for cyclists in Ontario and Nova Scotia indicate that cyclists in riding in Halifax are less likely to suffer a fatality or serious injury from a collision than cyclists in Waterloo. The extent of the analyses did not reveal which study area was better situated for cycling in regards to number of autos per capita and cycling-related policy.

Some of the findings from Chapter 4 will be further analysed in concert with the results of the statistical analysis of the survey results, which forms the basis of the following chapter.

Chapter 5: Part 2 of the Analysis, 'Bike Study' Survey

As mentioned in section 1.4 (page 4), the two main objectives of this thesis are first, to understand how variables relate to cycling use and cyclist type in Halifax and Waterloo, and second, to understand the general public's attitudes towards, and preferences for, cycling. Chapter 5 contributes to these objectives by analyzing the results of the Bike Study surveys. In Chapter 3, sections 3.4.2 (page 59) and 3.4.3 (page 59) include discussions of the categorization of the response variables analysed and of the statistical methods of analysis. The following paragraphs consider the statistically significant results of the Fisher's Exact Test (at a significance level of $p \leq 0.05$), which indicate that the differences in cell frequency revealed between the explanatory and response variables are unlikely to have occurred by chance.. While the differences in cell frequencies are typically not indicated, these can generally be inferred from the detailed results of the survey, provided as Appendix 3. As well, Appendix 9 (page 193) is a variable legend explaining the re-categorization of survey results and Appendix 12 is a table of the complete contingency analysis results for all of the explanatory variables.

5.1 Introduction to Analysis

In the following sections, the Bike Study survey results for Waterloo and Halifax are analysed in four ways. The overall method of analysis is to compare how the survey results from Waterloo and Halifax differ, in an effort to understand how cycling use and attitudes are influenced by the characteristics of each study area. The discussion forms the basis of Chapter 6. As discussed in Chapter 3, associations between the response variables 'bicycle use' and 'type of cyclist' and the many explanatory variables are measured. The following summarizes the layout of Chapter 5 analyses:

Section 5.2. Significant associations between 'bicycle use' and the explanatory variables for Halifax and Waterloo are compared.

Section 5.3. Significant associations between 'type of cyclist' and the explanatory variables for Halifax and Waterloo are compared.

Section 5.4. Significant differences in explanatory variables between Halifax and Waterloo are compared for all respondents regardless of cycling behaviour.

Section 5.5. Generalized findings regarding respondents' attitudes and preferences towards cycling in their communities are presented, separately, for Halifax and Waterloo.

Section 5.6. Significant associations are presented for Halifax and Waterloo responses combined (treated as one population) between the explanatory variables and both the 'bicycle use' and 'type of cyclist' response variables[16].

5.1.1 Variables' excluded from further analyses.

For nearly all 'household characteristic' explanatory variables (those relating to bicycle ownership, number of adults per household, and what these adults cycle for), significance of $p = 0.000$ was shown with 'type of cyclist' and 'bicycle use', except for 'number of adults who cycle to school per household.' This finding suggests that individual respondents' bicycle use, and what type of cyclists they are (utilitarian, recreational, or non-cyclist), are strongly related to bicycle ownership and, in general, household members' use of bicycles. These findings tell us two things: cyclists tend to own bicycles while non-cyclists tend not to (an obvious observation); and that cyclists tend to live in household with cyclists, while non-cyclists live in household with non-cyclists. However, since respondents themselves are considered members of their own households, their own cycling habits heavily influence this outcome and render the finding less interesting as well. Since these outcomes are not overly important or interesting and are consistent throughout, further analysis the 'household characteristics' explanatory variables will be limited. Similarly, association between 'bicycle use' and 'type of

[16]The combined survey results are excluded from the analysis in, keeping with the research objectives (see section 5.6 on page 132).

cyclist' was also *p* = 0.000 in all cases, confirming that non-cyclists don't cycle, that recreational cyclists tend to cycle less, and that utilitarian cyclists tend to cycle more; this finding was true in both Halifax and Waterloo.

5.2 Bicycle Use: Halifax and Waterloo Compared

The 'bicycle use' variable is derived from the number of times respondents use their bicycles per week for either recreational or utilitarian purposes. Results ranged from 0 times per week for non-cyclists to over 20 times per week.

Since the majority of the survey response data were nominal, the bicycle use information was re-categorized into three groups to facilitate contingency analysis: higher cycling-use (three or more times per week); lower cycling-use (less than three times per week); and no cycling-use (no times per week) (as provided in Appendix 9). Table 5.1 shows how respondents in Halifax and Waterloo vary based on cycling use.

Table 5.1: Survey respondents' levels of cycling use in Halifax and Waterloo

Cycling use category	Frequency	Percent
Waterloo		
High cycling-use	24	27.27%
Low cycling-use	35	39.77%
No cycling-use	29	32.95%
Halifax		
High cycling-use	20	29.41%
Low cycling-use	18	26.47%
No cycling-use	30	44.12%

Table 5.1 also reveals that 67 percent of Waterloo respondents use their bicycles for some purpose during an average week, while only 56 percent of respondents do in Halifax. And, despite this difference, the statistical analysis suggests that 'bicycle use' in Halifax is not significantly different from 'bicycle use' in Waterloo (*p* = 0.193).

Tables 5.2 and 5.3 show the significant associations between 'bicycle use' and various explanatory variables for Halifax and Waterloo.

Table 5.2: Variables significantly associated with 'bicycle use' in Halifax ($p \leq 0.050$)

Explanatory variables	*p* - values
<u>Bicycling habits</u>	
Consider bike rack usage on buses if more were installed (Halifax)	0.033
<u>Household characteristics</u>	
Bicycle ownership	0.000
Number of bikes per household	0.000
Number of adult cyclists per household	0.000
Number of utilitarian adult cyclists per household	0.000
Number of adults who cycle to work per household	0.004
Number of adults who cycle to shop or run errands per household	0.000
Number of adults who cycle to visit friends per household	0.000
Number of adults who cycle for recreation per household	0.000
<u>Demographics and geography</u>	
Travel distance between residence and work or school	0.024
<u>Mode choice</u>	
Mode choice influences: Travel time	0.031
Availability of public transit	0.032
<u>Climate and comfort on different facility types</u>	
Likeliness of cycling on days with: High humidity*	0.002
Comfort on: Major roads with bike lanes*	0.037
<u>Attitudes and preferences</u>	
Elements respondents assert would encourage them to cycle more:	
A reduction in speed maximums for road users	0.018

* data gathered from cyclists only

Table 5.3: Variables significantly associated with 'bicycle use' in Waterloo (p ≤ 0.050)

Explanatory variables		*p* - values
Bicycling habits		
Use of bike racks on GRT buses (Waterloo)		0.003
Household characteristics		
Bicycle ownership		0.000
Number of bikes per household		0.000
Number of adult cyclists per household		0.000
Number of utilitarian adult cyclists per household		0.000
Number of adults who cycle to work per household		0.000
Number of adults who cycle to school per household		0.004
Number of adults who cycle to shop or run errands per household		0.000
Number of adults who cycle to visit friends per household		0.000
Number of adults who cycle for recreation per household		0.000
Demographics and geography		
Age		0.007
Gender		0.015
Employment		0.007
Climate and comfort on different facility types		
Likeliness of cycling on days with:	Light rain*	0.000
	Light snow*	0.007
	High humidity*	0.000
	Cold temperature*	0.010
Attitudes and preferences		
Elements respondents assert would encourage them to cycle more:		
Nothing		0.003
More on-street bike lanes or paved shoulders		0.010
More off-street bicycle paths		0.019
Better bicycle route signage		0.004
Better education for motorists		0.017
Less truck traffic		0.023
Respondents' reasons for not cycling more for utilitarian purposes:		
Too many trucks		0.018
Respondents' concerns about cycling or cyclists:		
Careless driving		0.007
Lack of bike lanes or paved shoulders		0.006
Lack of bike route signage		0.001

* data gathered from cyclists only

The results from these tables will now be explored in the following subsections.

5.2.1 Cycling habits.

In both study areas, 'bicycle use' is not significantly associated with helmet use and sidewalk use among cyclists. Separate questions about combining cycling with public transit were asked for both study areas. In Waterloo, cyclists were asked about whether or not they have used bicycle racks attached to all Grand River Transit buses; cyclists who cycle more often use the racks more than those who cycle relatively little. In Halifax, all respondents were asked if they would be likely to use bike racks on buses if more were installed; likelihood was considerably higher among respondents who cycle the most.

5.2.2 Demographics and geography.

Bicycle use in Halifax tends not to be associated with respondents' demographic characteristics, when compared with Waterloo. In Waterloo, bicycle use and gender are associated and use is higher among males than it is among females; in Halifax, although more males do cycle, respondents' gender is very similar among non-cyclists, hence a less significant statistical association. Bicycle use is also associated with age and employment in Waterloo (the findings suggest a general negative association with age and that a higher percentage of non-cyclists are retired.

In Halifax, bicycle use is associated with driving distance from place of work or school; more non-cyclists in Halifax tend to live closer to their place of work, whereas those who cycle the most either live close or further from their work or school. No other explanatory variables related to 'geography' yielded significant associations in Halifax or Waterloo for the 'bicycle use' variable.

5.2.3 Mode choice.

The mode choice influences 'travel time' and 'the availability of public transit' are both associated with bicycle use in Halifax (a higher percentage of non-cyclists mention 'travel time' and respondents who cycle more mention public transit availability more often as influences), whereas no influences are associated with bicycle use in Waterloo. While travel time is slightly less important among non-cyclists in Halifax, than it is for cyclists, non-cyclists also reported the lowest average trip distance between home and work, or home or school. The influence of transit availability on mode choice is more important among respondents who cycle less and non-cyclists than for those who cycle the most. Non cyclists in Halifax, interestingly, were also the most likely, among respondents, to use public transit.

5.2.4 Climate and comfort on different facility types.

Bicycle use in Waterloo is positively associated with respondents' willingness to cycle in light rain, light snow, high humidity, and the cold; in Halifax bicycle use appears to have a significant positive association with a cyclists' willingness to cycle in high humidity only (it would appear as though bicycle use is more contingent on weather in Waterloo than in Halifax).

In Waterloo, bicycle use is not associated with comfort level on any types of surfaces and routes, whereas in Halifax there is a significant association between cycling use and respondents' comfort riding on major roads with bike lanes (respondents who cycle less expressed being less comfortable on those facilities).

5.2.5 Attitudes and preferences.

Four groups of questions were aimed at gathering information on respondents' concerns and desires related to cycling. In relation to bicycle use, it might be expected that those who cycle the most would be most comfortable and satisfied with existing facilities, since cycling is occasionally their method of travel. However, these groups are also most familiar with and critical of shortfalls of current infrastructure, as evidenced by this analysis. Non-cyclists, perhaps expectedly, are often unconcerned with flawed on non-existent cycling infrastructure and support. The paragraphs below delve into some key findings.

In Halifax, the maximum speed of traffic is of little concern to non-cyclists and respondents who cycle less, but respondents who cycle more tend to view traffic speed as a barrier to them cycling more often. In Waterloo, several significant associations exist between bicycle use and cycling-related elements that respondents identify as being 'encouraging' cycling-wise: respondents who cycle more tend to agree that better bike route signage, better education for motorists, more bike lanes and paths, and less truck traffic would encourage them to cycle more. Interestingly, a significant association also exists between cycling use and the feeling that nothing can be done to encourage respondents to cycle more (most respondents who cycle more disagree, and more than half of non-cyclists agree that nothing could be done to encourage them to cycle more).

Respondents' reasons for avoiding cycling for utilitarian purposes is not associated with cycling use in Halifax and, for the most part, in Waterloo as well. However, one significant association exists in Waterloo, between bicycle use and 'unsafe traffic conditions' as a reason for not cycling more: while few non-cyclists agreed, many cyclists asserted that unsafe traffic conditions prevents them from cycling more.

Significant associations exist between bicycle use and concerns with 'careless driving', 'lack of bike lanes or paved shoulders', and 'lack of bike route signage' in Waterloo (all sentiments expressed more frequently by respondents who cycle, rather than from those who do not). In Halifax, there is a significant association between concerns over cyclists using the sidewalks and bicycle use (a feeling expressed almost exclusively by non-cyclists).

5.3 Type of Cyclist: Halifax and Waterloo Compared

The 'type of cyclist' variable is based on if and how respondents use their bicycles: respondents who do not use their bicycles are labeled non-cyclists; respondents who answered that they use their bicycles to get to work, school, shop or run errands, or to visit friends were considered utilitarian cyclists; and respondents who only use their bicycles for recreational purposes were defined as recreational cyclists. Table 5.4 is a distribution of Waterloo and Halifax respondents based on these categories.

Table 5.4: Survey respondents, by 'type of cyclist' categories in Halifax and Waterloo

Type of cyclist category	Frequency	Percent
Waterloo		
Utilitarian cyclists	31	35.23%
Recreational cyclists	30	34.09%
Non-cyclists	27	30.68%
Halifax		
Utilitarian cyclists	25	36.76%
Recreational cyclists	14	20.59%
Non-cyclists	29	42.65%

The percentage of utilitarian cyclists in Waterloo and Halifax are rather similar, while the percentage of recreational cyclists is much greater in Waterloo. The percentage of non-cyclists is substantially greater in Halifax than in Waterloo. Although the Fisher's Exact Test comparing the two study areas does not indicate that the 'type of cyclist' distribution is significantly different between the two study areas, the resulting *p* – value of 0.130 hints at some difference, which is apparent in Table 5.4.

Tables 5.5 and 5.6 show which explanatory variables are significantly associated with the 'type of cyclist' variable, in Halifax and Waterloo, respectively. These findings are discussed in the paragraphs below.

Table 5.5: Variables significantly associated with 'type of cyclist' in Halifax (p ≤ 0.050)

Explanatory variables		*p* - values
Bicycling habits		
Bicycle use		0.000
Household characteristics		
Bicycle ownership		0.000
Number of bikes per household		0.000
Number of adult cyclists per household		0.000
Number of utilitarian adult cyclists per household		0.000
Number of adults who cycle to work per household		0.000
Number of adults who cycle to shop or run errands per household		0.000
Number of adults who cycle to visit friends per household		0.000
Number of adults who cycle for recreation per household		0.000
Mode choice		
Mode choice influences: Travel time		0.035
Climate and comfort on different facility types		
Number of months cycled*		0.030
Likeliness of cycling on days with:	Pleasant weather*	0.038
	Light rain*	0.043
	Warm temperature*	0.038
	High humidity*	0.002
Comfort on: Major roads with bike lanes*		0.005
Attitudes and preferences		
Elements respondents assert would encourage them to cycle more:		
Less car traffic		0.050
Respondents' reasons for not cycling more for utilitarian purposes:		
Incompatible with work clothes		0.004
Respondents' concerns about cycling or cyclists:		
Worried about accidents		0.030

* data gathered from cyclists only

Table 5.6: Variables significantly associated with 'type of cyclist' in Waterloo ($p \leq 0.050$)

Explanatory variables		*p* - values
Bicycling habits		
Bicycle use		0.000
Demographics and geography		
Gender		0.046
Employment		0.008
Income		0.034
Travel distance between residence and work or school		0.048
Household characteristics		
Bicycle ownership		0.000
Number of bikes per household		0.000
Number of adult cyclists per household		0.000
Number of utilitarian adult cyclists per household		0.000
Number of adults who cycle to work per household		0.000
Number of adults who cycle to school per household		0.008
Number of adults who cycle to shop or run errands per household		0.000
Number of adults who cycle to visit friends per household		0.000
Number of adults who cycle for recreation per household		0.000
Climate and comfort on different facility types		
Likeliness of cycling on days with:	Light rain*	0.003
	High humidity*	0.000
	Cold temperature*	0.012
Attitudes and preferences		
Elements respondents assert would encourage them to cycle more:		
Nothing		0.003
More on-street bike lanes or paved shoulders		0.024
More off-street bicycle paths		0.008
Better bicycle route signage		0.042
Better education for motorists		0.029
Shower and change facilities at work or school		0.015
Secure bicycle parking facilities		0.038
Less truck traffic		0.006
Respondents' reasons for not cycling more for utilitarian purposes:		
Lack of secure bike parking		0.046
Too many trucks		0.019
Free automobile parking at work (or school)		0.049
Respondents' concerns about cycling or cyclists:		
Careless driving		0.001
Lack of bike lanes or paved shoulders		0.002
Lack of bike route signage		0.001

* data gathered from cyclists only

5.3.1 Bicycling habits.

No significant associations were revealed between 'type of cyclist' and any of the 'bicycling habits' variables for Waterloo.

5.3.2 Demographics and geography.

No demographic explanatory variables were shown to have p – values below 0.050 in Halifax, yet in Waterloo gender, employment, and income have significant associations with the ‘type of cyclist’ variable. In Waterloo, there were twice as many male utilitarian and recreational cyclists than was the case for women, and there were twice as many non-cyclist women as there were non-cyclist males. This finding reveals that a considerably higher percentage of men ride bicycles in Waterloo (in Halifax, there were three times as many utilitarian male cyclists, but the recreational cyclist and non-cyclist groups had much more similar distributions). In Waterloo, income distribution did not vary notably between non-cyclists and utilitarian cyclists, but recreational cyclists are associated more with medium and higher income categories (no recreational cyclists reported having household incomes of between $0 and $40,000). In terms of employment, in Waterloo more non-cyclists are retired, and relatively few utilitarian cyclists are ‘employed full-time’; a higher percentage of recreational cyclists were employed full-time at the time of the survey.

In Halifax, none of the geographic explanatory variables were found to be associated with ‘type of cyclist’. In Waterloo, the only geographic variable associated with ‘type of cyclist’ was travel distance to work or school – a finding that suggests that more utilitarian cyclists live closer to work or school (within 5 kilometres), and that recreational and non-cyclists tend to require longer commutes.

5.3.3 Mode choice.

No significant associations were revealed between ‘type of cyclist’ and commuting mode choice or motor vehicle access in either Halifax or Waterloo. The mode choice influence variables also revealed largely insignificant associations, except for one in Halifax: travel time.

Travel time appears to have more of an influence for non-cyclists than for either recreational cyclists or for utilitarian cyclists .It is noteworthy that no utilitarian cyclists selected travel time as having an influence on their transportation mode choices.

5.3.4 Climate and comfort on different facility types.

In Halifax, ‘type of cyclist’ is associated with willingness to cycle in pleasant weather, light rain, warm temperature, and high humidity (recreational cyclists are more reluctant than utilitarian cyclists to cycle in any of these conditions). There is also a significant association between ‘type of cyclist’ and the number of months cycled in Halifax; many more utilitarian cyclists cycle for eight to 12 months per year than do recreational cyclists. In Waterloo, recreational cyclists are significantly less willing to cycle in light rain, high humidity, and cold temperature.

Recreational and utilitarian cyclists’ differing comfort levels on various bicycle route types did not yield significant associations in Waterloo. In Halifax ‘type of cyclist’ was found to be associated with respondents’ comfort level on ‘major roads with bike lanes’ (more recreational cyclists asserted that they do not feel comfortable on major roads with bike lanes).

5.3.5 Attitudes and preferences.

As shown in Table 5.6, in Waterloo, the ‘type of cyclist’ variable is significantly associated with eight factors that respondents feel might encourage them to cycle more. In all cases, except for the ‘nothing’ variable, utilitarian cyclists generally expressed that infrastructure improvements of many kinds would encourage them to cycle more, while recreational cyclists and, more-so, non-cyclists were less enthusiastic. More non-cyclists answered that ‘nothing’ would encourage them to cycle more, followed by recreational cyclists.

In Halifax, ‘type of cyclist’ is significantly associated with ‘less car traffic’ as a variable that would encourage respondents to cycle more; more recreational and utilitarian cyclists than non-cyclists share this attitude.

Three variables related to respondents’ reasons for not cycling more for utilitarian purposes were shown to be significantly associated with the ‘type of cyclist’ variable in Waterloo: ‘lack of secure bike parking’; ‘too many trucks’; and ‘free automobile parking at work (or school).’ More utilitarian cyclists felt that a lack of bike parking and too many trucks discourage them from bicycling more often, while some utilitarian cyclists and some non-cyclists mentioned free car parking at work as discouraging. In Halifax, a higher percentage of recreational cyclists mentioned cycling’s incompatibility with work clothes as a factor discouraging them from cycling more.

In Halifax, only one explanatory variable relating to respondents’ concerns was associated with type of cyclist: being worried about accidents (more non-cyclists and recreational cyclists expressed this concern). In Waterloo, concerns with ‘careless driving’ were prominent among utilitarian cyclists; a much higher percentage of recreational cyclists expressed concerns with a ‘lack of bike lanes or shoulders’. The ‘lack of bike route signage’ was a concern also often cited by Waterloo’s recreational cyclists (comparatively few non-cyclists expressed any of these concerns).

‘Type of cyclist’ yielded no significant ($p \leq 0.050$) associations when compared with the elements respondents suggest would improve cycling in their communities in Halifax or in Waterloo.

5.4 Differences in Survey Response between Halifax and Waterloo

The present section is an investigation into differences in survey response variables in Halifax and Waterloo, independent from the ‘cycling use’ and ‘type of cyclist’ variables. Separated by study area, survey results for all respondents were considered.

Table 5.7 shows survey response variables that differ[17] significantly between the two study areas. The following paragraphs will discuss these differences.

Table 5.7: Results which are significantly different (independent) in Halifax and Waterloo ($p \leq 0.050$)

Explanatory variables	*p* - values
Bicycling habits	
Helmet use*	0.000
Household characteristics	
Bicycle ownership	0.039
Number of bikes per household	0.040
Number of adult cyclists per household	0.025
Number of adults who cycle to shop or run errands per household	0.046
Demographics and geography	
Estimated cycle time from residence to nearest on or off-road bicycle lane, path, or trail	0.031
Mode choice	
Commute mode choice	0.000
Mode choice influences: Availability of public transit	0.002
Cimate and comfort on different facility types	
Comfort on: Rural roads*	0.044
Attitudes and preferences	
Respondents' reasons for not cycling more for utilitarian purposes:	
Lack of bike lanes/paths/paved shoulders	0.001
Respondents' concerns about cycling or cyclists:	
Road conditions	0.001
Car doors opening	0.010
Sewer grates	0.037
Lack of bike lanes or paved shoulders	0.000
Lack of paths and trails	0.000
Other	
Provision of shower and change facilities at work or school	0.042
Respondents' rating of the quality of cycling routes and facilities in their municipality	0.003

* data gathered from cyclists only

[17] In this context, the ‘differences’ refer to situations where results for an explanatory variable in Waterloo are shown to be statistically independent from results for the same variable in Halifax.

5.4.1 Bicycling habits.

Helmet use is significantly different in Halifax than is the case in Waterloo: more than half of Waterloo cyclists ride their bicycles without helmets, while less than ten percent ride without in Halifax.

5.4.2 Household characteristics.

Several variables relating to household characteristics were significant differences between Halifax and Waterloo. ‘Bicycle ownership’, ‘number of bikes per household’ and ‘number of adult cyclists per household’ were all higher in Waterloo, consistent with the findings in Table 5.2, which revealed a substantially higher percentage of cyclists in Waterloo. ‘Number of adults who cycle to shop or run errands per household’ was higher for the Halifax study area.

5.4.3 Demographics and geography.

Survey responses for demographic questions in Halifax and Waterloo were not significantly different. However, response for the geographic variable ‘estimated cycle time from residence to nearest on or off-road bicycle lane, path, or trail’ was different between the two study areas: most Waterloo respondents reported being within 10 minutes of a bike lane or path, while Halifax respondents reported being further. Although the overall residential density of census tracts was much higher in Waterloo than in Halifax, as discussed in section 4.1, this section of analysis revealed no significant differences in the distribution of respondents into ‘higher’ and ‘lower’ density categories in Halifax and Waterloo.

5.4.4 Mode choice.

Based on survey response, commute mode choices are significantly different in Halifax and Waterloo; fewer than half of Halifax respondents use their cars to commute, while more than 75 percent of Waterloo respondents use their cars to get to work or school. Another significant difference related to mode choice was respondents' feeling that public transit availability influences their transportation mode choices (most Halifax respondents agreed with the statement, while comparatively few Waterloo respondents did).

5.4.5 Climate and comfort on different facility types.

Only one significant difference was revealed between cycling respondents' comfort levels on various route types in Halifax and Waterloo; many more Halifax cyclists reported that they feel comfortable riding their bicycles on rural roads than cyclists in Waterloo. No significant differences between study areas were revealed regarding any of the climate-related explanatory variables.

5.4.6 Attitudes and preferences.

'A lack of bike lanes/paths/paved shoulders' was mentioned by many more Halifax respondents than by Waterloo respondents as being a reason for not cycling more for utilitarian purposes. Halifax respondents also expressed greater concern about 'road conditions', 'car doors opening', 'sewer grates', 'lack of bike lanes or paved shoulders', and 'lack of paths and trails'.

5.4.7 Other.

A higher percentage of Waterloo respondents reported having shower and change facilities at work or school. Waterloo respondents were more likely to rate the overall quality of cycling infrastructure in their communities as being 'good', 'very good', or 'excellent', in comparison with Halifax respondents, the majority of whom consider cycling facilities as being 'poor' (Table 5.9).

5.5 General Attitudes and Preferences towards cycling in Halifax and Waterloo

5.5.1 Attitudes and preferences: Halifax.

5.5.1.1 Overall quality of cycling.

Table 5.8 summarizes respondents' feelings about the quality of cycling in HRM. Very few respondents feel positively about the overall quality of cycling facilities in Halifax.

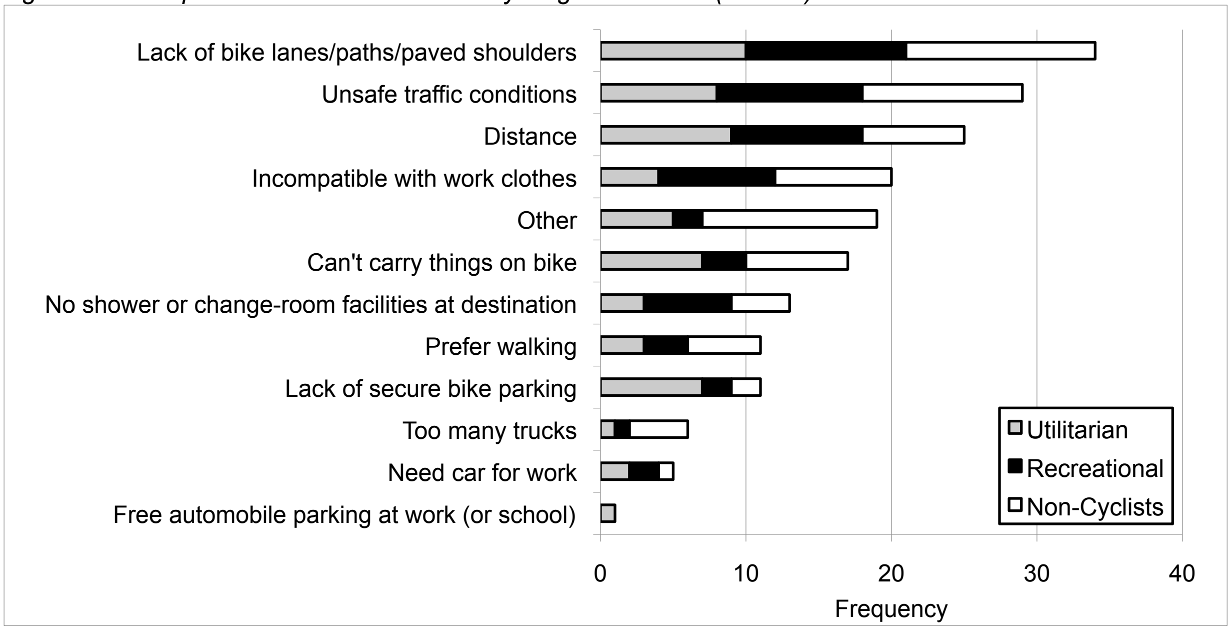
Table 5.8: Attitudes towards the quality of cycling facilities (Halifax)

	Excellent	Very Good	Good	Fair	Poor	Not Sure
Non-Cyclists	0%	0%	4%	18%	57%	21%
Recreational	0%	0%	14%	29%	57%	0%
Utilitarian	0%	0%	12%	24%	60%	4%
Overall	0%	0%	9%	22%	58%	10%

5.5.1.2 Reasons for not cycling more often.

All respondents were asked to choose the primary factors that affect their reluctance to cycle more for practical purposes. Recreational and utilitarian cyclists chose similar factors, and all three groups reported that 'a lack of bicycle routes' was the primary deterring factor. Figure 5.1 presents the results.

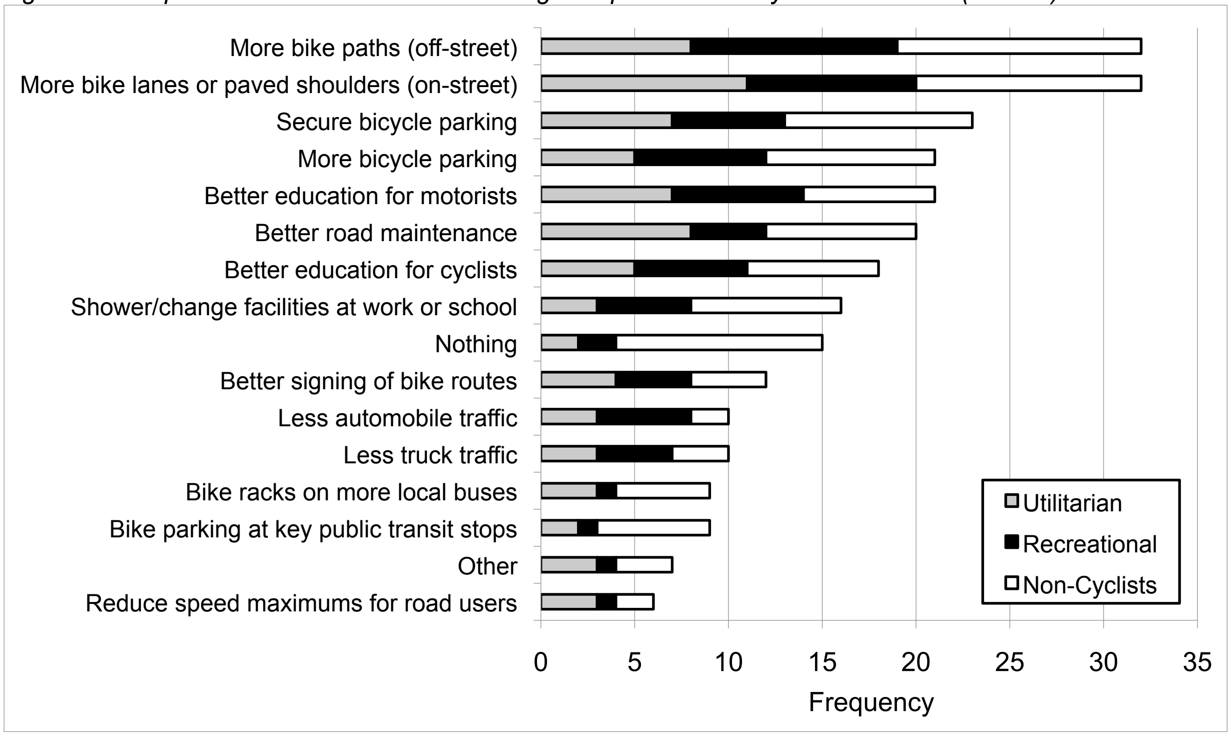
Figure 5.1: Respondents' reasons for not cycling more often (Halifax)



5.5.1.3 Factors that would encourage more use among respondents.

For all respondent types, the most desired improvements that HRM, their employers, or their schools might make, to encourage them to cycle more often were more bike lanes or paved shoulders (on-streets), more bike paths (off-street), and secure bicycle parking. Figure 5.2 is a breakdown of the response by respondent type.

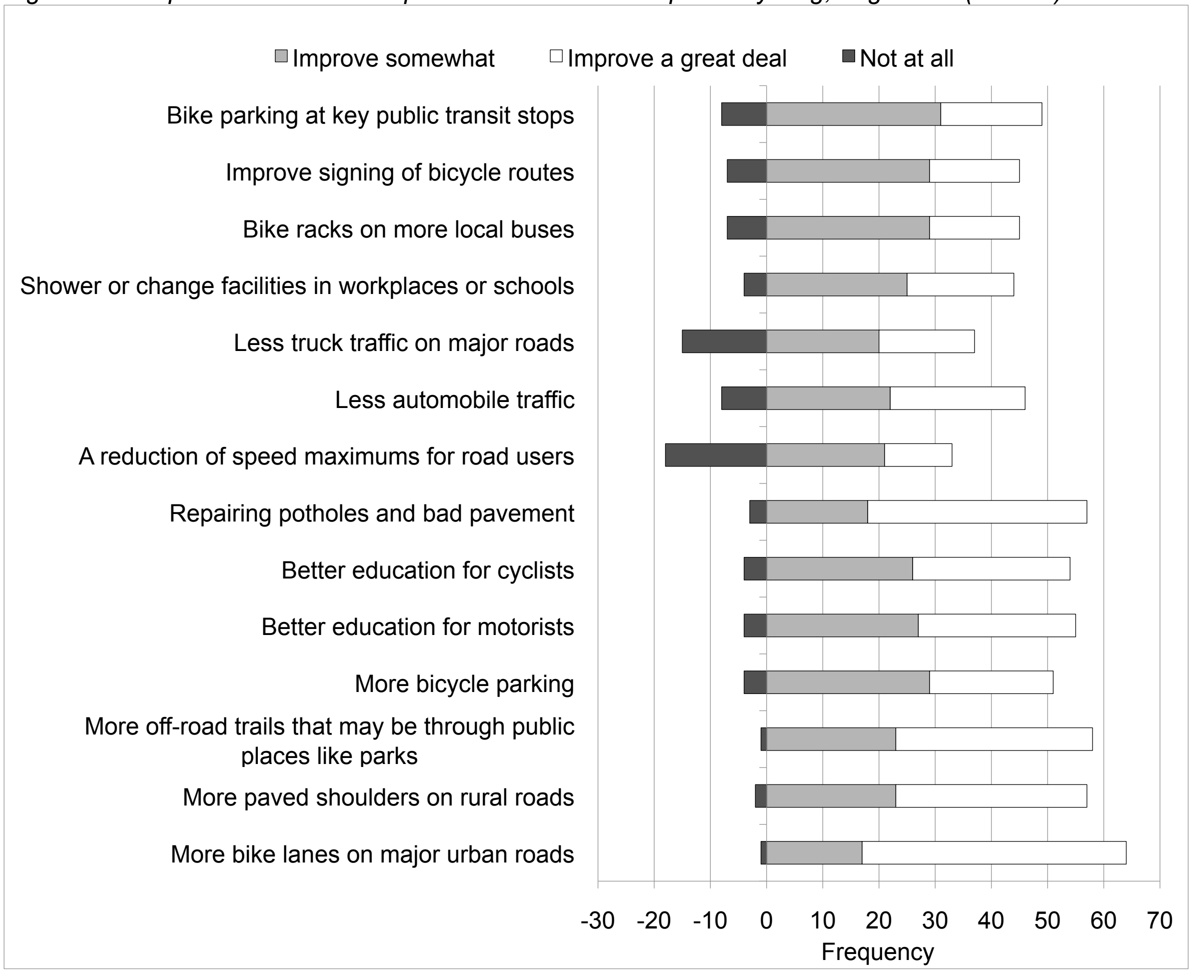
Figure 5.2: Improvements that would encourage respondents to cycle more often (Halifax)



5.5.1.4 Improvements, in general.

Figure 5.3 shows respondents' take on the improvements that would improve cycling in HRM, in general. All respondents felt that more bike lanes on major urban roads, repairing potholes and bad pavement, more off-road trails through public places like parks, and more paved shoulders on rural roads would improve cycling in HRM in general.

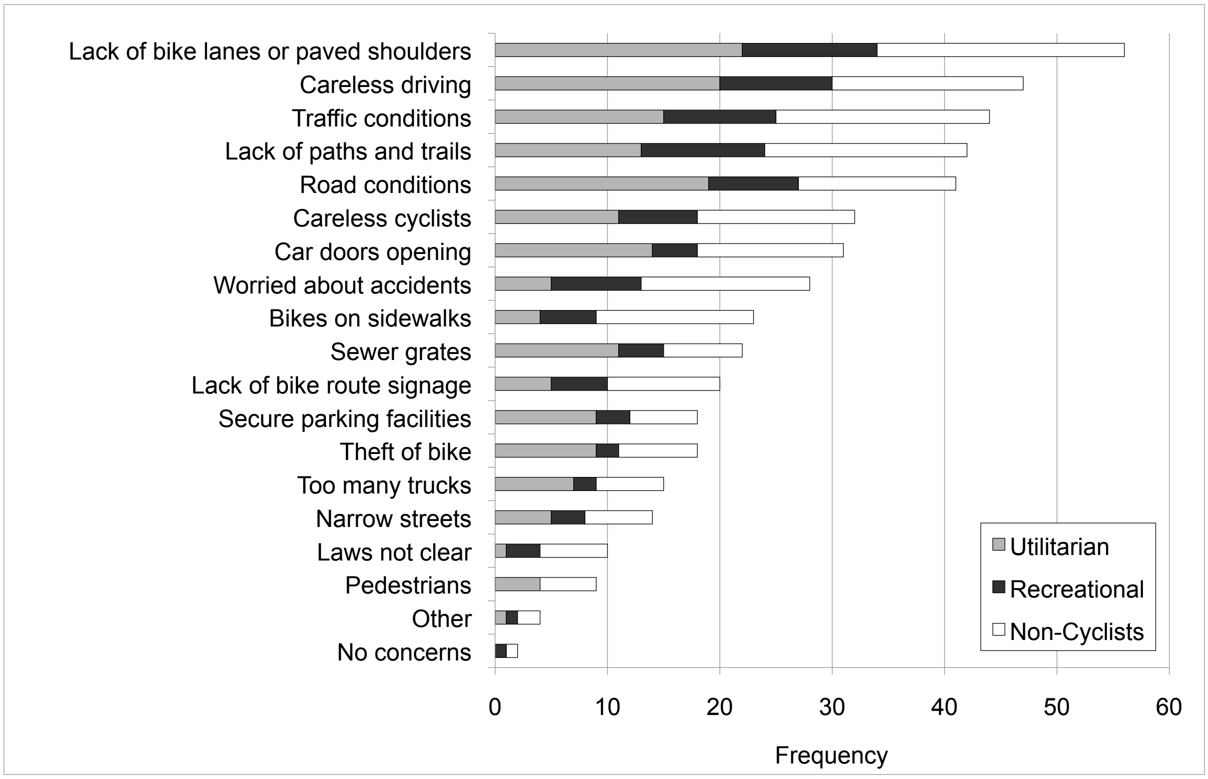
Figure 5.3: Improvements that respondents felt would improve cycling, in general (Halifax)



5.5.1.5 Top concerns, Halifax.

A lack of bicycle lanes was foremost among respondents' top safety concerns in regards to cycling in HRM. Figure 5.4 summarizes the response for all respondents.

Figure 5.4: Top cycling-related concerns (Halifax)



5.5.2 Attitudes and preferences: Waterloo.

5.5.2.1 Overall quality of cycling.

Table 5.9 summarizes respondents' feelings about the quality of cycling in Waterloo Region. Most respondents felt that the overall quality of cycling was either 'good' or 'fair'.

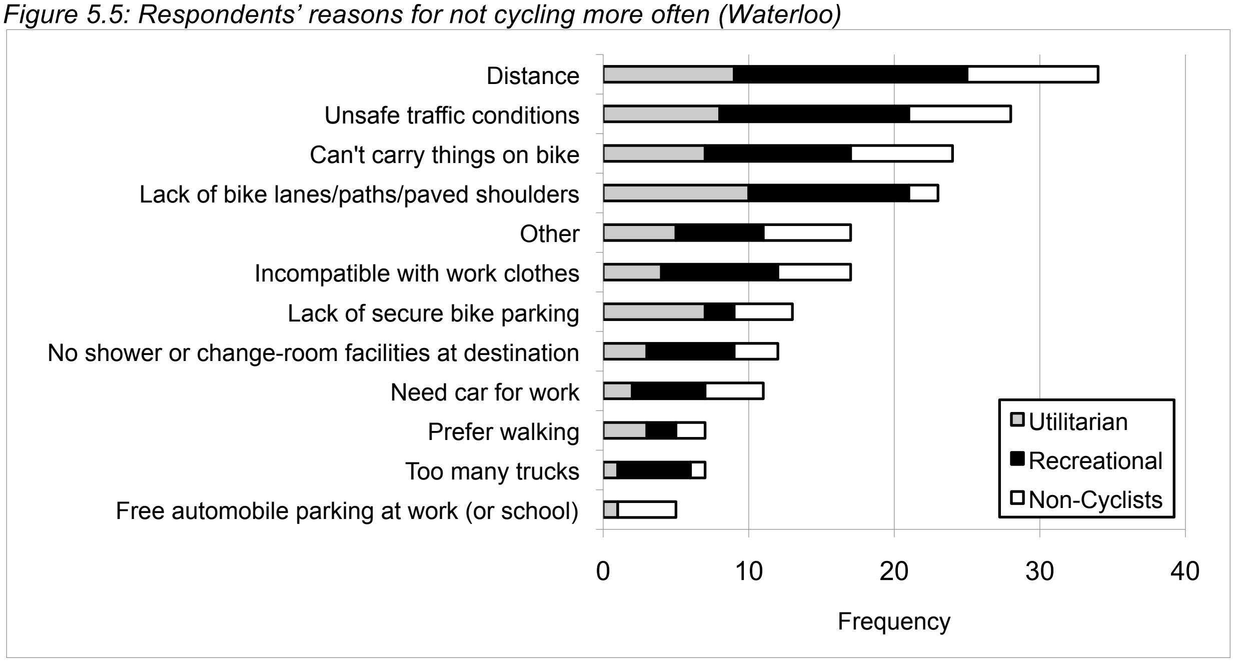
Table 5.9: Attitudes towards the quality of cycling facilities (Waterloo)

	Excellent	Very Good	Good	Fair	Poor	Not Sure
Non-Cyclists	0%	0%	15%	31%	12%	42%
Recreational	4%	7%	46%	25%	11%	7%
Utilitarian	6%	13%	42%	23%	6%	10%
Overall	4%	7%	35%	26%	9%	19%

5.5.2.2 Reasons for not cycling more often.

Respondents were asked to choose the primary factors that affect their choices not to cycle more for practical purposes. All three respondent types reported that distance was the primary deterring factor. Figure 5.5 presents the full results.

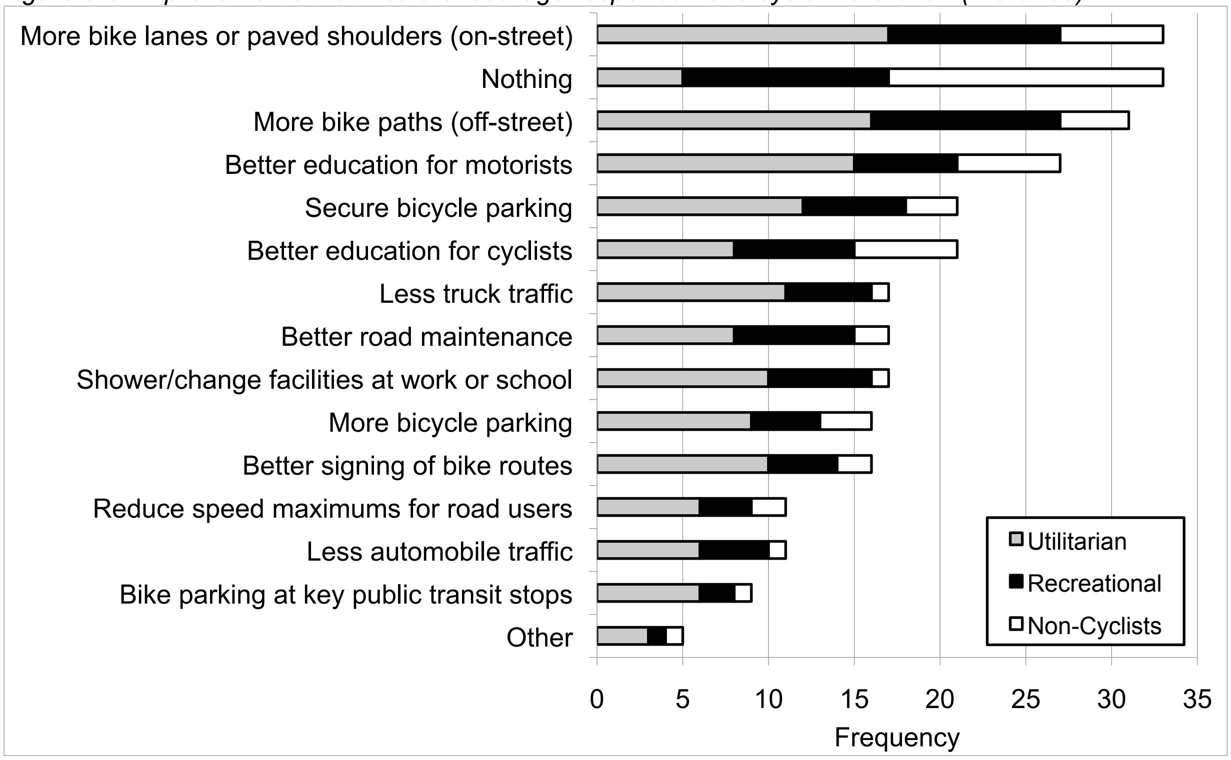
Figure 5.5: Respondents' reasons for not cycling more often (Waterloo)



5.5.2.3 Factors that would encourage more use among respondents.

The most selected improvements that respondents felt would encourage them to cycle more often (or at all) include more bike lanes or paved shoulders (on-street), more bike paths (off-street), and better education for motorists. Full results are shown in Figure 5.6.

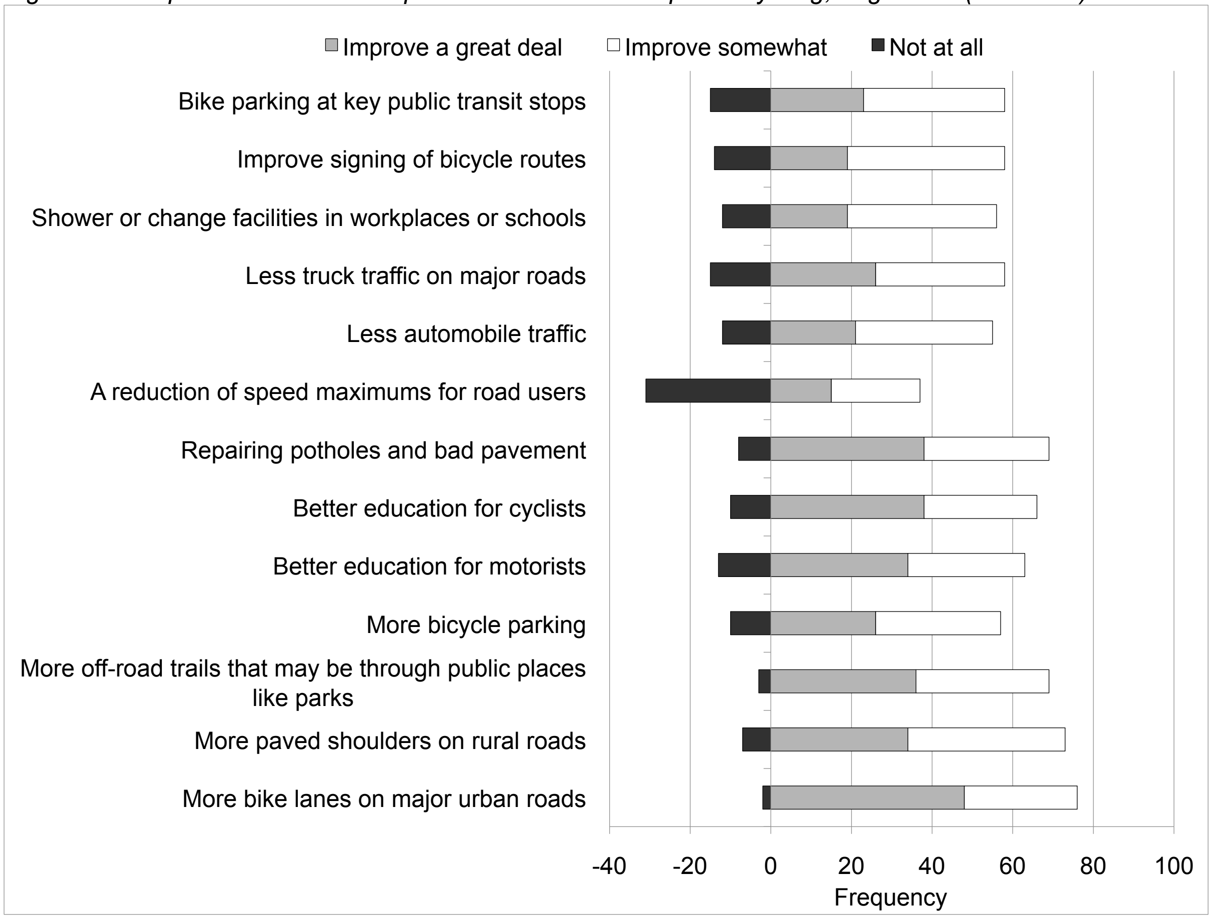
Figure 5.6: Improvements that would encourage respondents to cycle more often (Waterloo)



5.5.2.4 Improvements, in general.

The most commonly selected efforts or features that respondents felt would improve cycling in Waterloo Region were more bike lanes on major urban roads, more paved shoulders on rural roads, and repairing potholes and bad pavement. A large portion of respondents – 42 percent – also answered that there is nothing that can be done to encourage them to cycle more often. Figure 5.7 summarizes the results.

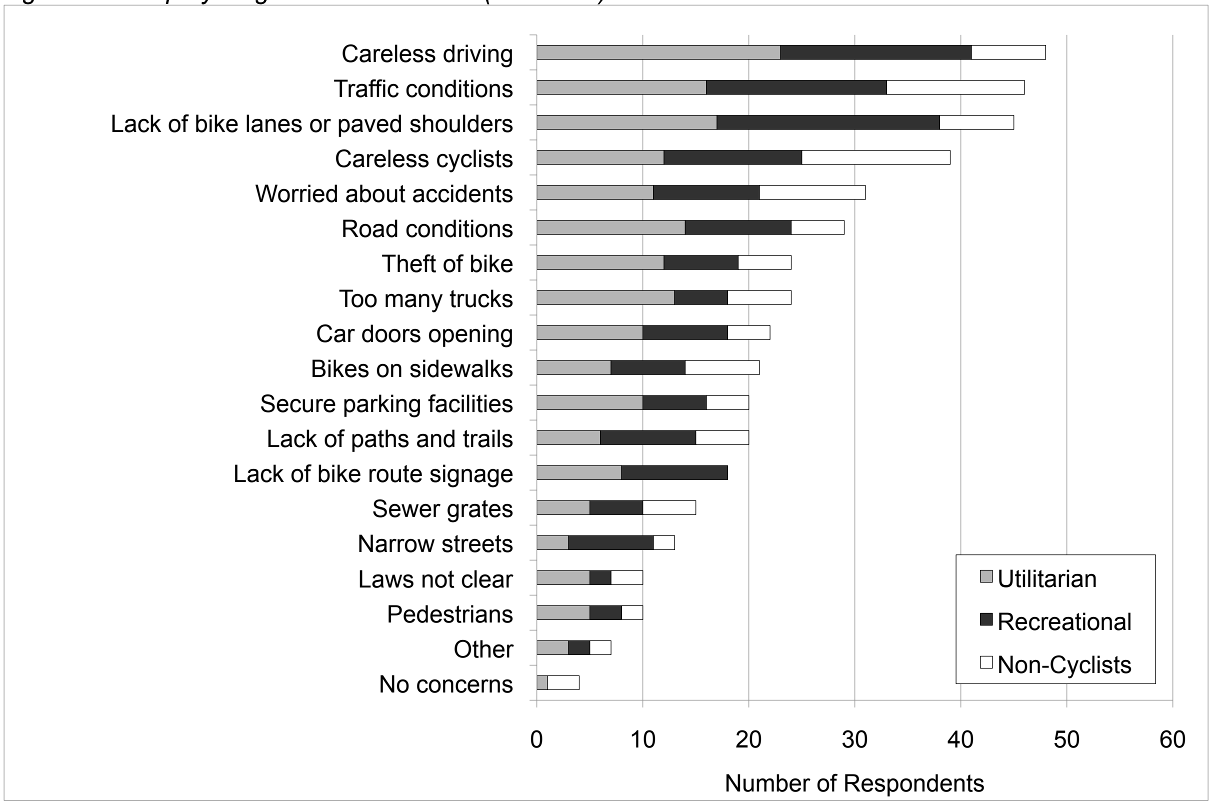
Figure 5.7: Improvements that respondents felt would improve cycling, in general (Waterloo)



5.5.2.5 Top concerns, Waterloo.

Comprehensively, careless driving was foremost among respondents' top safety concerns for cycling in Waterloo. Figure 5.8 summarizes the response for all respondents.

Figure 5.8: Top cycling-related concerns (Waterloo)



5.6 'Cycling Use' and 'Type of Cyclist': Both Study Areas Combined

Tables 5.10 and 5.11 reveal which explanatory variables were shown to be significantly related to 'bicycle use' and 'type of cyclist' for all respondents in both Halifax and Waterloo. Since the focus of the present thesis is the differences between Halifax and Waterloo, rather than of combined survey results, these tables will not be discussed herein. However, it should be noted that these tables, which could serve as a limited representation of mid-sized cities in Canada, provide an interesting comparison with findings from other cycling use studies in Canada and elsewhere.

Table 5.10: Variables significantly associated with 'bicycle use' (Halifax and Waterloo, $p \leq 0.050$)

Explanatory variables	*p* - values
<u>Household Characteristics</u>	
Bicycle ownership	0.000
Number of bikes per household	0.000
Number of adult cyclists per household	0.000
Number of utilitarian adult cyclists per household	0.000
Number of adults who cycle to work per household	0.000
Number of adults who cycle to school per household	0.002
Number of adults who cycle to shop or run errands per household	0.000
Number of adults who cycle to visit friends per household	0.000
Number of adults who cycle for recreation per household	0.000
<u>Demographics and geography</u>	
Age	0.002
Gender	0.003
Employment	0.001
Estimated bicycle time from home to work or school	0.005
<u>Mode choice</u>	
Motor vehicle access	0.039
Mode choice influences: Personal safety	0.024
<u>Climate and comfort on different facility types</u>	
Likeliness of cycling on days with: Light rain*	0.000
Light snow*	0.002
High humidity*	0.000
Cold temperature*	0.014
Comfort on: Major roads with bike lanes*	0.008
<u>Attitudes and preferences</u>	
Elements respondents assert would encourage them to cycle more:	
Nothing	0.011
More on-street bike lanes or paved shoulders	0.005
Better bicycle route signage	0.001
Better education for motorists	0.014
Less truck traffic	0.004
A reduction in speed maximums for road users	0.030
Respondents' concerns about cycling or cyclists:	
Careless driving	0.005
Lack of bike lanes or paved shoulders	0.024
Theft of bike	0.042

* data gathered from cyclists only

Table 5.11: Variables significantly associated with 'type of cyclist' (Halifax and Waterloo, $p \leq 0.050$)

Explanatory variables	*p* - values
<u>Bicycling habits</u>	
Bicycle use	0.000
<u>Household Characteristics</u>	
Bicycle ownership	0.000
Number of bikes per household	0.000
Number of adult cyclists per household	0.000
Number of utilitarian adult cyclists per household	0.000
Number of adults who cycle to work per household	0.000
Number of adults who cycle to school per household	0.001
Number of adults who cycle to shop or run errands per household	0.000
Number of adults who cycle to visit friends per household	0.000
Number of adults who cycle for recreation per household	0.000
<u>Demographics and geography</u>	
Age	0.013
Gender	0.009
Employment	0.001
<u>Mode choice</u>	
Commute mode choice	0.036
Mode choice influences: Travel time	0.014
Personal health	0.011
<u>Climate and comfort on different facility types</u>	
Number of months cycled*	0.001
Likeliness of cycling on days with: Pleasant weather*	0.020
Light rain*	0.000
Warm temperature*	0.009
High humidity*	0.000
Cold temperature*	0.001
Comfort on: Major roads with bike lanes*	0.017
Major roads with wide curb lanes*	0.014
<u>Attitudes and preferences</u>	
Elements respondents assert would encourage them to cycle more:	
Nothing	0.002
More on-street bike lanes or paved shoulders	0.008
More off-street bicycle paths	0.028
Better bicycle route signage	0.036
Better education for motorists	0.019
Less truck traffic	0.005
Less car traffic	0.029
Respondents' reasons for not cycling more for utilitarian purposes:	
Lack of secure bike parking	0.010
Respondents' concerns about cycling or cyclists:	
Careless driving	0.001
Road conditions	0.024
Lack of bike lanes or paved shoulders	0.021

* data gathered from cyclists only

Chapter 6: Discussion of Findings from Parts 1 and 2 of the Analyses

Chapters 4 and 5 have provided the foundation for a better understanding of how cycling is influenced by a host of variables in the Halifax and Waterloo study areas. Chapter 6 combines the information gathered in both of these analytical sections, in a discussion of interesting or noteworthy findings related to cycling use in the study areas.

The review of literature and research relating to cycling behaviour in Chapter 2, there are many potentially influential factors affecting cycling behaviour. Research relating to the following variables was explored: physical characteristics, transportation behaviour, socio-economic characteristics, bicycle infrastructure, and cycling-related policy.

Using the framework for discussion in Chapter 2, this chapter will consider the findings from Parts 1 (Chapter 4) and 2 (Chapter 5) of the analyses, and compare them to existing cycling research. Waterloo Region's comparatively higher percentage of cycling use among respondents – although it was not deemed to be statistically different – will direct the discussion.

While most existing research is focused on 'cycling use' as the percentages cycling comprises of overall mode share (compared with other modes such as: car as a driver, car as a passenger, and public transit), the present thesis has explored cycling behaviour in terms of both cycling use and purpose of use (i.e. recreational or utilitarian purposes). As such, the majority of the findings in the ensuing paragraphs relate to amount of cycling use as per the 'bicycle use' variable (high bicycle use, low bicycle use, and no bicycle use, as discussed in section 5.2 on page 109).

6.1 Findings: Physical Characteristics

According to the research, more cycling use is associated with compact cities, higher density, favourable weather, and little topographic variation. Part 1 of the analysis has shown that Waterloo is a more welcoming environment for cycling based on its size, density, overall weather, and topography. Part 2 of the analysis revealed that both ‘bicycle use’ and ‘type of cyclist’ in Waterloo are associated with respondents’ willingness to bicycle in less than favourable weather conditions (predictably, those who cycle less frequently, and recreational cyclists, are less willing to cycle in adverse weather). Recreational cyclists in Halifax were less likely to cycle in pleasant weather, light rain, warm temperature, and high humidity. Utilitarian cyclists also tend to cycle for more months of the year in Halifax. Although it can be determined that weather is associated with cycling, separately in both study areas, it cannot be determined that differences in willingness to cycle in various weather conditions in Halifax and Waterloo help explain Waterloo’s higher cycling use, since these differences were not statistically significant. And while the findings of this thesis are consistent with previous research confirm that cycling use is greater in areas with higher density, since this study is limited to the analysis of two study areas, the result is less robust. Additionally, the more in-depth density analysis, described in section 3.2.1 (page 46), which measured the association between survey respondents’ cycling behavior (based on the ‘bicycle use’ and ‘type of cyclist’ variables) with their residential densities (either greater than or less than 20.76 dwelling units per hectare), did not reveal any statistically significant results for either study area. Findings for the topography variable are similarly limited in this research. Although it was revealed that Waterloo is less topographically diverse than Halifax and that Waterloo has higher cycling use than Halifax, since only two study areas are included in this analysis, an association between cycling use and topography can only be suggested based on these results.

In summary, the results from Part 1 of the analysis only allow us to suggest that city size, density, and topography might help to explain Waterloo's higher percentage of cycling use, and do not provide any statistically significant evidence. Whereas the findings from Part 2 of the analysis has confirmed previous research findings that suggest that weather is associated with cycling – both in terms of amount of cycling use and purpose of cycling use.

6.2 Findings: Transportation Purpose and Automobile Use

Previous cycling behaviour research has suggested that more cycling use is associated with more public transit use, less auto use, higher cost of owning an automobile, and a lower number of autos per capita. Part 1 of the analysis has shown that public transit use, auto use, and the cost of owning an automobile all make Halifax more conducive to cycling – findings which are at odds with Waterloo's comparatively higher cycling use, and with the findings of previous cycling research. Part 2 of the analysis is also at odds with Waterloo's higher cycling use: survey responses suggest that a substantially higher percentage of Waterloo residents use their vehicles to get to work or school. As a result, previous research associating greater cycling use with lower auto use and transit cannot be confirmed.

6.3 Findings: Socio-economic Characteristics

Socio-economic characteristics are commonly studied in attempts to understand influences of cycling use. The research suggests that cycling use is negatively associated with income and age, that more males cycle, and that education is positively associated with utilitarian cycling.

Part 1 of the analysis revealed that Waterloo is more conducive to higher levels of cycling in terms of age and gender, while Halifax is more conducive in terms of income and education. In Part 2 of the analysis, no socio-economic variables were revealed to have significant differences based on study area, nor do the ‘bicycle use’ or ‘type of cyclist’ variables in Halifax reveal any significant associations. However, in Waterloo, gender, employment, and income were all related to the ‘type of cyclist’ variable, suggesting that cycling is more popular among males, that recreational cyclists tend to have relatively higher incomes and higher rates of full-time employment, that non-cyclists more often are retired; and that utilitarian cyclists are less often employed full-time. Age, gender, and employment were associated with the ‘bicycle use’ variable in Waterloo: the age variable suggests a negative association with cycling use; cycling appears to be more popular among males; and more non-cyclists are retired (as revealed for the ‘type of cyclist’ variable).

The findings from Parts 1 and 2 confirm the research findings that cycling is negatively associated with age and that more males than females cycle. However, neither of the results from Parts 1 or 2 confirm or disprove potential associations with income or education.

6.4 Findings: Cycling Infrastructure

Many cycling studies set out to investigate how the provision of bicycle lanes and paths affect levels of cycling. Although causal relationships are unlikely to be fully proven, many studies suggest that the provision of bicycle infrastructure is one of the most important controllable factors related to cycling use. Not only can bike lanes, paths, or trails provide cyclists with a level of protection from other road users, dedicated (or partially dedicated) cycling infrastructure also has the ability to attract new cyclists by reducing people’s fear relating to safety. Part 1 of the analysis has shown that Halifax has a history of fewer cycling injuries and deaths per vehicle kilometres traveled, compared with Waterloo's records. However, perhaps most important among all variables addressed in this study, Waterloo has more than twice the number of kilometres of bicycle infrastructure than does Halifax.

Part 2 of the analysis examined a variety of information regarding safety and infrastructure, and several significant differences between Halifax and Waterloo were revealed. 'Estimated cycle time from residence to nearest on or off-road bicycle lane, path, or trail' was found to be substantially lower for Waterloo respondents than for Halifax respondents – a clear reflection of the related finding in Part 1 of the analysis. Respondents' comparative concerns in Halifax and Waterloo also speak to differences in safety, and to how adequate are the cycling facilities provided. Significant differences in response based on study area were revealed for respondents concerns about 'road conditions,' 'car doors opening,' 'sewer grates,' 'lack of bike lanes or paved shoulders', 'lack of paths and trails,' as well as 'provision of shower and change facilities at work or school' and the following reason for not cycling more for utilitarian purposes: 'lack of bike lanes/paths/paved shoulders' – all of these concerns or issues were expressed more by Halifax respondents. The sole safety or infrastructure-related variable that favoured safety in Halifax was respondents' reported comfort cycling on rural roads (Waterloo respondents expressed much more concern).

It should also be noted that several attitudes and concerns relating to safety and cycling infrastructure were found to be associated with 'bicycle use' and 'type of cyclist' in Halifax and Waterloo, separately: Waterloo utilitarian cyclists and those who cycle more in Waterloo expressed concerns and suggestions for improvements more frequently than other respondents. As mentioned below in section 6.5 (page 140), Waterloo respondents were also more likely than those from Halifax to rate the overall quality of cycling facilities in their communities as 'good,' 'very good,' or 'excellent'.

The association of concerns and attitudes to the explanation of a variable such as cycling use is in keeping with Komanoff's (1997) assertion that cycling-related fear is the number one disincentive to higher levels of cycling use among the general public. As such, owing to Halifax respondents' comparatively strong concern about the lack of bicycle infrastructure and general cycling safety, it may be concluded that these concerns help explain lower levels of cycling use in Halifax. And, although the cyclist injury and death data suggest that cycling is more dangerous in Waterloo, the provision of more than twice the total kilometres of bicycle infrastructure in Waterloo also helps to explain Waterloo's higher levels of cycling use. This suggestive finding lends itself to the established conclusion among existing cycling literature that more cycling infrastructure is associated with higher levels of cycling.

6.5 Findings: Policy

Previous research findings have demonstrated that more cycling-supportive policy is associated with greater cycling use. In Part 1 of the analysis, some prominent differences in policy support for cycling in Halifax and Waterloo were highlighted, but which of these study areas had a more supportive policy foundation for improving cycling was not determined. Similarly, while Part 2 of the analysis revealed several findings related to cycling policy support, it did not expressly address whether or not cycling use is associated with policy. However, a few prominent policy-related findings from both analyses lend themselves to the conclusion that cycling use is associated with policy support.

Nova Scotia's requirement that cyclists must wear helmets appears to be effective; 'helmet use' was found to be considerably higher in Halifax than in Waterloo. As mentioned above in section 6.4 (page 138), more respondents in Halifax noted a general lack of bicycle routes as a concern and as a reason they don't cycle more often – an attitude which suggests less success in the development of Halifax's bicycle system, compared with Waterloo. As well, Waterloo Region respondents expressed greater overall satisfaction with the quality of the bicycle facilities in their communities – a finding which is perhaps most indicative of a higher level of effectiveness of the cycling-related policies in Waterloo.

In summary, the cycling-related policies in Waterloo seem to be more effective in promoting cycling, since cycling use there is greater, there are twice as many kilometres of bicycle lanes, and the majority of the public surveyed feel as though cycling facilities are more than just adequate.

Chapter 7: Conclusion

The two main objectives of this thesis were to understand how variables relate to cycling use and cyclist type in Halifax and Waterloo and to understand the general public's attitudes and preferences towards cycling in each of these study areas. Research into the characteristics of Halifax and Waterloo, and subsequent analyses of the results of cycling use surveys, have revealed several interesting findings. A summary of these findings in the context of each of the study areas, discussions of study limitations, recommendations, and suggestions for further research form the basis of this conclusion.

7.1 Summary: Factors Associated with Cycling Use and Attitudes towards Cycling

Many of the variables identified in previous research as having varying levels of association with bicycling behaviour have been analysed in this thesis. As mentioned in section 2.6 (page 40), this conclusion will focus on findings related to public attitudes, policy, and the provision of infrastructure.

Several findings from Parts 1 and 2 of the analysis point to the provision of cycling infrastructure as having a weighty influence on levels of cycling in Halifax and Waterloo. Broadly, four factors contribute to this conclusion: the much greater amount of cycling infrastructure in Waterloo; the greater percentage of cycling use in Waterloo; the general dissatisfaction with the provision of cycling infrastructure in Halifax; and higher levels of concern regarding the safety of cycling in Halifax. The following paragraphs highlight some of these keys findings.

Part 1 of the analysis revealed that Waterloo had more than twice the total number of kilometres of bicycle routes than Halifax (109.7km in Waterloo versus 49.3km in Halifax). Further, the majority of Waterloo respondents reported being significantly closer to bicycle paths or lanes (within 10 minutes, by bicycle) than Halifax respondents, most of whom reported being more than 10 minutes away. These findings indicate that the bicycle route network is much more extensive in Waterloo than in Halifax. As well, public attitudes and preferences revealed in the Bike Study surveys also suggest that Waterloo residents are better served by bicycle facilities than Haligonians. Respondents were asked to rate the overall quality of cycling facilities in their communities and only nine percent of Haligonian respondents answered either 'good,' 'very good,' or 'excellent,' while 46 percent of Waterloo respondents answered either 'good,' 'very good,' or 'excellent' (58 percent of Haligonian respondents rated the overall quality of cycling facilities as being 'poor', compared to nine percent in Waterloo). As mentioned in section 6.4 (page 138), concerns about 'road conditions,' 'car doors opening,' 'sewer grates,' 'lack of bike lanes or paved shoulders', 'lack of paths and trails,' and the following reason for not cycling more for utilitarian purposes: 'lack of bike lanes/paths/paved shoulders' were also expressed much more by Halifax respondents than by Waterloo respondents.

A consideration of the above findings along with the higher rate of cycling use in Waterloo suggests that, in general, the provision of cycling facilities is positively associated with cycling use and the public's attitudes towards cycling – a finding that mirrors the findings of existing cycling-use research.

While Waterloo respondents' higher rate of cycling and overall higher level of satisfaction with bicycle facilities are also suggestive of likely differences in cycling-related policies between the two study areas, the in-depth analysis of cycling-related provisions in provincial and municipal policy documents and transportation planning strategies in section

4.13 did not reveal any sweeping differences in policy content. However, owing to the differences in satisfaction and cycling use between the two areas, this research suggests that the policies affecting cycling in Waterloo Region are more appropriate or are more effectively administered to enable greater cycling use. These findings also suggest that the few policy differences revealed which appear to favour greater cycling use in Waterloo could relate to Waterloo's greater overall level of success with cycling, including the inclusion of cycling in land-use objectives in Ontario's Provincial Policy Statement; Halifax Regional Municipality's lack of a Transportation Master Plan; and the requirement in the Region of Waterloo's Official Plan for government to work towards acquiring abandoned rail corridors for bike and pedestrian trails. However, as noted at the beginning of section 4.13 on page 83, a more in-depth policy analysis involving specific evaluation of the effectiveness of various policies and programmes, is necessary in order to yield a more conclusive finding regarding differences in cycling-related policy.

Helmet use in Halifax must also be acknowledged here in connection with the findings from Part 1 of the analysis which suggest a greater level of safety for cyclists in Nova Scotia. Less than half of Waterloo cyclists ride their bicycles with helmets, while more than 90 percent ride with helmets in Halifax – certainly a difference relating to mandatory helmet use for all cyclists in Nova Scotia. As mentioned in section 4.11 (page 81), the likelihood that a cyclist is the victim of a fatal collision is 25.5 percent greater in Ontario than in Nova Scotia and the likelihood that a cyclist is seriously injured in a collision is 52.4 percent greater in Ontario. While these findings suggest that cycling in Halifax is safer than in Waterloo in terms of province-wide reported injuries and deaths resulting from motor-vehicle collisions and provide evidence that helmet use is much greater in Halifax, it is difficult to directly associate these two findings; a more robust analysis investigating the role of helmet use in these collisions, and involving an analysis of differences in motor-vehicle driving behavior, is crucial to a better understanding.

The findings from Parts 1 and 2 of the analysis have also revealed several firm or suggested associations between cycling behavior and cycling-related variables. These are summarized below[18]:

1. Based on Waterloo's higher overall level of cycling use, Part 1 of the analysis suggests that cycling use is associated with city size, density, weather, topography, age, and gender, since it has been determined that Waterloo is better positioned for cycling than Halifax with respect to those characteristics.

2. Part 2 of the analysis revealed that, based on the 'type of cyclist' variable, purpose of cycling use in Halifax is associated with weather; in Waterloo, purpose of use is associated with weather, gender, and employment.

3. Based on the 'bicycle use' variable, Part 2 of the analysis confirmed that cycling use in Waterloo is associated with weather, age, gender, employment, and income.

The following sections point to some limitations with this research and provide recommendations for future research and several suggestions for policy-makers.

[18] For more detailed analysis, including the directionality of the associations, please refer to the summaries in Chapter 6 or the initial presentations of the results in Chapters 4 and 5.

7.2 Research Limitations

Parts 1 and 2 of the analysis provide helpful insight into how a variety of factors are related to cycling in Halifax and Waterloo. However, as mentioned in section 4.14, an analysis involving additional study areas would have enabled a much more advanced comparison of the relative importance of the characteristics of each study area.

The major limitations of this research are associated with the survey instrument and its distribution methods. As discussed, the instrument was chosen, in part, to enable a comparison between cycling behaviour in Waterloo in 2002 and 2008. And although such a comparison is now possible, this facilitation came at a cost. While the instrument invites the collection of a rich range of data concerning individuals' cycling behaviour, its length and design are cumbersome for both respondent and analyst. For example, the survey contains 35 questions, many of which should have been eliminated or merged. As well, the survey questions generate data in a variety of levels of measurement including nominal, ordinal, interval, and open ended, and lead to increased complexity during data analysis. A more concise survey with consistent questioning methods would have strengthened the analysis.

The survey distribution method and resulting sample size also limit the findings of this study. Although the Fisher's Exact Test method for contingency analysis reduces concerns relating to small sample size for whatever results are gathered, it is inherent that the robustness of the input data would be increased with a greater sample size by reducing the variability of responses. For example, Krejcie and Morgan (1970), suggest a sample size of approximately 380 when target populations exceed 40,000 for questions with one degree of freedom.

Based on the response rate that was generated by the secondary distribution attempts through mail-out survey advertisement, it would appear as though the primary distribution method (advertising the online survey via telephone) was much less effective. An alternate distribution method would have improved the quality of the survey response data.

7.3 Recommendations

Several findings revealed in this thesis can help influence greater use of cycling in Halifax, Waterloo, and elsewhere. As discussed in section 2.5 (page 36), attitudinal surveys of the general public offer professionals the opportunity to digest public opinion and, in part based on the findings these instruments generate, plan systematic changes. And although an analysis of the content of policies affecting cycling, as carried out in section 4.13, can also help to inform recommendations, this thesis does not include a full content analysis of policies developed since 2008. As such, the majority of the recommendations below are limited to the prominent findings of the Bike Study surveys[19].

7.3.1 Recommendations for Halifax.

1. Continue the expansion of the bicycle route network.

The survey results suggest that most Haligonians are unsatisfied with the current quality of bicycle facilities. Adding more bicycle lanes is fundamental to improving cycling in HRM; respondents expressed the view that the current lack of bicycle lanes is the biggest safety concern for cycling in HRM, and that more off-street bicycle paths and more secure bicycle parking would encourage them to cycle more often. The top four safety concerns for all cyclists speak to an obvious need for more dedicated space for bicycle users on and off public

[19] Reports summarizing the results of the Bike Study surveys, including recommendations, were prepared and distributed to planning staff at the Waterloo Region and Halifax Regional Municipality.

right-of-ways. These concerns were lack of bike lanes or paved shoulders, lack of paths and trails, traffic conditions, and careless driving.

2. Incorporate more off-road trails and residential streets into the bicycle route network.

Cyclists largely favoured off-road trails and residential streets when questioned about their level of comfort cycling on different route types. Rural roads and major roads with bike lanes were also favoured, but more so by utilitarian cyclists than by recreational cyclists.

3. Continue to create more bicycle parking.

Respondents ranked having more secure bicycle parking as the third most important improvement to cycling in HRM. Further, only 45 percent of respondents reported that they have convenient and secure bicycle parking at their workplaces or schools.

4. Encourage more utilitarian cycling.

Although survey results suggest that 54 percent of respondents are cyclists, only 20 percent of respondents use their bicycles to get to work or school at least some of the time. And while some respondents explained why they can't commute by bicycle (for example, some because of age, others because of conflicting priorities with children or employment requirements), sixty-two percent of non-cycling respondents listed factors that would encourage them to cycle more often, indicating that they are potential choice riders.

7.3.2 Recommendations for Waterloo.

1. Continue the expansion of the bicycle route network.

Respondents expressed the view that adding more bicycle lanes is key to improving cycling, would most encourage them to cycle, and that the current lack of bicycle lanes is a primary safety concern.

2. Continue to work towards creating safer roads.

Respondents' top two safety concerns were 'careless drivers' and 'traffic conditions'. Education for road users, including cyclists, was among the main factors that respondents felt would improve cycling, and also was among the main factors that would encourage respondents to cycle more. Only 58 percent of cyclists always wear helmets in Waterloo, whereas in Halifax (where helmets are mandatory) 92 percent of cyclists wear helmets; these differences suggest that helmet use in Waterloo could be augmented if helmet laws were amended.

3. Encourage more utilitarian cycling.

Although survey results suggest that 72 percent of respondents are cyclists, only 11 percent of respondents cycle to work at least some of the time. As such, the potential for greater utilitarian bicycle-use is substantial and could contribute to reduced levels of auto use in Waterloo Region.

7.4 Areas of Further Research

As cited in section 1.2 (page 2), Sallis et al. (2004) have argued that, "…increased attention to active transportation could contribute to solutions to a variety of transportation problems, whether the primary motivation is to enhance public health or improve transportation." (p. 263) The bulk of research into cycling-use, including this thesis to an extent, is primarily focused on understanding how variables relate to cycling behaviour and about current cyclists' route preferences. However, more comprehensive research focusing on non-cyclists, dedicated to understanding why they don't choose cycling, could result in a more expedient transition towards higher rates of cycling-use.

As well, preliminary research into the nature and methodologies of current bicycle-use surveys has revealed that a wide range of approaches is currently employed. Research into the relative effectiveness of these approaches and, separately, efforts towards establishing a universal cycling-use survey instrument would enable a much more detailed understanding of differences across jurisdictions.

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Appendices

Appendix 1: Recent cycling surveys in Canadian cities

Location	Year	Title of Survey	Survey Methodology and Response
Nanaimo, B.C.	Current	Nanaimo Cycling Survey	Online survey.
Guelph, ON	Current	(not yet titled)	Survey to be distributed by telephone to a randomly selected population of 400 residents aged 16 years and over.
Mississauga, ON	2008	Mississauga Cycling Survey	Responses was collected online from 617 particpants.
Calgary, AB	2006	Downtown Commuter Cyclist Survey	Surveys were left at stations for randomly passing cyclists to collect and responses were mailed. 1883 responses were collected with a response rate of 67.3-percent.
Winnipeg, MB	2004	The City of Winnipeg Public Works Survey	Population was surveyed at random by telephone about active transportation and transportation in general. There were 300 responses with a response rate of 13.4-percent.
Winnipeg, MB	2004	Fall Active Transportation Survey	The online survey was promoted as part of annual 'Commuter Challenge' activities. There were 434 respondents.
Parksville, B.C.	2003	City of Parksville Bicycle Survey	The mail-out survey - sent to property owners listed for utlity billing with the city - yielded responses from 228 participants with a response rate of 5.0-percent.
Waterloo, ON	2002	Region of Waterloo Region of Waterloo 2002 Cycling Study - Public Attitude Survey	This survey was carried out over the telephone. There were 371 respondents and a response rate of 21.3-percent.
Niagara, ON	2002	Region of Niagara Bikeways Master Plan Study (BMPS) - Random Intercept Survey	Questionnaires were given to cyclists by way of random-intercept at strategic locations in the city. 71 cyclists completed interviews.
Niagara, ON	2001	Bikeways Master Plan Study Public Attitude Survey	This survey was carried out over the telephone. There were 66 complete interviews.
Toronto, ON	1999	City of Toronto City of Toronto 1999 Cycling Study - Public Attitude Survey	This survey was carried out over the telephone. There were 1001 complete interviews and a response rate of 20.9-percent.
Vancouver, BC	1998	City of Vancouver 1998 Cycling Survey - Cyclists	This survey was advertised in local newspapers and through e-mail list-serves and surveys were made available online and by mail. There were 1784 responses.
Vancouver, BC	1998	City of Vancouver 1998 Cycling Survey - Residents	This survey was mailed to residents who live directly on bikeways. 1863 surveys were returned for a response rate of 19-percent.
Vancouver, BC	1998	City of Vancouver 1998 Cycling Survey - Realtors	Surveys were mailed to 250 realtors to assess how bike routes affect property values. 66 responses were collected for a response rate of 26-percent.
Hamilton, ON	1997	Hamilton-Wentworth Community Cycling Survey	Surveys were disributed through mail. There were 2643 completed surveys with a response rate of 13.4-percent.

Appendix 2: Dwelling unit densities by census tract grouped into 'higher density' (>20.76 units per ha) and 'lower density' (5.0 – 20.76 units per ha) categories.

Halifax Regional Muncipality

Census Tract ID	Population	# of Private Dwellings	Area (sq km)	Area (hectares)	Dwelling Unit Density (sq km)	Dwelling Unit Density (hectare)
2050003.00	2637.0	1371.0	2.4	236.1	580.6	5.8
2050123.06	2894.0	1141.0	1.9	195.0	585.3	5.9
2050122.02	7553.0	2772.0	4.7	471.1	588.4	5.9
2050108.00	4140.0	1972.0	2.9	293.2	672.6	6.7
2050104.01	2054.0	887.0	1.3	125.4	707.2	7.1
2050107.00	3140.0	1348.0	1.9	189.0	713.2	7.1
2050121.08	3976.0	1222.0	1.7	170.5	716.6	7.2
2050123.05	3422.0	1455.0	2.0	196.4	740.8	7.4
2050121.02	3408.0	1299.0	1.7	171.6	757.1	7.6
2050131.01	5311.0	1897.0	2.5	250.1	758.4	7.6
2050131.02	4509.0	1776.0	2.3	229.7	773.1	7.7
2050105.02	4858.0	1777.0	2.2	220.9	804.5	8.0
2050106.01	3728.0	1650.0	1.9	189.1	872.8	8.7
2050122.01	3497.0	1360.0	1.5	153.5	886.1	8.9
2050112.00	1977.0	1523.0	1.6	163.3	932.4	9.3
2050005.00	1796.0	725.0	0.8	76.7	945.0	9.5
2050103.00	4401.0	1971.0	2.1	206.3	955.6	9.6
2050026.02	3311.0	1533.0	1.5	152.4	1005.9	10.1
2050020.00	2672.0	1041.0	1.0	99.4	1047.3	10.5
2050014.00	4023.0	1962.0	1.9	186.2	1053.5	10.5
2050022.00	5489.0	3009.0	2.8	284.8	1056.6	10.6
2050105.01	3272.0	1343.0	1.3	125.8	1067.4	10.7
2050007.00	1780.0	1259.0	1.2	117.1	1075.3	10.8
2050101.00	3433.0	1845.0	1.6	163.7	1127.4	11.3
2050015.00	4746.0	2502.0	2.1	205.5	1217.8	12.2
2050110.00	1684.0	987.0	0.8	80.7	1222.6	12.2
2050024.00	5387.0	2767.0	2.2	218.7	1265.2	12.7
2050025.02	4879.0	2548.0	1.9	193.2	1318.8	13.2
2050023.00	4239.0	2089.0	1.5	153.6	1360.0	13.6
2050025.03	6258.0	3462.0	2.5	251.2	1378.1	13.8
2050109.00	3366.0	1784.0	1.3	127.6	1398.6	14.0
2050018.00	3642.0	1985.0	1.4	138.1	1437.0	14.4
2050013.00	2613.0	1162.0	0.8	78.9	1473.0	14.7
2050102.00	4191.0	2233.0	1.5	147.1	1518.1	15.2
2050006.00	3217.0	1790.0	1.1	105.2	1702.3	17.0
2050021.00	3090.0	1567.0	0.9	88.2	1777.6	17.8
2050026.01	11376.0	5030.0	2.8	282.9	1778.3	17.8
2050111.00	3214.0	1836.0	1.0	96.5	1902.1	19.0
2050009.00	1859.0	1223.0	0.6	63.7	1919.5	19.2
2050025.01	4625.0	2173.0	1.1	105.9	2052.1	20.5
2050012.00	2594.0	1212.0	0.5	52.3	2316.8	23.2
2050019.00	4412.0	2269.0	0.9	89.8	2527.3	25.3
2050010.00	4699.0	2877.0	0.8	82.8	3473.0	34.7
2050011.00	5768.0	2922.0	0.8	80.8	3617.3	36.2
2050008.00	2641.0	2073.0	0.5	50.1	4140.9	41.4
2050004.01	3259.0	2437.0	0.4	42.3	5757.1	57.6
2050004.02	4221.0	3038.0	0.5	48.1	6314.8	63.1

Appendix 2: continued

Region of Waterloo

Census Tract ID	Population	# of Private Dwellings	Area (sq km)	Area (hectares)	Dwelling Unit Density (sq km)	Dwelling Unit Density (hectare)
5410130.00	5204.0	1749.0	3.4	336.8	519.3	5.2
5410025.00	2012.0	728.0	1.3	129.1	564.0	5.6
5410129.01	3669.0	1393.0	2.1	211.9	657.3	6.6
5410123.02	2962.0	1043.0	1.6	158.5	658.0	6.6
5410125.00	5670.0	2339.0	3.4	336.8	694.4	6.9
5410014.05	6902.0	2243.0	2.3	230.3	974.0	9.7
5410024.00	4196.0	1566.0	1.5	151.9	1030.7	10.3
5410101.04	3733.0	1410.0	1.1	113.2	1245.1	12.5
5410001.02	8902.0	2808.0	2.2	222.7	1260.8	12.6
5410126.05	779.0	284.0	0.2	22.3	1271.7	12.7
5410120.01	7119.0	2404.0	1.9	188.8	1273.6	12.7
5410126.06	7681.0	2257.0	1.7	173.2	1303.4	13.0
5410002.08	14430.0	4739.0	3.5	352.6	1344.2	13.4
5410123.01	4704.0	1947.0	1.4	144.6	1346.4	13.5
5410108.01	7639.0	2503.0	1.8	183.8	1361.6	13.6
5410109.04	13389.0	4368.0	2.9	291.7	1497.6	15.0
5410002.01	2316.0	1009.0	0.7	67.0	1506.0	15.1
5410008.01	5321.0	2105.0	1.4	136.4	1543.0	15.4
5410109.05	7375.0	2522.0	1.6	162.1	1556.2	15.6
5410122.01	6104.0	2276.0	1.5	145.4	1564.9	15.6
5410100.00	5372.0	2324.0	1.5	146.6	1585.4	15.9
5410009.03	9374.0	2852.0	1.8	179.8	1585.8	15.9
5410008.04	4600.0	1456.0	0.9	89.2	1633.0	16.3
5410109.02	6427.0	2085.0	1.3	126.0	1655.3	16.6
5410108.02	6340.0	2200.0	1.3	132.5	1660.2	16.6
5410019.00	3854.0	1774.0	1.0	104.2	1703.0	17.0
5410131.03	5783.0	1955.0	1.1	114.0	1714.4	17.1
5410109.01	5900.0	1998.0	1.1	111.0	1799.8	18.0
5410131.04	8392.0	2637.0	1.5	145.7	1810.0	18.1
5410014.03	7471.0	2879.0	1.6	156.9	1834.8	18.3
5410126.07	6636.0	1917.0	1.0	104.4	1836.9	18.4
5410003.00	3989.0	1821.0	1.0	98.7	1844.4	18.4
5410006.00	1183.0	597.0	0.3	31.9	1871.4	18.7
5410008.06	3813.0	1147.0	0.6	61.3	1871.5	18.7
5410129.02	4055.0	1730.0	0.9	91.9	1881.8	18.8
5410107.02	5765.0	2793.0	1.5	147.5	1894.1	18.9
5410104.00	6514.0	3047.0	1.6	160.2	1902.0	19.0
5410107.01	4806.0	1719.0	0.9	89.3	1925.2	19.3
5410002.07	6744.0	1999.0	1.0	102.8	1944.9	19.4
5410015.00	5181.0	2426.0	1.2	123.2	1968.6	19.7
5410008.02	3439.0	1221.0	0.6	61.8	1974.6	19.7
5410008.05	3637.0	1120.0	0.6	55.6	2015.3	20.2
5410121.00	4992.0	2128.0	1.0	102.2	2082.4	20.8
5410127.01	5874.0	2031.0	1.0	96.5	2105.3	21.1
5410013.00	3325.0	1481.0	0.7	69.2	2139.0	21.4
5410004.01	5812.0	2364.0	1.1	109.2	2164.6	21.6
5410103.00	3634.0	1916.0	0.9	87.4	2193.1	21.9
5410014.04	3578.0	1565.0	0.7	71.1	2202.2	22.0
5410126.09	3295.0	1111.0	0.5	50.0	2223.0	22.2
5410120.02	7301.0	2642.0	1.2	117.1	2255.6	22.6
5410001.01	5923.0	2755.0	1.2	121.8	2261.3	22.6
5410131.01	3861.0	1651.0	0.7	72.2	2287.3	22.9
5410122.02	4803.0	1779.0	0.8	76.8	2317.3	23.2
5410127.02	4284.0	1889.0	0.8	81.3	2323.7	23.2
5410126.01	3652.0	1835.0	0.8	78.2	2347.8	23.5
5410101.03	6210.0	2659.0	1.1	112.3	2368.6	23.7
5410002.06	3060.0	1073.0	0.5	45.0	2382.9	23.8
5410002.04	4183.0	1610.0	0.7	66.7	2413.9	24.1
5410126.02	4275.0	1587.0	0.6	64.9	2444.2	24.4
5410014.02	4597.0	1837.0	0.8	75.1	2446.7	24.5

(continued on next page)

Region of Waterloo (continued)

Census Tract ID	Population	# of Private Dwellings	Area (sq km)	Area (hectares)	Dwelling Unit Density (sq km)	Dwelling Unit Density (hectare)
5410004.02	7282.0	2771.0	1.1	107.1	2588.3	25.9
5410106.02	3619.0	1989.0	0.7	74.2	2681.3	26.8
5410126.08	4700.0	1533.0	0.6	56.0	2736.4	27.4
5410023.00	3415.0	1757.0	0.6	63.6	2763.2	27.6
5410022.00	1051.0	520.0	0.2	18.7	2781.5	27.8
5410002.03	2897.0	1278.0	0.4	44.8	2852.0	28.5
5410106.01	1874.0	2050.0	0.7	70.5	2909.8	29.1
5410002.02	6026.0	2379.0	0.8	80.6	2950.0	29.5
5410018.00	2281.0	1014.0	0.3	32.9	3077.9	30.8
5410101.01	3830.0	2236.0	0.7	71.7	3116.5	31.2
5410021.00	4426.0	2195.0	0.7	70.3	3122.2	31.2
5410007.00	7195.0	3417.0	1.1	109.3	3126.4	31.3
5410105.00	1265.0	865.0	0.2	24.5	3524.0	35.2
5410009.02	6505.0	2612.0	0.7	70.1	3727.5	37.3
5410009.01	6442.0	2677.0	0.7	71.2	3762.0	37.6
5410102.00	2658.0	1606.0	0.4	37.9	4239.1	42.4
5410005.00	7379.0	3379.0	0.8	79.0	4278.2	42.8
5410010.00	5242.0	2571.0	0.6	58.7	4376.2	43.8
5410016.00	5634.0	3019.0	0.6	63.7	4737.5	47.4
5410012.00	2128.0	1082.0	0.2	22.5	4811.5	48.1
5410128.00	1930.0	1035.0	0.2	20.1	5149.6	51.5
5410020.00	2548.0	1318.0	0.3	25.4	5189.7	51.9
5410124.00	2646.0	1437.0	0.2	24.5	5853.7	58.5
5410101.02	1100.0	363.0	0.1	5.9	6111.1	61.1
5410011.00	4509.0	2332.0	0.4	37.6	6205.4	62.1

Appendix 3: Bike Study Halifax – Survey questions and results.

1. Please indicate if you agree to continue:

Choices: Yes, I Agree or No, I do not agree

(All respondents agreed to participate)

2. Please answer the following information to help us understand how geography plays a role in participants' attitudes and habits. Your home phone number lets us know that you've completed the survey, and will allow us to contact you if you are a winner of one of four $50 prize packages.

Sections: City/Town; Postal Code; and Home Phone Number

(See Appendix 12 for a map of respondents' residential locations based on their postal codes)

3. Do you or does anyone else in your household own a bicycle?

Choices: Yes or No

	UTIL	REC	NON
Yes	25	12	8
No	0	2	21
Total (n)	25	14	29

4. How many bikes are there in your household?

Choices: 0; 1; 2; 3; 4; 5; 6; 7; 8; 9; 10; or more than 10

	UTIL	REC	NON
0	0	2	21
1	6	3	2
2	6	5	5
3	7	1	1
4	2	2	0
5	2	1	0
6	1	0	0
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
more than 10	1	0	0
Total (n)	25	14	29

5. How many persons 15 years of age or over live in your household?

Choices: 1; 2; 3; 4; 5; 6; 7; 8; 9; 10; or more than 10

	UTIL	REC	NON
1	6	2	8
2	14	9	13
3	3	2	5
4	2	0	1
5	0	0	0
6	0	1	1
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
more than 10	0	0	0
Total (n)	25	14	28

6. Including yourself, how many persons 15 years of age and over in your household ride a bicycle?

Choices: 0; 1; 2; 3; 4; 5; or more than 5

	UTIL	REC	NON
0	0	1	23
1	10	6	1
2	12	7	3
3	2	0	0
4	1	0	0
5	0	0	1
more than 5	0	0	0
Total (n)	25	14	28

7. Including yourself, how many persons 15 years of age and over in your household ride a bike for practical purposes (such as going to work or school, shopping, running errands, or visiting friends)?

Choices: 0; 1; 2; 3; 4; 5; or more than 5

	UTIL	REC	NON
0	1	13	5
1	16	1	0
2	7	0	0
3	1	0	0
4	0	0	0
5	0	0	0
more than 5	0	0	0
Total (n)	25	14	5

*only respondents with cyclists 15 years of age and over in their household were asked this question

8. More specifically...

How many persons 15 years of age and over ride a bike to WORK in good weather?
How many persons 15 years of age and over ride a bike to SCHOOL in good weather?
How many persons 15 years of age and over ride a bike for SHOPPING or RUNNING

ERRANDS in good weather?
How many persons 15 years of age and over ride a bike to VISIT FRIENDS in good weather?

Choices: 0; 1; 2; 3; 4; 5; or more than 5

		Work	School	Shopping or running errands	Visit friends
UTIL	0	9	19	3	4
	1	12	4	17	13
	2	4	1	4	7
	3	0	0	0	0
	4	0	0	0	0
	5	0	0	0	0
	more than 5	0	0	0	0
	Total (n)	25	24	24	24
REC	0	14	14	13	13
	1	0	0	1	1
	2	0	0	0	0
	3	0	0	0	0
	4	0	0	0	0
	5	0	0	0	0
	more than 5	0	0	0	0
	Total (n)	14	14	14	14
NON	0	5	5	5	4
	1	0	0	0	0
	2	0	0	0	1
	3	0	0	0	0
	4	0	0	0	0
	5	0	0	0	0
	more than 5	0	0	0	0
	Total (n)	5	5	5	5

*only respondents with cyclists 15 years of age and over in their household were asked this question

9. How many persons 15 years of age and over ride a bike for RECREATION or FITNESS in good weather?

Choices: 0; 1; 2; 3; 4; 5; or more than 5

	UTIL	REC	NON
0	0	0	3
1	11	7	1
2	12	7	1
3	1	0	0
4	1	0	0
5	0	0	0
more than 5	0	0	0
Total (n)	25	14	5

*only respondents with cyclists 15 years of age and over in their household were asked this question

10. Do you personally ride a bike in good weather for any of the following reasons?

To go to work
To go to school
To go shopping or run errands
To visit friends
For recreation or fitness

Choices: (either selected or not)

		Work	School	Shop or running errands	Visit friends	Recreation or fitness
UTIL	Yes	15	1	19	17	22
	No	10	24	6	8	3
	Total (n)	25	25	25	25	25
REC	Yes	0	0	0	0	14
	No	14	14	14	14	0
	Total (n)	14	14	14	14	14
NON	Yes	0	0	0	0	0
	No	29	29	29	29	29
	Total (n)	29	29	29	29	29

11. In good weather, how many days per week do you ride a bike for the following:

To go to work
To go to school
To go shopping or run errands
To visit friends
For recreation or fitness

Choices: 5 to 7 days; 2 to 4 days; 1 day per week; or Less than once per week

		Work	School	Shopping or running errands	Visit friends	Recreation or fitness
UTIL	None (none selected)	10	24	6	9	3
	Less than once per week	1	0	7	7	6
	1 day per week	11	0	6	5	3
	2 to 4 days	3	1	6	4	13
	5 to 7 days	0	0	0	0	0
	Total (n)	25	25	25	25	25
REC	None (none selected)	14	14	14	14	1
	Less than once per week	0	0	0	0	6
	2 day per week	0	0	0	0	5
	3 to 4 days	0	0	0	0	2
	6 to 7 days	0	0	0	0	0
	Total (n)	14	14	14	14	14

12. If you bike to work or school, on average, how long does your bike trip take in minutes?

Choices: 0-10; 10-20; 20-30; 30-45; or 45 or more

	UTIL	REC
0-10	3	0
10-20	7	0
20-30	0	0
30-45	3	0
45 or more	2	0
Total (n)	15	0

13. How do you most often commute to work or school when NOT cycling? By:

Choices: (either selected or not)

	UTIL	REC
Car (as a driver)	15	6
Car (as a passenger)	2	1
Public Transit	2	3
Walk	3	1
Carpool	1	0
Taxi	0	0
In-line skates or skateboard	0	0
I don't travel to work or school	1	2
Other	0	0
Total (n)	24	13

14. In what months of the year do you cycle? (Check all that apply)

Choices: (either selected or not)

	All Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
UTIL (n = 25)	4	0	0	5	18	20	20	21	21	21	16	9	0
REC (n = 13)	2	0	0	0	4	7	11	11	11	8	4	0	0

15. How likely are you to cycle on days with...

Choices: Very likely; Likely; Unlikely; Very unlikely

		Pleasant weather conditions	Light rain	Heavy rain	Light snow	Heavy snow	Icy conditions	High humidity	Warm temperature (more than 20 degrees Celsius)	Cold temperature (less than 5 degrees Celsius)
UTIL	Very likely	20	5	1	1	0	0	8	16	2
	Likely	4	8	2	0	0	0	12	8	9
	Unlikely	1	10	5	6	3	2	2	1	9
	Very unlikely	0	2	16	17	21	21	1	0	5
	Total (n)	25	25	24	24	24	23	23	25	25
REC	Very likely	2	1	1	1	1	1	1	1	1
	Likely	7	1	0	0	0	0	2	8	1
	Unlikely	2	3	1	0	0	0	6	2	1
	Very unlikely	2	7	9	10	10	10	1	2	8
	Total (n)	13	12	11	11	11	11	10	13	11

16. For each of the following statements please answer YES or NO. Would you say that you are comfortable cycling on...

Choices: Yes or No

	UTIL			REC		
	YES	NO	Total (n)	YES	NO	Total (n)
Rural roads	24	0	24	10	3	13
Groomed or paved off-road trails...	25	0	25	13	0	13
Residential streets	25	0	25	11	2	13
Major roads with bike lanes	22	1	23	7	6	13
Major roads with a wide curb lane...	15	8	23	4	8	12
Major roads without bike lanes or wide curb lanes	8	17	25	1	12	13

17. Do you wear a helmet when cycling?

Choices: Always; Never; or Sometimes

	UTIL	REC
Always	24	11
Sometimes	1	2
Never	0	0
Total (n)	25	13

18. Do you ride your bike on sidewalks?

Choices: Always; Never; or Sometimes

	UTIL	REC
Always	0	0
Sometimes	17	8
Never	8	5
Total (n)	25	13

19. Please indicate how heavily the following factors influence your choice of transportation modes (car, bike, public transit, etc.).

Choices: No Influence; Little Influence; Medium Influence; Major Influence; N/A

	UTIL					REC					NON				
	No	Little	Mediu	Major	Total (n)	No	Little	Some	Major	Total (n)	No	Little	Some	Major	Total (
Travel time	0	0	13	12	25	1	1	3	9	14	3	3	9	11	[illegible]
Personal safety	4	6	9	6	25	1	2	5	6	14	2	7	6	12	[illegible]
Cost of fuel	2	7	11	4	24	2	6	4	2	14	5	7	12	3	[illegible]
Availability of... transit	5	5	7	8	25	2	3	5	4	14	4	2	6	16	[illegible]
Climate change	4	3	11	6	24	1	3	5	4	13	7	4	11	6	[illegible]
Air quality	6	5	11	3	25	3	3	7	1	14	6	6	11	5	[illegible]
Cost of owning... auto...	5	11	3	4	23	3	4	5	1	13	4	5	12	4	[illegible]
Safety of others...	7	5	5	3	20	4	2	2	6	14	5	4	7	9	[illegible]
Your image	17	6	1	0	24	11	1	2	0	14	15	9	2	0	[illegible]
Personal Health	2	1	5	17	25	2	3	6	3	14	6	3	13	4	[illegible]
Weather	0	4	13	8	25	0	3	5	6	14	1	6	8	12	[illegible]

20. How do you most often commute to work or school? By...

Choices: (either selected or not)

	UTIL	REC	NON
Car (as a driver)	8	7	10
Car (as a passenger)	2	1	0
Public Transit	1	2	7
Walk	1	1	4
Bicycle	9	0	0
Carpool	0	0	0
Taxi	0	0	0
In-line skates or skateboard	0	0	0
Other	3	3	6
Total (n)	24	14	27

21. What, if anything, could HRM or your employer or school do to encourage you to bike to work or school?

Choices: (either selected or not)

	UTIL (n = 15)	REC (n = 14)	NON (n = 29)
Nothing	2	2	11
More bike lanes or paved shoulders (on-street)	11	9	12
More bike paths (off-street)	8	11	13
Better signing of bike routes	4	4	4
Better education for MOTORISTS	7	7	7
Better education for CYCLISTS	5	6	7
Shower/change facilities at work or school	3	5	8
More bicycle parking	5	7	9
Secure bicycle parking	7	6	10
Bike parking at key public transit stops	2	1	6
Bike racks on more local buses	3	1	5
Better road maintenance	8	4	8
Less truck traffic	3	4	3
Less automobile traffic	3	5	2
Reduce speed maximums for road users	3	1	2
Other	3	1	3

22. Do you have convenient and secure bicycle parking facilities at your workplace or school?

Choices: Yes; No; Not sure; or Don't work or go to school

	UTIL	REC	NON
Yes	13	4	6
No	9	6	5
Not Sure	1	2	5
Don't work or go to school	1	2	13
Total (n)	24	14	29

23. Do you have convenient shower/change facilities at your workplace or school?

Choices: Yes; No; Not sure; or Don't work or go to school

	UTIL	REC	NON
Yes	8	1	2
No	14	9	13
Not Sure	1	2	1
Don't work or go to school	1	2	12
Total (n)	24	14	28

24. How far in minutes do you live BY BICYCLE from the nearest major on or off-road bicycle lane, path, or trail?

Choices: (open ended response)

	UTIL (n = 22)	REC (n = 11)	NON (n = 15)
MIN	1	1	2
MEDIAN	8.75	10	10
MAX	30	20	20
MEAN	10.25	9.05	9.97

25. What is the POSTAL CODE of your place of work (or school if you are a full time student). If you do not know, please estimate the distance in kilometers.

Choices: (open ended response)

	UTIL (n = 22)	REC (n = 12)	NON (n = 17)
MIN	0	0	0.5
MEDIAN	6.7	8.8	5.3
MAX	30	85.7	25
MEAN	10.13	16.18	6.68

* Distances between residential and work (or school) postal codes are communicated in the above table

26. Why don't you use your bike to get to work, school, or for shopping, running errands, or visiting friends?

Choices: (either selected or not)

	UTIL (n = 23)	REC (n = 14)	NON (n = 27)
Lack of secure bike parking	7	2	2
Distance	9	9	7
Unsafe traffic conditions	8	10	11
Too many trucks	1	1	4
Need car for work	2	2	1
Can't carry things on bike	7	3	7
Prefer walking	3	3	5
Incompatible with work clothes	4	8	8
Lack of bike lanes/paths/paved shoulders	10	11	13
Free automobile parking at work (or school)	1	0	0
No shower or change-room facilities at destination	3	6	4
Other	5	2	12

27. Would you consider combining cycling and public transit in the same trip if there were convenient and secure bike racks attached to more Metro Transit buses?

Choices: Yes; No; I already do this; or Not sure

	UTIL	REC	NON
Yes	13	2	6
No	9	8	16
I already do this	0	0	0
Not Sure	3	4	7
Total (n)	25	14	29

28. How often do you have access to a motor vehicle?

Choices: All of the time; Several times per week; Occasionally; or Never

	UTIL	REC	NON
All of the time	22	14	23
Several times per week	1	0	0
Occasionally	0	0	4
Never	2	0	2
Total (n)	25	14	29

29. Thinking about the overall quality of cycling routes and facilities available to residents of HRM, would you say they are...

Choices: Excellent; Very Good; Good; Fair; Poor; or Not Sure

	UTIL	REC	NON
Poor	15	8	16
Fair	6	4	5
Good	3	2	1
Very Good	0	0	0
Excellent	0	0	0
Not sure	1	0	6
Total (n)	25	14	28

30. What concerns, if any, do you have about cycling or cyclists in HRM? (Please check all that apply)

Choices: (either selected or not)

	UTIL (n = 24)	REC (n = 14)	NON (n = 29)
No Concerns	0	1	1
Traffic conditions	15	10	19
Careless driving	20	10	17
Road conditions	19	8	14
Car doors opening	14	4	13
Sewer grates	11	4	7
Lack of bike lanes or paved shoulders	22	12	22
Careless cyclists	11	7	14
Worried about accidents	5	8	15
Pedestrians	4	0	5
Too many trucks	7	2	6
Theft of bike	9	2	7
Narrow streets	5	3	6
Laws not clear	1	3	6
Bikes on sidewalks	4	5	14
Lack of paths and trails	13	11	18
Lack of bike route signage	5	5	10
Secure parking facilities	9	3	6
Other	1	1	2

31. For each of the following, describe whether you think it would improve cycling in HRM a great deal, improve cycling somewhat, or not at all? How about...

Choices: Improve a great deal; Improve somewhat; Not at all; or Not Sure

		More bike lanes on major urban roads	More paved shoulders on rural roads	More off-road trails that may be through public places like parks	More bicycle parking	Better education for MOTORISTS	Better education for CYCLISTS	Repairing potholes and bad pavement	Less automobile traffic	A reduction of speed maximums for road users	Less truck traffic on major roads	Shower or change facilities in workplaces or schools	Bike racks on more local buses	Improve signing of bicycle routes	Bike parking at key public
UTIL	Great	21	12	15	9	10	9	17	11	4	6	7	8	6	
	Some	3	9	9	12	11	12	4	9	12	12	12	12	11	1
	Not	0	0	0	2	2	2	1	2	6	4	2	2	2	
	N.sure	1	4	1	1	1	1	2	2	2	2	1	1	4	
	Total (n)	25	25	25	24	24	24	24	24	24	24	22	23	23	2
REC	Great	9	5	8	5	7	7	6	7	3	4	6	1	4	
	Some	5	7	5	7	5	5	6	5	5	5	2	5	6	
	Not	0	1	0	1	0	0	1	1	3	2	1	2	2	
	N.sure	0	1	0	1	2	2	1	1	2	3	3	3	1	
	Total (n)	14	14	13	14	14	14	14	14	13	14	12	11	13	1
NON	Great	17	17	12	8	11	12	16	6	5	7	6	7	6	1
	Some	9	7	9	10	11	9	8	8	4	3	11	12	12	1
	Not	1	1	1	1	2	2	1	5	9	9	1	3	3	
	N.sure	1	4	4	5	3	3	1	4	6	4	6	4	2	
	Total (n)	28	29	26	24	27	26	26	23	24	23	24	26	23	2

32. Please indicate your age category:

Choices: 16-24; 25-34; 35-44; 45-54; 55-64; 65-74; or 75 and over

	UTIL	REC	REC
16-24	1	1	1
25-34	4	2	1
35-44	5	3	4
45-54	7	3	5
55-64	7	4	9
65-74	0	1	5
75 and over	1	0	4
Total (n)	25	14	29

33. What is the highest level of education you have achieved?

Choices: Some high school or less; High school graduate; Some college; College degree; Some university; University degree; Post-graduate studies; Other (trade school, etc.)

	UTIL	REC	NON
Post-graduate studies	8	4	12
University degree	6	5	5
Some university	2	1	4
College degree	6	2	2
Some college	0	0	3
High school graduate	0	0	1
Some high school or less	0	1	0
Other (trade school, etc.)	3	1	2
Total (n)	25	14	29

34. Please describe your current employment situation (check all that apply):

Choices: (either selected or not)

	UTIL (n = 24)	REC (n = 14)	NON (n = 29)
Employed full time	16	8	10
Employed part time	4	3	2
Self-employed	4	1	4
Retired	3	3	14
A home-maker	0	0	1
Not employed	0	1	0
Student (full time)	0	1	1
Student (part time)	0	0	1

35. Was your annual household income before taxes in 2007 between:

Choices: $0 and $40,000; $40,000 and $60,000; $60,000 and $80,000; $80,000 and $100,000; or $100,000 and $120,000

	UTIL	REC	REC
$0 and $40,000	4	4	8
$40,000 and $60,000	8	2	5
$60,000 and $80,000	3	2	7
$80,000 and $100,000	4	2	2
$100,000 and more	3	4	4
Total (n)	22	14	26

36. Please indicate your gender:

Choices: Female or Male

	UTIL	REC	NON
Female	6	6	15
Male	18	8	13
Total (n)	25	14	28

37. If you would like to clarify or add to any of your responses, comment on your use of bicycles, or on your attitudes towards cycling in Halifax please feel free to do so in the box below.

Choices: (open ended response)

(confidential responses)

38. If you would like to be informed about the results of this study, please enter your e-mail address in the box below. You will not be contacted for any other purpose.

Choices: (open ended response)

(confidential responses)

Appendix 4: Bike Study Waterloo – Survey questions and results.

1. Please indicate if you agree to continue:

Choices: Yes, I Agree or No, I do not agree

(All respondents agreed to participate)

2. Please answer the following information to help us understand how geography plays a role in participants' attitudes and habits. Your home phone number lets us know that you've completed the survey, and will allow us to contact you if you are a winner of one of four $50 prize packages.

Sections: City/Town; Postal Code; and Home Phone Number

(See Appendix 13 for a map of respondents' residential locations based on their postal codes)

3. Do you or does anyone else in your household own a bicycle?

Choices: Yes or No

	UTIL	REC	NON
Yes	30	29	13
No	1	1	14
Total (n)	31	30	27

4. How many bikes are there in your household?

Choices: 0; 1; 2; 3; 4; 5; 6; 7; 8; 9; 10; or more than 10

	UTIL	REC	NON
0	1	1	14
1	4	5	5
2	6	13	3
3	4	4	3
4	8	4	2
5	6	2	0
6	2	1	0
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
more than 10	0	0	0
Total (n)	31	30	27

5. How many persons 15 years of age or over live in your household?

Choices: 1; 2; 3; 4; 5; 6; 7; 8; 9; 10; or more than 10

	UTIL	REC	NON
1	4	1	5
2	14	16	12
3	7	11	5
4	6	0	3
5	0	0	0
6	0	0	0
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
more than 10	0	0	0
Total (n)	31	28	25

6. Including yourself, how many persons 15 years of age and over in your household ride a bicycle?

Choices: 0; 1; 2; 3; 4; 5; or more than 5

	UTIL	REC	NON
0	0	0	17
1	4	8	2
2	20	17	6
3	4	4	1
4	2	1	1
5	0	0	0
more than 5	0	0	0
Total (n)	30	30	27

7. Including yourself, how many persons 15 years of age and over in your household ride a bike for practical purposes (such as going to work or school, shopping, running errands, or visiting friends)?

Choices: 0; 1; 2; 3; 4; 5; or more than 5

	UTIL	REC	NON
0	5	25	9
1	12	4	0
2	12	1	2
3	2	0	0
4	0	0	0
5	0	0	0
more than 5	0	0	0
Total (n)	31	30	11

*only respondents with cyclists 15 years of age and over in their household were asked this question

8. More specifically...

How many persons 15 years of age and over ride a bike to WORK in good weather?
How many persons 15 years of age and over ride a bike to SCHOOL in good weather?
How many persons 15 years of age and over ride a bike for SHOPPING or RUNNING

ERRANDS in good weather?
How many persons 15 years of age and over ride a bike to VISIT FRIENDS in good weather?

Choices: 0; 1; 2; 3; 4; 5; or more than 5

		Work	School	Shopping or running errands	Visit friends
UTIL	0	18	20	12	8
	1	11	7	12	11
	2	1	2	5	9
	3	1	0	2	2
	4	0	0	0	1
	5	0	0	0	0
	more than 5	0	0	0	0
	Total (n)	31	29	31	31
REC	0	28	27	27	24
	1	0	1	1	2
	2	0	0	0	1
	3	0	0	0	0
	4	0	0	0	0
	5	0	0	0	0
	more than 5	0	0	0	0
	Total (n)	28	28	28	27
NON	0	9	10	10	8
	1	0	0	0	0
	2	1	0	0	2
	3	0	0	0	0
	4	0	0	0	0
	5	0	0	0	0
	more than 5	0	0	0	0
	Total (n)	10	10	10	10

*only respondents with cyclists 15 years of age and over in their household were asked this question

9. How many persons 15 years of age and over ride a bike for RECREATION or FITNESS in good weather?

Choices: 0; 1; 2; 3; 4; 5; or more than 5

	UTIL	REC	NON
0	1	0	5
1	8	11	2
2	16	16	3
3	3	3	1
4	3	0	0
5	0	0	0
more than 5	0	0	0
Total (n)	31	30	11

*only respondents with cyclists 15 years of age and over in their household were asked this question

10. Do you personally ride a bike in good weather for any of the following reasons?

To go to work
To go to school
To go shopping or run errands
To visit friends
For recreation or fitness

Choices: (either selected or not)

		Work	School	Shop or running errands	Visit friends	Recreation or fitness
UTIL	Yes	10	5	20	23	29
	No	21	26	11	8	2
	Total (n)	31	31	31	31	31
REC	Yes	0	0	0	0	30
	No	30	30	30	30	0
	Total (n)	30	30	30	30	30
NON	Yes	0	0	0	0	0
	No	27	27	27	27	27
	Total (n)	27	27	27	27	27

11. In good weather, how many days per week do you ride a bike for the following:

To go to work
To go to school
To go shopping or run errands
To visit friends
For recreation or fitness

Choices: 5 to 7 days; 2 to 4 days; 1 day per week; or Less than once per week

		Work	School	Shopping or running errands	Visit friends	Recreation or fitness
UTIL	None (none selected)	19	24	9	9	2
	Less than once per week	1	2	6	10	6
	1 day per week	6	3	12	7	9
	2 to 4 days	5	2	4	5	14
	5 to 7 days	0	0	0	0	0
	Total (n)	31	31	31	31	31
REC	None (none selected)	30	30	30	30	2
	Less than once per week	0	0	0	0	22
	2 day per week	0	0	0	0	3
	3 to 4 days	0	0	0	0	3
	6 to 7 days	0	0	0	0	0
	Total (n)	30	30	30	30	30

12. If you bike to work or school, on average, how long does your bike trip take in minutes?

Choices: 0-10; 10-20; 20-30; 30-45; or 45 or more

	UTIL	REC
0-10	7	0
10-20	5	0
20-30	1	0
30-45	2	0
45 or more	0	0
Total (n)	15	0

13. How do you most often commute to work or school when NOT cycling? By:

Choices: (either selected or not)

	UTIL	REC
Car (as a driver)	19	22
Car (as a passenger)	0	0
Public Transit	5	0
Walk	2	1
Carpool	0	0
Taxi	0	0
In-line skates or skateboard	0	0
I don't travel to work or school	5	6
Other	0	0
Total (n)	31	29

14. In what months of the year do you cycle? (Check all that apply)

Choices: (either selected or not)

	All Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
UTIL (n = 30)	2	0	0	6	15	25	27	28	28	24	18	9	
REC (n = 30)	0	0	0	1	7	20	28	30	30	23	12	2	

15. How likely are you to cycle on days with...

Choices: Very likely; Likely; Unlikely; Very unlikely

		Pleasant weather conditions	Light rain	Heavy rain	Light snow	Heavy snow	Icy conditions	High humidity	Warm temperature (more than 20 degrees Celsius)	Cold temperature (less than 5 degrees Celsius)
UTIL	Very likely	14	5	0	0	0	0	5	10	3
	Likely	16	7	2	5	0	1	17	17	6
	Unlikely	0	10	6	1	1	1	4	0	6
	Very unlikely	0	6	20	21	27	26	2	1	13
	Total (n)	30	28	28	27	28	28	28	28	28
REC	Very likely	9	0	0	0	0	0	0	3	0
	Likely	17	2	0	0	0	0	7	20	1
	Unlikely	3	9	2	3	2	1	13	4	6
	Very unlikely	0	16	26	24	25	26	6	1	20
	Total (n)	29	27	28	27	27	27	26	28	27

16. For each of the following statements please answer YES or NO. Would you say that you are comfortable cycling on...

Choices: Yes or No

	UTIL			REC		
	YES	NO	Total (n)	YES	NO	Total (n)
Rural roads	23	8	31	20	9	29
Groomed or paved off-road trails...	30	1	31	28	1	29
Residential streets	30	0	30	28	1	29
Major roads with bike lanes	23	7	30	19	10	29
Major roads with a wide curb lane...	17	13	30	10	19	29
Major roads without bike lanes or wide curb lanes	6	23	29	4	25	29

17. Do you wear a helmet when cycling?

Choices: Always; Never; or Sometimes

	UTIL	REC
Always	18	19
Sometimes	6	5
Never	7	6
Total (n)	31	30

18. Do you ride your bike on sidewalks?

Choices: Always; Never; or Sometimes

	UTIL	REC
Always	1	1
Sometimes	23	23
Never	7	6
Total (n)	31	30

19. Please indicate how heavily the following factors influence your choice of transportation modes (car, bike, public transit, etc.).

Choices: No Influence; Little Influence; Medium Influence; Major Influence; N/A

	UTIL					REC					NON				
	No	Little	Mediun	Major	Total (n)	No	Little	Some	Major	Total (n)	No	Little	Some	Major	Total (r
Travel time	1	1	12	17	31	3	3	7	16	29	2	2	4	17	
Personal safety	1	9	6	15	31	1	7	10	11	29	2	2	7	13	
Cost of fuel	6	12	9	3	30	5	11	10	3	29	5	7	6	6	
Availability of... transit	12	6	5	8	31	13	4	7	5	29	5	8	5	6	
Climate change	4	7	9	11	31	8	7	8	6	29	6	7	9	3	
Air quality	7	6	10	8	31	6	10	9	4	29	5	6	10	3	
Cost of owning... auto...	5	15	7	4	31	8	11	8	2	29	7	8	6	3	
Safety of others...	7	7	6	11	31	4	6	12	7	29	5	4	4	10	
Your image	16	11	2	2	31	16	8	3	1	28	14	7	2	1	
Personal Health	3	5	15	8	31	4	11	9	5	29	5	6	7	6	
Weather	2	5	11	12	30	3	4	13	9	29	1	4	10	10	

20. How do you most often commute to work or school? By...

Choices: (either selected or not)

	UTIL	REC	NON
Car (as a driver)	19	23	17
Car (as a passenger)	0	0	3
Public Transit	4	0	0
Walk	1	1	1
Bicycle	2	0	0
Carpool	0	0	0
Taxi	0	0	0
In-line skates or skateboard	0	0	0
Combination (please describe)	2	0	2
Other	1	1	1
Total (n)	29	25	24

21. What, if anything, could the Region or your employer or school do to encourage you to bike to work or school?

Choices: (either selected or not)

	UTIL (n = 28)	REC (n = 27)	NON (n = 25)
Nothing	5	12	16
More bike lanes or paved shoulders (on-street)	17	10	6
More bike paths (off-street)	16	11	4
Better signing of bike routes	10	4	2
Better education for MOTORISTS	15	6	6
Better education for CYCLISTS	8	7	6
Shower/change facilities at work or school	10	6	1
More bicycle parking	9	4	3
Secure bicycle parking	12	6	3
Bike parking at key public transit stops	6	2	1
Better road maintenance	8	7	2
Less truck traffic	11	5	1
Less automobile traffic	6	4	1
Reduce speed maximums for road users	6	3	2
Other	3	1	1

22. Do you have convenient and secure bicycle parking facilities at your workplace or school?

Choices: Yes; No; Not sure; or Don't work or go to school

	UTIL	REC	NON
Yes	15	12	6
No	9	6	9
Not Sure	2	5	2
Don't work or go to school	5	6	9
Total (n)	31	29	26

23. Do you have convenient shower/change facilities at your workplace or school?

Choices: Yes; No; Not sure; or Don't work or go to school

	UTIL	REC	NON
Yes	8	13	6
No	15	9	11
Not Sure	3	1	0
Don't work or go to school	5	6	9
Total (n)	31	29	26

24. How far in minutes do you live BY BICYCLE from the nearest major on or off-road bicycle lane, path, or trail?

Choices: (open ended response)

	UTIL (n = 29)	REC (n = 25)	NON (n = 14)
MIN	1	1	2
MEDIAN	5	5	7.5
MAX	30	50	60
MEAN	6.31	9.22	10.64

25. What is the POSTAL CODE of your place of work (or school if you are a full time

student). If you do not know, please estimate the distance in kilometers.

Choices: (open ended response)

	UTIL (n = 25)	REC (n = 22)	NON (n = 14)
MIN	0	0	2
MEDIAN	4.9	12	14.5
MAX	99.7	58.3	45
MEAN	9.28	14.13	14.94

* Distances between residential and work (or school) postal codes are communicated in the above table

26. Why don't you use your bike to get to work, school, or for shopping, running errands, or visiting friends?

Choices: (either selected or not)

	UTIL (n = 28)	REC (n = 30)	NON (n = 23)
Lack of secure bike parking	9	2	4
Distance	15	16	9
Unsafe traffic conditions	11	13	7
Too many trucks	10	5	1
Need car for work	7	5	4
Can't carry things on bike	14	10	7
Prefer walking	2	2	2
Incompatible with work clothes	8	8	5
Lack of bike lanes/paths/paved shoulders	7	11	2
Free automobile parking at work (or school)	3	0	4
No shower or change-room facilities at destination	8	6	3
Other	8	6	6

27. Have you used the bike racks attached to all GRT buses?

Choices: Yes; No; or No (I don't ride a bike)

	UTIL	REC	NON
Yes	7	2	0
No	23	25	8
I already do this	1	2	19
Total (n)	31	29	27

28. How often do you have access to a motor vehicle?

Choices: All of the time; Several times per week; Occasionally; or Never

	UTIL	REC	NON
All of the time	22	26	23
Several times per week	2	1	1
Occasionally	5	2	0
Never	2	0	3
Total (n)	31	29	27

29. Thinking about the overall quality of cycling routes and facilities available to

residents of the Region of Waterloo, would you say they are...

Choices: Excellent; Very Good; Good; Fair; Poor; or Not Sure

	UTIL	REC	NON
Poor	2	3	3
Fair	7	7	8
Good	13	13	4
Very Good	4	2	0
Excellent	2	1	0
Not sure	3	2	11
Total (n)	31	28	26

30. What concerns, if any, do you have about cycling or cyclists in the Region? (Please check all that apply)

Choices: (either selected or not)

	UTIL (n = 31)	REC (n = 28)	NON (n = 26)
No Concerns	1	0	3
Traffic conditions	16	17	13
Careless driving	23	18	7
Road conditions	14	10	5
Car doors opening	10	8	4
Sewer grates	5	5	5
Lack of bike lanes or paved shoulders	17	21	7
Careless cyclists	12	13	14
Worried about accidents	11	10	10
Pedestrians	5	3	2
Too many trucks	13	5	6
Theft of bike	12	7	5
Narrow streets	3	8	2
Laws not clear	5	2	3
Bikes on sidewalks	7	7	7
Lack of paths and trails	6	9	5
Lack of bike route signage	8	10	0
Secure parking facilities	10	6	4
Other	3	2	2

31. For each of the following, describe whether you think it would improve cycling in the Region a great deal, improve cycling somewhat, or not at all? How about...

Choices: Improve a great deal; Improve somewhat; Not at all; or Not Sure

		More bike lanes on major urban roads	More paved shoulders on rural roads	More off-road trails that may be through public places like parks	More bicycle parking	Better education for MOTORISTS	Better education for CYCLISTS	Repairing potholes and bad pavement	Less automobile traffic	A reduction of speed maximums for road users	Less truck traffic on major roads	Shower or change facilities in workplaces or schools	Improve signing of bicycle routes	Bike parking at key public transit stops
UTIL	Great	20	8	16	10	12	11	13	8	9	13	8	6	10
	Some	9	19	9	12	13	14	14	6	12	11	13	12	11
	Not	0	3	2	2	4	3	3	11	4	5	2	6	5
	N.sure	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total (n)	29	30	27	24	29	28	30	25	25	29	23	24	26
REC	Great	16	14	12	7	9	13	13	4	7	5	4	3	4
	Some	12	13	15	14	10	8	12	8	12	13	15	21	16
	Not	0	1	0	4	6	5	2	12	6	7	5	3	7
	N.sure	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total (n)	28	28	27	25	25	26	27	24	25	25	24	27	27
NON	Great	12	12	8	9	13	14	12	3	5	8	7	10	9
	Some	7	7	9	5	6	6	5	8	10	8	9	6	8
	Not	2	3	1	4	3	2	3	8	2	3	5	5	3
	N.sure	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total (n)	21	22	18	18	22	22	20	19	17	19	21	21	20

32. Please indicate your age category:

Choices: 16-24; 25-34; 35-44; 45-54; 55-64; 65-74; or 75 and over

	UTIL	REC	REC
16-24	5	1	0
25-34	5	4	3
35-44	8	6	1
45-54	7	6	10
55-64	4	8	7
65-74	2	3	6
75 and over	0	2	0
Total (n)	31	30	27

33. What is the highest level of education you have achieved?

Choices: Some high school or less; High school graduate; Some college; College degree; Some university; University degree; Post-graduate studies; Other (trade school, etc.)

	UTIL	REC	NON
Post-graduate studies	7	9	6
University degree	7	9	9
Some university	8	3	2
College degree	3	2	2
Some college	4	2	4
High school graduate	1	2	3
Some high school or less	1	0	0
Other (trade school, etc.)	0	2	0
Total (n)	31	29	26

34. Please describe your current employment situation (check all that apply):

Choices: (either selected or not)

	UTIL (n = 31)	REC (n = 29)	NON (n = 27)
Employed full time	13	17	13
Employed part time	8	3	0
Self-employed	5	5	2
Retired	4	7	12
A home-maker	2	1	2
Not employed	1	0	1
Student (full time)	7	1	0
Student (part time)	1	0	0

35. Was your annual household income before taxes in 2007 between:

Choices: $0 and $40,000; $40,000 and $60,000; $60,000 and $80,000; $80,000 and $100,000; or $100,000 and $120,000

	UTIL	REC	REC
$0 and $62,000	8	0	6
$62,000 and $60,000	4	7	4
$60,000 and $80,000	5	4	3
$80,000 and $100,000	2	7	4
$100,000 and more	8	6	6
Total (n)	27	24	23

36. Please indicate your gender:

Choices: Female or Male

	UTIL	REC	NON
Female	12	11	18
Male	19	19	9
Total (n)	31	30	27

37. If you would like to clarify or add to any of your responses, comment on your use of bicycles, or on your attitudes towards cycling in the Region please feel free to do so in the box below.

Choices: (open ended response)

(confidential responses)

38. If you would like to be informed about the results of this study, please enter your e-mail address in the box below. You will not be contacted for any other purpose.

Choices: (open ended response)

(confidential responses)

Appendix 5: Sample of a telephone script used to recruit potential respondents.

Hello, my name is [NAME OF CALLER] and I'm calling from the University of Waterloo. We are conducting an online survey about people's attitudes towards cycling in [HRM or WATERLOO REGION]. You don't have to answer the survey right now, and if you complete the survey your name will be entered into a draw for one of four $50 prize packages.

Are you willing to participate in our survey?

Great. So, if you can grab a pen and paper, I'll give you a web address to visit where you can take our survey. It'll take about 10 minutes to complete, all of your answers will be kept confidential, and you can refuse to answer any questions that you don't wish to answer.

Do you have a pen and paper ready?

The address is: WWW.BIKESTUDY.CA, that's W-W-W, DOT, B-I-K-E-S-T-U-D-Y, DOT, C-A. When you arrive, there will be a short information letter for you to read. The letter will inform you about the purpose of the study and affirm that the University's Office of Research Ethics has approved the study. Once you have read this, just click on the [HRM OR WATERLOO REGION] link in the centre of the page.

Thanks again for agreeing to participate and have a great day.

Appendix 6: Mail-out letter used to recruit a small portion of potential respondents

UNIVERSITY OF
Waterloo

SCHOOL OF PLANNING
University of Waterloo, 200 University Avenue West, Waterloo, Ontario, Canada N2L 3G1
519-888-4567, ext. 36564 | **www.environment.uwaterloo.ca/planning**

March 27, 2009

Hello!

You have been randomly selected to participate in an **online survey** of public attitudes towards **cycling in the Region of Waterloo**. *Bike Study* is a University of Waterloo research initiative that sets out to understand how the general public sees cycling in their communities.

You do not have to be a cyclist to participate. In fact, since the study is focused on understanding how the general public views cycling, it's just as important for you to participate if you are not a cyclist. If you do participate and complete the survey, you have the chance of winning **one of four $50.00 prizes from great local businesses.**

Your participation is voluntary. All **information that you offer will be kept confidential**. You will not be contacted again unless you win one of our four great prizes. Participants in our survey must be 16 years of age or older.

To participate, please visit **http://www.bikestudy.ca**

Before taking the survey, please take some time to read the short information letter on our website that will inform you about the purposes of our study. Then, click on the Region of Waterloo link on the main page. Depending on your answers, **the survey will take between 8 and 12 minutes to complete**.

If you have any questions about the survey, or more generally about *Bike Study*, please contact the student investigator, Benjamin Clare, at bmclare@envmail.uwaterloo.ca. The faculty supervisor for this project is Clarence Woudsma of the School of Planning. In advance, I'd like to thank you for your participation.

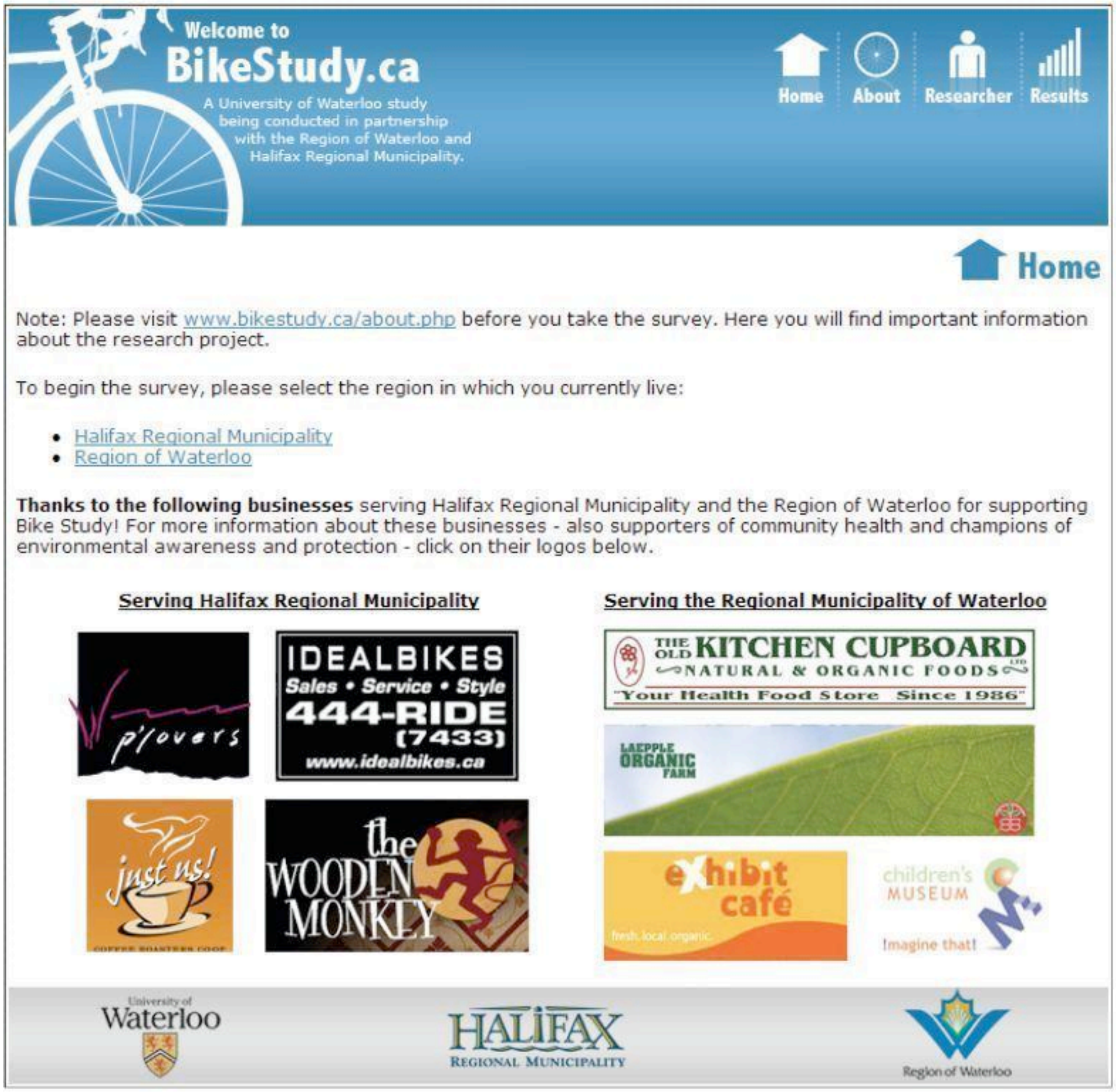
Sincerely,

Ben Clare

Benjamin Clare
MA (Candidate)
School of Planning
University of Waterloo

Waterloo
FACULTY OF ENVIRONMENT

Appendix 7: Screenshot from the <www.bikestudy.ca> homepage



Appendix 8: Letter of approval from the Office of Research Ethics

UNIVERSITY OF WATERLOO

OFFICE OF RESEARCH ETHICS

Notification of Full Ethics Clearance of Application to Conduct Research with Human Participants

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Faculty Supervisor: Clarence Woudsma **Department:** Planning, School of
Student Investigator: Benjamin Clare **Department:** Planning, School of

ORE File #: 14892

Project Title: Public Attitudes Towards Cycling: Empirical Analyses in the Region of Waterloo and Halifax Regional Municipality

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*This certificate provides confirmation that the additional information/revised materials requested for the above project have been reviewed and are considered acceptable in accordance with the University of Waterloo's Guidelines for Research with Human Participants and the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans. Thus, the provisional ethics clearance status has been removed and the project now has received full ethics clearance. This clearance is valid for a period of **four years** from the date shown below and is subject to an **annual ethics review process** (see Note 2). A new application must be submitted for on-going projects continuing beyond four years.*

***Note 1**: This project must be conducted in accordance with the description in the application and revised materials for which full ethics clearance has been granted. All subsequent modifications to the application must be submitted for prior ethics review using ORE Form 104 and must not be intiated until notification of ethics clearance has been received.*

***Note 2**: All ongoing research projects must undergo annual ethics review. ORE Form 105 is used for this purpose and must be submitted by the Faculty Investigator/Supervisor (FI/FS) when requested by the ORE. Researchers must submit a Form 105 at the conclusion of the project if it continues for less than a year.*

***Note 3**: FIs and FSs also are reminded that they must immediately report to the ORE (using ORE Form 106) any events related to the procedures used that adversely affected the participants and the steps taken to deal with these.*

ADDITIONAL COMMENTS:

[✓] No additional comments
[ ] Additional comments emailed on date shown below.

Susanne Santi (signature)

Susan E. Sykes, Ph.D., C.Psych.
Director, Office of Research Ethics
OR
Susanne Santi, M. Math ✓
Manager, Research Ethics

7/17/08
Date

Appendix 9: Variable legend showing re-categorization of survey questions for Part 2 of the analysis

Variables	Question	Sub-question	Possible Answers	Re-categorization for Contingency Analysis (Chapter 5)
Response Variables				
Bicycle use	In good weather, how many days per week do you ride a bike for the following:	To get to work	Less than once per week, 1 day per week, 2 to 4, days, 5 to 7 days	High (3 or more times per week), Low (less than 3 times per week), No (no times per week)
		To get to school		
		To go shopping or		
		To visit friends		
		For recreation or fitness		
Type of cyclist	Do you personally ride a bike in good weather for any of the following reasons?	To go to work	Either selected or not	Utilitarian cyclist (cycles to get to work, school, for shopping or running errands, to visit friends, and might cycle for recreation or fitness as well), Recreational cyclist (cycles for only recreation or fitness), Non-cyclist (does not cycle for any reason)
		To go to school		
		To go shopping or		
		To visit friends		
		For recreation or fitness		
Study area	Respondents answered different surveys based on their locations		Region of Waterloo, Halifax Regional Municipality	Not re-categorized
Explanatory Variables				
Bicycling habits				
Helmet use*	Do you wear a helmet when cycling?		Yes or No	Not re-categorized
Use of sidewalk for cycling*	Do you ride your bike on sidewalks?		Yes or No	Not re-categorized
Use of bike racks on GRT buses (Waterloo)	Have you used the bike racks attached to all GRT buses?		Yes, No, No (I don't ride a bike)	Yes, No
Consider bike rack usage on buses if more were installed (Halifax)	Would you consider combining cycling and public transit in the same trip if there were convenient and secure bike racks attached to more Metro Transit buses?		Yes, No, No (I don't ride a bike)	Yes, No

Appendix 9: continued

Demographics and geography				
Age	Please indicate your age category:		16-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75 and up	16-34, 35-54, 55 and up
Gender	Please indicate your gender:		Male or Female	Not re-categorized
Level of education	What is the highest level of education you have achieved?		Post-graduate studies, University degree, College degree, Other (trade school, etc.), Some university, Some college, High school graduate, Some highschool or less	Some university or more, no university
Employment	Please describe your current employment situation (check all that apply):	Employed full time	Either selected or not	Employed full time, other
		Employed part time		
		Self-employed		
		Retired		
		A home-maker		
		Not employed		
		Student (full time)		
		Student (part time)		
Income	Was your annual household income before taxes in 2007 between:		$0 and $40,000, $40,000 and $60,000, $60,000 and $80,000, $80,000 and $100,000, $100,000 or more	$0 and 40,000, $40,000 and $80,000, $80,000 or more

Appendix 9: continued

Residential density	Postal Code	Calculated based on respondents' residential postal codes in census tracts with either: greater than 20.76 dwelling untis per square hectare or between 5.0 and 20.75 dwelling units per square hectare		High density, low density
Estimated cycle time from residence to nearest on or off-road bicycle lane, path, or trail	How far in minutes do you live BY BICYCLE from the nearest major on or off-road bicycle lane, path, or trail?			0 to 5, 5 to 10, 10 to 15, more than 15 (minutes)
Travel distance between residence and work or school	What is the POSTAL CODE of your place of work (or school if you are a full time student). If you do not know, please estimate the distance in kilometers.	Calculated based on driving distance between respondents' residential postal codes and the postal codes of their places of work or school		0 to 5, 6 to 10, more than 10 (kilometres)
Estimated bicycle time from home to work or school	If you bike to work or school, on average, how long does your bike trip take in minutes?		Distance in minutes	0 to 10, 10 to 20, 20 to 30, 30 to 45, more than 45
Household characteristics				
Bicycle ownership	Do you or does anyone else in your household own a bicycle?		Yes or No	Not re-categorized
Number of bikes per household	How many bikes are there in your household?		0,1,2,3,4,5,6,7,8,9, 10,more than 10	1 or 2, more than 2
Number of adults per household	How many persons 15 years of age or over live in your household?		0,1,2,3,4,5,6,7,8,9, 10,more than 10	1, 2, 3, more than 3
Number of adult cyclists per household	Including yourself, how many persons 15 years of age and over in your household ride a bicycle?		0,1,2,3,4,5,more than 5	0, 1, 2, 3, more than 3
Number of utilitarian adult cyclists per household	Including yourself, how many persons 15 years of age and over in your household ride a bike for practical purposes (such as going to work or school, shopping, running errands, or visiting friends)?		0,1,2,3,4,5,more than 5	0, 1, 2 or more
Number of adults who cycle to work per household	How many persons 15 years of age and over ride a bike to WORK in good weather?		0,1,2,3,4,5,more than 5	0, 1 or more

Appendix 9: continued

Number of adults who cycle to school per household	How many persons 15 years of age and over ride a bike to SCHOOL in good weather?		0,1,2,3,4,5,more than 5	0, 1 or more
Number of adults who cycle to shop or run errands per household	How many persons 15 years of age and over ride a bike for SHOPPING or RUNNING ERRANDS in good weather?		0,1,2,3,4,5,more than 5	0, 1 or more
Number of adults who cycle to visit friends per household	How many persons 15 years of age and over ride a bike to VISIT FRIENDS in good weather?		0,1,2,3,4,5,more than 5	0, 1 or more
Number of adults who cycle for recreation per household	How many persons 15 years of age and over ride a bike for RECREATION or FITNESS in good weather?		0,1,2,3,4,5,more than 5	0, 1 or more
Mode choice				
Commute mode of transportation (other than bicycle)	How do you most often commute to work or school when NOT cycling? By:		Car (as a driver), Car (as a passenger), Public Transit, Walk, Carpool, Taxi, In-line skates or snowboard, I don't travel to work or school, Other	Car (driver or passenger), Other
Commute mode choice	How do you most often commute to work or school? By...		Car (as a driver), Car (as a passenger), Public Transit, Walk, Bicycle, Carpool, Taxi, In-line skates or snowboard, I don't travel to work or school, Other	Car (driver or passenger), Bicycle, Other
Motor vehicle access	How often do you have access to a motor vehicle?	n/a	All of the time, Several times per week, Occasionally, Never	Low (never or occasionally), high (all of the time, several times per week)

Mode choice influences:				
Travel time	Please indicate how heavily the following factors influence your choice of transportation modes (car, bike, public transit, etc.).		No Influence, Little Influence, Medium Influence, Major Influence	Major/medium influence, Little/no influence
Personal safety				
Fuel costs				
Availability of public transit				
Feelings towards climate				
Feelings towards air quality				
Cost of maintaining and owning a vehicle				
Others' safety				
Personal image				
Personal health				
Weather				
Climate and comfort on different facility types				
Number of months cycled*	In what months of the year do you cycle? (Check all that apply)		(all months were available to select separately)	0 to 4 months, 4 to 8 months 8 to 12 months
Likeliness of cycling on days with:				
Pleasant weather*	How likely are you to cycle on days with...		Very likely, Likely, Unlikely, Very unlikely	Likely, unlikely
Light rain*				
Heavy rain*				
Light snow*				
Heavy snow*				
Icy conditions*				
Warm temperature*				
High humidity*				
Cold temperature*				
Comfort on different facility types:				
Rural roads*	For each of the following statements please answer YES or NO. Would you say that you are comfortable cycling on...		Yes or No	Not re-categorized
Off-road trails*				
Residential streets*				
Major roads with bike lanes*				
Major roads with wide curb lanes*				
Major roads without bike lanes or wide curb lanes*				

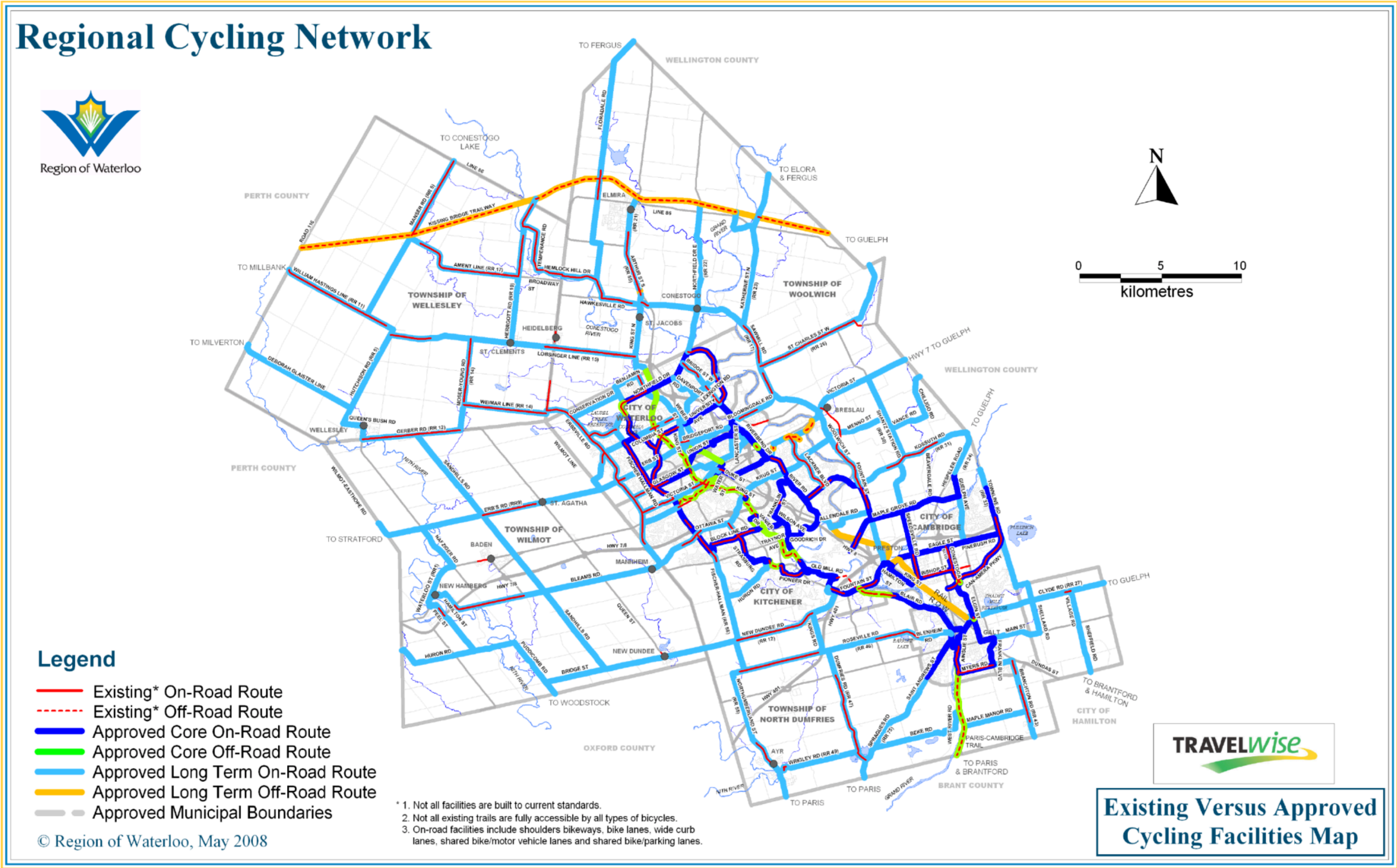
Attitudes and preferences				
Elements respondents assert would encourage them to cycle more:				
Nothing	What, if anything, could HRM or your employer or school do to encourage you to bike to work or school?		Either selected or not	Not re-categorized
More on-street bike lanes or paved shoulders				
More off-street bicycle paths				
Better bicycle route signage				
Better education for motorists				
Better education for cyclists				
Shower and change facilities at work or school				
More bicycle parking facilities				
Secure bicycle parking facilities				
Bicycle parking at key public transit stops				
Bike racks on more local buses (Halifax)				
Better road maintenance				
Less truck traffic				
Less car traffic				
A reduction in speed maximums for road users				
Other				
Elements respondents assert would improve cycling in their communities:				
More bike lanes on major urban roads	For each of the following, describe whether you think it would improve cycling in HRM a great deal, improve cycling somewhat, or not at all? How about...		Improve a great deal, Improve somewhat, Not at all, Not sure	Improve, or not
More paved shoulders on rural roads				
More off-road trails that may be through public places like parks				
More bicycle parking				
Better education for motorists				
Better education for cyclists				
Repairing potholes and bad pavement				

A speed limit reduction for automobile traffic				
Less automobile traffic				
Less truck traffic on major roads				
Shower or change facilities in workplaces or schools				
Bike racks on more local buses (Halifax)				
Improve signing of bicycle routes				
Bike parking at key public transit stops				
Respondents' reasons for not cycling more for utilitarian purposes:				
Lack of secure bike parking	Why don't you use your bike to get to work, school, or for shopping, running errands, or visiting friends?		Either selected or not	Not re-categorized
Distance				
Unsafe traffic conditions				
Too many trucks				
Need car for work				
Can't carry things on bike				
Prefer walking				
Incompatible with work clothes				
Lack of bike lanes/paths/paved shoulders				
Free automobile parking at work (or school)				
No shower or change-room facilities at destination				
Other				
Respondents' concerns about cycling or cyclists				
No concerns	What concerns, if any, do you have about cycling or cyclists in HRM? (Please check all that apply)		Either selected or not	Not re-categorized
Traffic conditions				
Careless driving				
Road conditions				
Car doors opening				
Sewer grates				

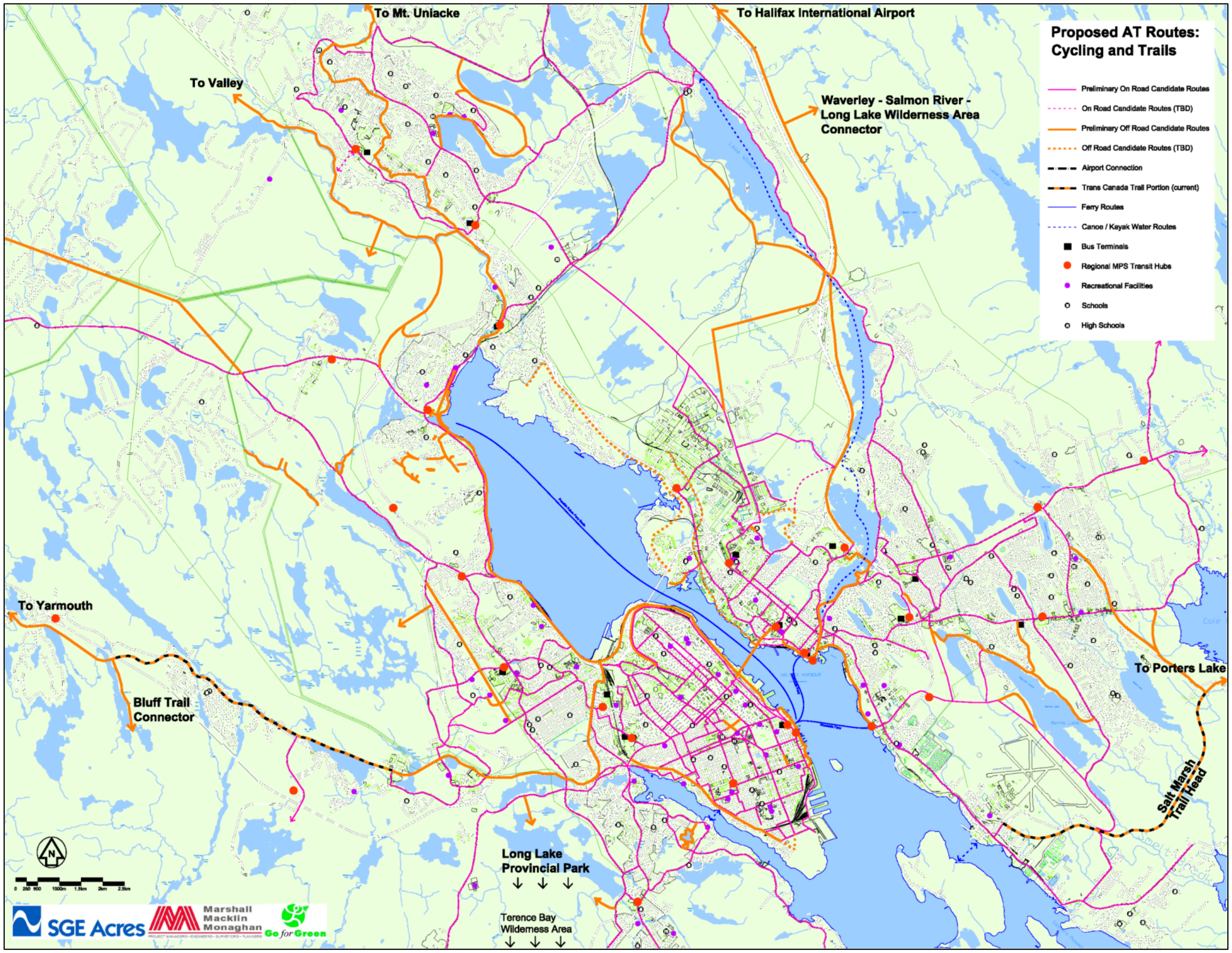
Appendix 9: continued

Lack of bike lanes or paved shoulders				
Careless cyclists				
Worried about accidents				
Pedestrians				
Too many trucks				
Theft of bike				
Narrow streets				
Laws not clear				
Bikes on sidewalks				
Lack of paths and trails				
Lack of bike route signage				
Secure parking facilities				
Other				
Other				
Provision of bicycle parking facilities at work or school	Do you have convenient and secure bicycle parking facilities at your workplace or school?		Yes or No	Not re-categorized
Provision of shower and change facilities at work or school	Do you have convenient shower/change facilities at your workplace or school?		Yes or No	Not re-categorized
Respondents' rating of the quality of cycling routes and facilities in their municipality	Thinking about the overall quality of cycling routes and facilities available to residents of HRM, would you say they are...		Excellent, Very good, Good, Fair, Poor, Not Sure	Excellent/very good/good, or fair/poor

Appendix 10: Map showing existing and approved cycling routes in 2004 from the Region of Waterloo Cycling Master Plan



Appendix 11: Map of the Active Transportation Network Plan from Halifax Regional Municipality's Active Transportation Functional Plan (2006)



Appendix 12: Complete survey analysis results: p - values (Fisher's Exact Test)

Explanatory variables	*p* - values						
	Respondent Type			Bicycle Use			Independence of Study Areas
	Waterloo	Halifax	Both Study Areas	Waterloo	Halifax	Both Study Areas	
Bicycling habits							
Respondent type							0.130
Bicycle use	**0.000**	**0.000**	**0.000**				0.193
Helmet use*	0.795	0.265	0.651	0.423	0.595	1.000	**0.000**
Use of sidewalk for cycling*	1.000	0.480	1.000	1.000	0.307	0.493	0.168
Use of bike racks on GRT buses (Waterloo)	0.149			**0.003**			
Consider bike rack usage on buses if more were installed (Halifax)		0.051			**0.033**		
Household Characteristics							
Bicycle ownership	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.039**
Number of bikes per household	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.040**
Number of adults per household	0.073	0.960	0.090	0.415	0.566	0.654	0.102
Number of adult cyclists per household	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.025**
Number of utilitarian adult cyclists per household	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	0.221
Number of adults who cycle to work per household	**0.000**	**0.000**	**0.000**	**0.000**	**0.004**	**0.000**	0.089
Number of adults who cycle to school per household	**0.008**	0.124	**0.001**	**0.004**	0.308	**0.002**	0.778
Number of adults who cycle to shop or run errands per household	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.046**
Number of adults who cycle to visit friends per household	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	0.445
Number of adults who cycle for recreation per household	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	0.749
Demographics and geography							
Age	0.104	0.170	**0.013**	**0.007**	0.216	**0.002**	0.449
Gender	**0.046**	0.089	**0.009**	**0.015**	0.170	**0.003**	0.514
Level of education	0.875	0.790	0.905	0.729	0.563	0.575	1.000
Employment	**0.008**	0.058	**0.001**	**0.007**	0.105	**0.001**	0.523
Income	**0.034**	0.572	0.244	0.228	0.966	0.353	0.233
Study area			0.130			0.193	
Residential density	0.574	0.376	0.365	0.771	0.120	0.204	0.069
Estimated cycle time from residence to nearest on or off-road bicycle lane, path, or trail	0.188	0.762	0.195	0.507	0.172	0.559	**0.031**
Travel distance between residence and work or school	**0.048**	0.209	0.441	0.248	**0.024**	0.151	0.779
Estimated bicycle time from home to work or school	1.000	(note[1])	1.000	0.125	0.066	**0.005**	0.160
Mode choice							
Commute mode of transportation (other than bicycle)	0.052	0.438	0.197	0.069	0.259	0.410	0.273
Commute mode choice	0.056	0.478	**0.036**	0.093	0.771	0.097	**0.000**
Motor vehicle access	0.205	0.154	0.140	0.101	0.119	**0.039**	0.811
Mode choice influences:							
Travel time	0.264	**0.035**	**0.014**	1.000	**0.031**	0.405	0.812
Personal safety	0.449	0.530	0.440	0.121	0.094	**0.024**	0.370

Appendix 14: (continued)

Fuel costs	0.788	0.529	0.701	0.923	0.050	0.187	0.246
Availability of public transit	0.924	0.380	0.261	0.670	**0.032**	0.134	**0.002**
Feelings towards climate change	0.350	0.788	0.349	0.140	0.750	0.114	0.134
Feelings towards air quality	0.580	1.000	0.704	0.329	0.904	0.616	0.625
Cost of maintaining and owning a vehicle	1.000	0.064	0.175	0.405	0.055	0.082	0.173
Others' safety	0.690	0.284	0.306	0.845	0.212	0.268	0.495
Personal image	1.000	0.530	0.715	0.389	0.373	0.948	0.424
Personal health	0.102	0.117	**0.011**	0.055	0.559	0.064	0.082
Weather	0.948	0.686	0.909	0.945	0.866	1.000	0.845
Climate and comfort on different facility types							
Number of months cycled*	0.055	**0.030**	**0.001**	0.273	0.831	0.363	0.132
Likeliness of cycling on days with:							
Pleasant weather*	0.237	**0.038**	**0.020**	0.284	0.653	0.234	0.256
Light rain*	**0.003**	**0.043**	**0.000**	**0.000**	0.315	**0.000**	0.170
Heavy rain*	0.491	1.000	1.000	0.161	0.603	0.086	0.199
Light snow*	0.051	1.000	0.129	**0.007**	0.486	**0.002**	0.816
Heavy snow*	(note[2])	0.314	0.422	(note[2])	1.000	0.449	0.389
Icy conditions*	1.000	0.324	1.000	0.407	1.000	0.204	1.000
Warm temperature*	0.193	**0.038**	**0.009**	0.384	0.170	0.103	0.752
High humidity*	**0.000**	**0.002**	**0.000**	**0.000**	**0.002**	**0.000**	0.178
Cold temperature*	**0.012**	0.259	**0.001**	**0.010**	0.502	**0.014**	0.083
Comfort on: Rural roads*	0.777	0.107	0.146	0.836	1.000	0.471	**0.044**
Off-road trails*	1.000	(note[2])	1.000	0.771	(note[2])	0.499	0.520
Residential streets*	0.492	0.111	0.078	0.509	1.000	1.000	0.559
Major roads with bike lanes*	0.399	**0.005**	**0.017**	0.144	**0.037**	**0.008**	0.342
Major roads with wide curb lanes*	0.119	0.090	**0.014**	0.425	0.318	0.148	0.523
Major roads without bike lanes or wide curb	0.730	0.126	0.066	0.724	0.130	0.121	0.446
Attitudes and preferences							
Elements respondents assert would encourage them to cycle more:							
Nothing	**0.003**	0.159	**0.002**	**0.003**	0.082	**0.011**	0.072
More on-street bike lanes or paved shoulders	**0.024**	0.103	**0.008**	**0.010**	0.140	**0.005**	0.122
More off-street bicycle paths	**0.008**	0.131	**0.028**	**0.019**	0.172	0.065	0.060
Better bicycle route signage	**0.042**	0.477	**0.036**	**0.004**	0.149	**0.001**	1.000
Better education for motorists	**0.029**	0.158	**0.019**	**0.017**	0.299	**0.014**	0.857
Better education for cyclists	0.950	0.429	0.702	1.000	0.751	0.942	0.570
Shower and change facilities at work or school	**0.015**	0.637	0.260	0.111	0.928	0.405	0.423
More bicycle parking facilities	0.167	0.518	0.512	0.197	0.935	0.434	0.051
Secure bicycle parking facilities	**0.038**	0.732	0.100	0.128	0.725	0.224	0.101
Bicycle parking at key public transit stops	0.136	0.229	0.300	0.554	0.500	0.525	0.610
Bike racks on more local buses (Halifax)		0.716			0.709		
Better road maintenance	0.139	0.228	0.131	0.081	0.500	0.279	0.119
Less truck traffic	**0.006**	0.247	**0.005**	**0.023**	0.180	**0.004**	0.665
Less car traffic	0.194	**0.050**	**0.029**	0.387	0.180	0.098	0.635
A reduction in speed maximums for road users	0.364	0.525	0.134	0.387	**0.018**	**0.030**	0.122
Other	0.612	0.577	0.325	0.314	0.869	0.408	0.236

Elements respondents assert would improve cycling in their communities:							
More bike lanes on major urban roads	**0.017**	1.000	0.060	0.154	1.000	0.063	1.000
More paved shoulders on rural roads	0.424	0.693	0.831	0.710	0.742	0.686	0.301
More off-road trails that may be through public places like parks	0.462	0.593	0.554	0.166	1.000	0.249	0.627
More bicycle parking	0.592	0.520	0.726	0.862	0.309	0.451	0.256
Better education for motorists	1.000	0.673	0.761	0.251	0.671	0.853	0.115
Better education for cyclists	0.634	0.671	0.826	0.833	0.557	0.937	0.271
Repairing potholes and bad pavement	0.806	1.000	1.000	0.642	0.458	1.000	0.351
A speed limit reduction for automobile traffic	0.865	0.270	0.670	0.953	0.234	0.654	0.347
Less automobile traffic	0.720	0.298	0.677	0.611	0.098	0.953	0.806
Less truck traffic on major roads	0.614	0.111	0.301	0.357	0.149	0.305	0.297
Shower or change facilities in workplaces or schools	0.381	1.000	0.462	0.787	0.817	1.000	0.181
Bike racks on more local buses (Halifax)		0.878			0.488		
Improve signing of bicycle routes	0.370	0.884	0.725	0.800	1.000	0.912	0.470
Bike parking at key public transit stops	0.716	0.242	0.182	0.711	0.429	0.239	0.365
Respondents' reasons for not cycling more for utilitarian purposes:							
Lack of secure bike parking	**0.046**	0.096	**0.010**	0.508	0.154	0.175	1.000
Distance	0.523	0.055	0.052	0.815	0.082	0.119	0.242
Unsafe traffic conditions	0.625	0.091	0.229	0.733	0.948	0.810	0.402
Too many trucks	**0.019**	0.556	0.280	**0.018**	0.555	0.223	0.104
Need car for work	0.776	0.432	0.578	0.777	0.593	0.333	0.057
Can't carry things on bike	0.314	0.876	0.325	0.773	0.936	0.665	0.212
Prefer walking	1.000	0.764	0.811	1.000	0.127	0.206	0.117
Incompatible with work clothes	0.902	**0.004**	0.348	0.853	0.159	0.317	0.578
Lack of bike lanes/paths/paved shoulders	0.067	0.099	0.110	0.074	0.769	0.418	**0.001**
Free automobile parking at work (or school)	**0.049**	0.578	0.132	0.218	0.562	0.429	0.078
No shower or change-room facilities at destination	0.405	0.094	0.270	0.783	0.166	0.278	1.000
Other	0.766	0.097	0.152	0.684	0.141	0.287	0.571
Respondents' concerns about cycling or cyclists:							
No concerns	0.109	0.685	0.385	0.129	0.742	0.444	0.695
Traffic conditions	0.734	0.944	0.763	0.762	1.000	0.935	0.184
Careless driving	**0.001**	0.145	**0.001**	**0.007**	0.195	**0.005**	0.094
Road conditions	0.132	0.068	**0.024**	0.191	0.279	0.144	**0.001**
Car doors opening	0.318	0.198	0.231	0.423	0.186	0.452	**0.010**
Sewer grates	1.000	0.249	0.626	0.090	0.539	0.682	**0.037**
Lack of bike lanes or paved shoulders	**0.002**	0.269	**0.021**	**0.006**	0.051	**0.024**	**0.000**
Careless cyclists	0.519	1.000	0.633	0.225	0.329	0.786	0.871
Worried about accidents	1.000	**0.030**	0.178	0.920	0.082	0.199	0.509
Pedestrians	0.701	0.298	0.430	0.440	0.653	1.000	0.808
Too many trucks	0.101	0.559	0.068	0.175	0.930	0.238	0.458
Theft of bike	0.253	0.289	0.114	0.193	0.229	**0.042**	1.000
Narrow streets	0.075	1.000	0.290	0.604	1.000	0.719	0.399
Laws not clear	0.586	0.144	0.691	0.837	0.279	0.516	0.633
Bikes on sidewalks	0.951	0.056	0.115	0.628	**0.020**	0.178	0.211
Lack of paths and trails	0.453	0.352	0.424	0.899	0.651	0.935	**0.000**
Lack of bike route signage	**0.001**	0.511	0.151	**0.001**	0.743	0.169	0.259
Secure parking facilities	0.311	0.400	0.119	0.619	0.781	0.499	0.707

Appendix 14: (continued)

Other	1.000	1.000	1.000	0.617	0.279	1.000	0.756
<u>Other</u>							
Provision of bicycle parking facilities at work or school	0.287	0.664	0.485	0.260	0.861	0.379	0.688
Provision of shower and change facilities at work or school	0.197	0.191	0.298	0.764	0.754	0.573	**0.042**
Respondents' rating of the quality of cycling routes and facilities in their municipality	0.139	(note[2])	0.108	0.197	(note[2])	0.081	**0.003**

* data gathered from cyclists only
note[1]: all respondents were utilitarian
note[2]: all responses were identical