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Effects of new urban greenways on transportation energy use and greenhouse gas emissions: A longitudinal study from Vancouver, Canada

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1. Introduction

Urgent action on global climate change is necessary to avoid its most dangerous effects on human settlements and natural ecosystems within the next century. Multiple levels of government are now collectively addressing anthropogenic causes of climate change, including setting targets and actions for reducing greenhouse gas (GHG) emissions (Rogelj et al., 2016). In Canada, passenger road transportation accounts for 19% of all GHG emissions, with a continuing trend of rising emissions from increasing total vehicle-kilometers travelled (VKT) and the number of motor vehicles (Environment Canada, 2016). Major transportation decisions made at the local and regional levels will need to prioritize strategies that most effectively reduce GHG emissions (Baynham and Stevens, 2014; Yang et al., 2015). Investments in active transportation infrastructure are considered an important way to reduce motor vehicle use, and subsequently motorized energy use and emissions (Frank et al., 2010).

However, meaningful progress on climate change action has been difficult to achieve, in part due to the political infeasibility of the rapid changes needed to retrofit existing communities to be more energy efficient and less auto-dependent (Senbel and Church, 2011). For example, the implementation of active transportation improvement projects, such as protected bicycle lanes (or cycle tracks), have proven to be controversial among the general public (Siemiatycki et al., 2016). Reallocation of existing road space for other road users is perceived by many motorists as a “war on the car” despite established evidence of benefits for all road users (Cairns et al., 2002). In light of these barriers, coupled with the imperative of climate action, where should planning and transportation practitioners prioritize their efforts in order to maximize progress towards more environmentally sustainable development?

Research has long documented positive and statistically significant associations between built environment features and travel behavior (Ewing and Cervero, 2010; Frank et al., 2006). However, these conclusions are generally arrived at through the use of cross-sectional studies. The absence of controlled, longitudinal studies in the travel behavior literature makes it difficult to assess causal relationships of new transportation infrastructure on VKT reductions, and subsequently, energy use and GHG emissions. Researchers have made calls to expand the literature to include more evaluation studies of the built environment to provide causal evidence (Boarnet, 2011; Handy, 2017). Moreover, the adoption of longitudinal methods provides the additional benefit of addressing the residential self-selection issue in transportation research, where observed travel behavior is not only a function of people’s residential built environment, but their attitudinal predispositions towards certain travel modes (Mokhtarian and Cao, 2008). For practitioners, causal evidence will help prioritize and better guide sustainable transportation policy and decision-making.

There exists a limited number of longitudinal studies evaluating the effects of active transportation infrastructure on travel behavior (Goodman et al., 2013, 2014; Hunter et al., 2015; Pucher et al., 2010; Yang et al., 2010). Even fewer studies evaluate the specific effect on motorized travel behavior and the impact on energy use and GHG emissions (Brand et al., 2014; Zahabi et al., 2016),

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with these studies only investigating the overall effect of multiple improvement projects or entire cycling networks. To address this gap in the literature, we present the results of a longitudinal case study of a single urban greenway.

Urban greenways are landscaped and traffic-calmed pathways with a mix of bicycle facilities and other streetscape improvements that link open spaces, parks, public facilities, and neighborhood centers together. Greenways support a variety of active travel uses, including walking, running, bicycling, and skating (Krizek et al., 2007; Lindsey, 1999). These types of multi-use facilities are preferred by a greater diversity of potential bicycle users, particularly women and adults with children (Winters and Teschke, 2010). Installing greenways have been found to improve perceptions among residents that their neighborhood environment is more favorable towards non-motorized travel (Ma and Dill, 2015). As a result, the provision of greenways is hypothesized to be an effective strategy to reduce motor vehicle use among the general population. However, existing research on greenways focus exclusively on the effects on active travel behavior (Evenson et al., 2005; Fitzhugh et al., 2010; Merom et al., 2003; West and Shores, 2011), with no formal evaluation on motor vehicle use and changes in VKT.

The aim of this paper is to evaluate the effect of an urban greenway on motorized travel behavior. This paper uses data from the Comox-Helmcken Greenway Study, a three-year study led by Dr. Lawrence Frank that took place from 2012 to 2015 investigating the impacts of the Comox-Helmcken Greenway (Comox Greenway) in Vancouver, Canada before and after its construction. We make two novel contributions to the literature—this is the among the first quasi-experimental, longitudinal cohort study of the travel behavior effects of active transportation infrastructure, and likely the first reported study of the effect of an urban greenway on energy use and GHG emissions. For the present study, we ask the following question: what was the effect of the Comox Greenway on transportation energy use and GHG emissions for residents living near the greenway before and after its construction?

2. Methods

2.1. Study area

The study area is in the West End neighborhood of downtown Vancouver. The West End is a high-density, mixed residential and commercial neighborhood, and is considered to be one of the most compact and non-auto-dependent neighborhoods in the Vancouver region (Frank et al., 2010).

This study evaluates the Comox Greenway, a major active transportation corridor extending west-to-east from Stanley Park through downtown Vancouver between Stanley Park Lane and Hornby Street. The greenway was designed to be comfortable and safe for users of all ages and abilities, providing a new route in the downtown bicycle network for both utilitarian commuters and recreational riders. Fig. 1 shows the changes along the Comox Greenway. The two-kilometer long corridor consists of a mix of cycling facility improvements: one-way shared on-street with counterflow lanes (22%); one-way protected (29%); and two-way shared on-street (49%). Other improvements included: (1) new and upgraded traffic signals; (2) new street paving, concrete medians and curb bulges, catch basins, paint, and signage; (3) new sidewalks, curb ramps, and raised crosswalks; (4) new and upgraded street, sidewalk, and park lighting; and (5) new public realm amenities, such as seating, planting, trees, drinking fountains, and wayfinding features.

2.2. Sampling procedure

The Comox-Helmcken Greenway Study is a natural experiment that tracked a cohort of residents during two waves of longitudinal samples. A random sample of household addresses were identified by Mustel Group, a third-party market research company, using the Canada Post address data file as the sampling frame. Invitation letters were sent out by mail by the City of Vancouver to potential participants. Residents were recruited into the study if they were living approximately within a kilometer of the Comox Greenway in Vancouver and had no plans to move outside the study area during the time of the study. Reference to the Comox Greenway was not specified to minimize participation bias.

A survey was conducted during the fall and winter for both before-and-after periods with a two-year follow-up period (time 1 baseline: October 2012 – March 2013; time 2 follow-up: October 2014 – March 2015); the greenway completed construction and opened in June 2013. Participants completed an online two-day personal travel survey and a detailed questionnaire with a hardcopy back-up available. Incentives for participation included gift certificates and a prize draw to civic facilities ($10 and $1,000 value respectively). A total of 1,744 mailings were sent out. For the baseline period, a total of 1,113 participants were recruited (63.82% response rate).

Participants were excluded from the study if they did not participate in the follow-up period ($n = 556$), did not complete the survey for the two survey days ($n = 25$), or were otherwise ineligible ($n = 8$). The final sample size for analysis was 524 participants (30.1% response rate; 47.1% attrition rate).

For the present study, the sample was assigned to two groups based on residential proximity from the greenway in order to estimate the intervention exposure: 239 participants in the treatment group living within 300 m of the Comox Greenway, and 285 participants in the control group living further than 300 m (see Fig. 2). The use of proximity to define the treatment condition is similar to previous longitudinal research (West and Shores, 2011, 2015). The base threshold of 300 m in this study was selected based on a qualitative assessment. First, 300 m is equal to two-and-a-half street blocks using the existing street grid in the study area before reaching a major commercial street (Davie Street). Beyond this distance, residents have the option of choosing a more attractive off-road shared pedestrian and cyclist pathway along the waterfront (Seaside Greenway); this type of facility has been identified as the most preferred route type among current and potential cyclists (Winters and Teschke, 2010). Second, 300 m provides a roughly equal