Transport Infrastructure Indicators in Nova Scotia

ESTIMATES OF BASELINE DATA FOR THE TEN MOST POPULOUS MUNICIPALITIES

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Summary

The Province of Nova Scotia aims to transition to a more sustainable transportation system with increased support for Active Transportation (AT). The *Choose How You Move* and *Thrive!* strategies by the departments of Energy and Health and Wellness respectively, as well as the Union of Nova Scotia Municipalites, and many business and non-profit organizations share this aim, and also have explicitly noted the importance of data collection, analysis and dissemination in achieving this aim.

The Dalhousie Transportation Collaboratory (DalTRAC) has become a partner with the Province to help collect, analyze and disseminate data on transportation. Indicators are a useful tool for data collection and have become a focus of DalTRAC research. This report collects and analyzes indicator data on transportation infrastructure in Nova Scotian municipalities. Nova Scotia faces challenges with population, rurality, bureaucracy, finances, staff limitations, and coordination.

This report explicitly includes both indicators of infrastructure for vehicular transport *and* of infrastructure for AT transport. It includes data on roads, trails, bicycle lanes and sidewalks for the ten most populous municipalities in the province, sourced from calls and emails to municipalities and provincial departments. The report compares numerical data in charts and GIS data in maps.

On average across the ten municipalities studied, there is less than 1 metre of trail, of bicycle lane and of sidewalk per capita, and almost 150 metres of road per capita. The two most populous municipalities studied (Halifax Regional Municipality, and Cape Breton Regional Municipality) have higher amounts of AT infrastructure than the other municipalities, but the Towns studied have higher per capita amounts. For the most part, municipalities with higher population densities have fewer roads per capita. Many municipalities have no bicycle lanes or sidewalks.

In most cases, municipalities collect this data, but it is not readily available. A few municipalities made their data available via open access websites. This report includes a prototype tool for making infrastructure data, both charts and GIS maps, available publicly on the web, through ArcGIS Online.

The indicator set and analysis provided in this report can allow for and facilitate:

- prioritization of infrastructure investments based on planning goals and planning indicators, including the set proposed in this report;
- continued investing in AT infrastructure;
- continued data collection and data archiving, and make data publicly and readily available; and,
- progress-tracking towards planning goals through comparison of indicators over time.

Future research should:

- include other types of transport infrastructure, such as parking lots and transit assets;
- explore bidirectionality of infrastructure, especially for sidewalks and bicycle lanes, to ensure consistent data collection;
- gather data for the remaining municipalities in the province;
- track indicators of land consumption - which takes into account area of infrastructure instead of just length; and
- track indicators of connectivity, such as number of road intersections per square kilometre, since this can provide a better sense of the quality of the infrastructure.

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Introduction

Sustainable Transportation

Most Nova Scotians use a personal vehicle for transportation. Only 8% commute by walking, 6% by public transit and 1% by bicycle (Province of Nova Scotia, 2013b). The Province of Nova Scotia aims to increase mode share for active transportation (AT) modes such as walking or bicycling, and communal modes such as public transportation and carpooling (Province of Nova Scotia, 2013). This would make amenities more accessible for those who would prefer to use non-automobile alternatives, and reduce congestion, pollution, road fatalities, energy consumption, land consumption and urban sprawl (Province of Nova Scotia, 2013).

Providing AT infrastructure allows Nova Scotia to better support its aging population, many of whom are no longer able to drive themselves, and to attract more young people to rural areas, some of whom cannot yet drive or cannot afford a vehicle (Transport Canada, 2009). Reducing sprawl by densifying transportation networks can improve cost efficiency.

As we work towards a more sustainable transportation system we, "must consider current infrastructure realities" because "...in certain situations more efficient vehicle use is the only reasonable option" (Ecology Action Centre, 2008, p. 27). To that end, this report is about understanding the current state of transportation infrastructure in Nova Scotia.

85%

6%

1%

8%

Tracking Progress

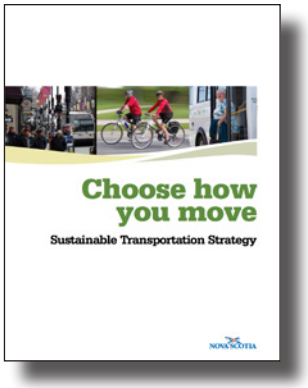
PROVINCIAL SUPPORT

Two recent strategies in Nova Scotia have identified a need to monitor progress towards achieving AT goals. The *Choose How You Move*: *Sustainable Transportation Strategy* (2013) discusses two actions related to Tracking Progress:

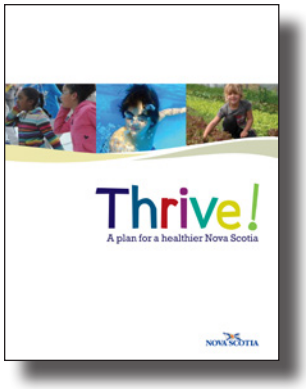
1. "The province will publish baseline data on sustainable transportation, develop and monitor key indicators over time, and report annually to the public."
2. "A Sustainable Transportation Centre will be created (see Action #5). The Centre will collect, track, analyze, and make available transportation data, trends, and behaviour at the national, provincial, municipal, and community level." (p. 35)

Dalhousie Transportation Collaboratory (DalTRAC) serves as the Sustainable Transportation Centre and has begun collecting and publishing data on sustainable transportation indicators (see <http://novascotia.ca/sustainabletransportation/tracking-progress.asp>).

Thrive! (2012), the province's health strategy, similarly recommends that Nova Scotia should increase mode share in active transportation, "measure and report on progress" and "publish a report every two years that provides... status of key indicators" (p. 62).



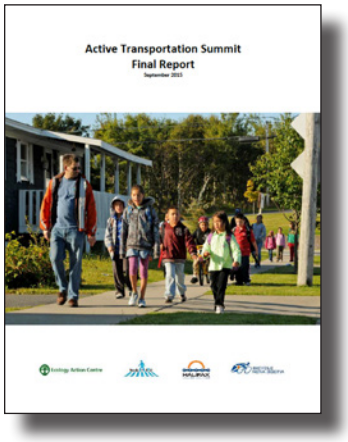
Department of Energy



Department of Health and Wellness

MUNICIPAL SUPPORT

The Union of Nova Scotia Municipalities (UNSM), which includes members from all municipalities, made AT a priority in 2008 and resolved to improve infrastructure to support AT (UNSM, 2015). Many municipalities individually track their progress. However, often data comes from different departments (e.g. Planning vs. Public Works), is not compiled and is not readily available for analysis or comparison.



Active Transportation Summit Draft Report

NON-PROFIT SUPPORT

Non-profit and advocacy groups have also recently underlined the importance of data collection. After research and consultation with nine communities, the Ecology Action Centre's ***Green Mobility Strategy*** (2008) recommended that Nova Scotia "Establish indicators for annually measuring progress toward sustainable transportation" (p. 9), noting that "measurement of sustainable transportation progress in Nova Scotia is hindered by a lack of complete, reliable data." Specifically, they recommend "annual reviews... five-year assessments of targets" and "public presentation of all results" (p. 42).

COLLABORATIVE SUPPORT

In September 2015, almost 50 AT participants from various organizations, including non-profit organizations, bicycle related business owners and provincial and municipal departments, gathered at the ***Active Transportation Summit*** (2015) to discuss what should be the "Three Big Moves" prioritized by stakeholders in Nova Scotia (presentation at Nova Scotia Bike Summit, Janet Barlow, October 2015). The second most important move identified was: "Collect and mobilize effective and comprehensive evidence and data" (p. 2, Active Transportation Summit, 2015).

INDICATORS

Indicators are a common way to track progress for planning purposes. They are variables that measure phenomena (Haghshenas & Vaziri, 2012). They can be qualitative or quantitative. Indicators are useful for

"highlighting problems, identifying trends, contributing to priority-setting, policy formulation and evaluation and monitoring of progress and… informing the public and decision-makers" (Dobranskyte-Niskota, 2007, p. 4).

The Federation of Canadian Municipalities has advocated for indicators in sustainable transportation and recommends the following process (FCM, 2008, p. 1):

- identify benefits,
- define indicators,
- set targets,
- organize data collection,
- analyze data.

To receive Gas Tax Funding from the federal government, Canadian municipalities are required to show infrastructure asset management (Infrastructure Canada, 2014). Indicator monitoring is a method of asset management and typically includes (FCM, 2002)

- inventory,
- replacement value,
- condition,
- repair and construction history,
- repair and replacement cost, and
- budget allocations.

Data is available and readily accessible for Nova Scotia's roads (e.g. Department of Transportation and Infrastructure Renewal, 2014), but not for active transportation infrastructure. A study in the province of New Brunswick notes that "most Canadian municipalities lack basic metrics on AT, which has led to difficulty in measuring outcomes and justifying future projects" (Hanson, 2015, p. 1).

Transportation indicators
http://www.drivingtesttips.biz/wp-content/uploads/2014/05/car-indicators.jpg

RESEARCH INITIATIVES

This report provides baseline indicator data on transportation infrastructure in ten Nova Scotian municipalities. It responds to the objectives and actions of ***Thrive!*** and ***Choose How You Move***, with the intention of tracking Nova Scotia's progress towards a sustainable transportation system, as part of a larger project with DalTRAC.

DalTRAC has continuing research on transportation indicators in Nova Scotia. Most research has focused on demand-related indicators such mode choice, vehicle kilometres traveled and greenhouse gas emissions (DalTRAC, 2015).

In 2014 and 2015, DalTRAC, in collaboration with the Union of Nova Scotia Municipalities (UNSM) and Community Transit Nova Scotia (CTNS) completed surveys of Nova Scotian muncipalities, to track their transportation supply and demand. DalTRAC received data from 28 of the province's municipalities. Eleven municipalities responded neither to DalTRAC's 2014 nor 2015 surveys (personal communication, Sara Campbell, September, 2015). Surveys included sections on planning capacity, infrastructure and community transit.

This report follows up on the 2014 DalTRAC survey by focusing on infrastructure inventory, and explicitly comparing infrastructure for different modes of transportation. Currently "very little of the available data... provides detail within the various modes of transportation" (Province of Nova Scotia, 2013, p. 4). This study is the first to compile data on sidewalks in Nova Scotian municipalities.

Within DalTRAC's framework of transportation indicators, which considers Environmental, Social, Economic and Land-Use, transportation infrastructure indicators fall under Land-Use (see DalTRAC, 2015, p. 14 for diagram). Province-wide adoption of a standardized set can facilitate consistent methods of measurement for municipalities and provincial bodies and comparison between muncipalities.

http://www.dal.ca/content/dam/dalhousie/pdf/sites/share-the-road/Partners/Partner_LogoSized/UNSM.png

Infrastructure

SUPPLY INFLUENCES DEMAND

It can be difficult to justify expenses for amenities used by a small portion of the population. But unavailable or inadequate infrastructure can be a significant deterrent for aspiring cyclists and walkers. Multiple studies demonstrate that transportation supply has an impact on transportation demand (see Transport Canada, 2010).

According to the Fraser Basin Council, improvements to physical infrastructure are one of three main ways to influence transportation demand in small and medium sized communities, along with education and plans and policies (2009, p. 7). Communities with more kilometres of bicycle facilities and more density of bicycle lanes have higher AT mode shares (TCAT, 2010, p. viii).

Sometimes roads are without sidewalks. http://www.dailyrepublic.com/files/2015/04/walk_family-courts-1-1024x709.jpg

PROVINCIAL PRIORITY

It is a provincial priority that physical networks explicitly for AT and public and community transit are developed (Province of Nova Scotia, 2013, p. 3) and that destinations are "connected by pathways, trails, bike lanes, sidewalks, and public transit" (Department of Health and Wellness, 2012, p. 53).

MUNICIPAL PRIORITY

Municipalities recognize the importance of infrastructure. The UNSM note in their AT Survey, ***Where it's AT,*** the need for "expansion and maintenance of infrastructure" for AT (UNSM, 2010) and considers infrastructure one of their three central mandates (UNSM, 2010, p. 15). In the Ecology Action Centre's (EAC) 2008 consultation with citizens in nine communities in the province, infrastructure and support facilities were among the top issues mentioned in their vision of sustainable transportation for Nova Scotia (p. 97).

Challenges

MUNICIPAL

Municipalities are often held responsible for building and maintaining AT infrastructure (TCAT, 2010, p. 12). A study of New Brunswick municipalities found that “council and municipal staff were most often involved in starting” AT initiatives and municipal staff were most involved with developing, realizing and sustaining the initiatives (Hanson, 2015). Municipal responsibility can make AT development difficult for several reasons:

- infrastructure is expensive - in 2014, transportation accounted for 22% of the expenditures in municipalities (Department of Municipal Affairs);
- municipalities only have the powers that they do because of their status granted by the Province;
- municipal sometimeis have limited financial prowess, especially in areas with relatively low populations and low tax revenue,
- municipalities sometimes have limited staff resources (Federation of Canadian Municipalities, 2011), and
- appreciation of the value of Active Transportation is sometimes not high - for example, the Halifax Regional Municipality’s “Explore HRM” website categorizes bike routes and trails as “recreation and facilities”, which does not acknowledge their potential to support transportation (Explore HRM).

PROVINCIAL

The Province of Nova Scotia's Department of Transportation and Infrastructure Renewal's yearly mandate is typically dominated by detailed descriptions of upgrades to be made to road infrastructure. DTIR is responsible for 90% of the province's roads (Department of Transportation and Infrastructure Renewal, 2014). In addition to these important responsibilities, the province has the opportunity to provide support for the development of AT infrastructure, both directly, and through funding provided to municipalities.

Lack of coordination has been an ongoing issue in regards to provincial initiatives for sustainable transportation. Many provincial departments have had input into sustainable transportation, including the departments of:

- Transportation and Infrastructure Renewal,
- Municipal Affairs,
- Energy,
- Health and Wellness,
- Environment,
- Economic Development, and
- Tourism.

No department has taken the lead. Significant documents have come from the Department of Energy (***Choose How You Move***) and the Department of Health and Wellness (***Thrive!***).

Despite these challenges, there has been some progress in provision of AT infrastructure. On August 6, 2015, the first segment of the Blue Route opened: a 56 km section of bicycle path connecting the town of Pictou and just outside of Truro (presentation by Ben Buckwold, Nova Scotia Bike Summit, October, 2015). The Blue Route is a network of cycling paths intended to connect the entire province (see <http://blueroute.ca/>).

RURAL

Nova Scotia faces unique challenges in developing AT infrastructure because it is a highly rural province.

A rural population density is typically less than 0.5 persons per acre, and suburban is between 0.5 and 5 persons per acre (Victoria Transport Policy Institute, 2015b). By this definition, of Nova Scotia's top ten most highly populated municipalities, all are rural, except for the towns of Amherst and Truro, which are suburban. The province as a whole has only 0.07 persons per acre (Statistics Canada, 2011).
A dispersed population tends to be more automobile dependent (Federation of Canadian Municipalities, 2009).

The figure at the right illustrates these population densities, showing just how much space must be covered by infrastructure in order to service a dispersed population.

It can be challenging for rural communities in Canada to fund new initiatives for transportation because of

- slowly growing, or sometimes declining populations (Transport Canada, 2009)
- a lack of dedicated staff "to develop and sustain initiatives" (Hanson, 2015, p. 6), and
- a smaller tax base to draw from than urban communities (Federation of Canadian Municipalities, 2009).

1 PERSON ON 1 ACRE OF LAND

10 PEOPLE ON 1 ACRE OF LAND

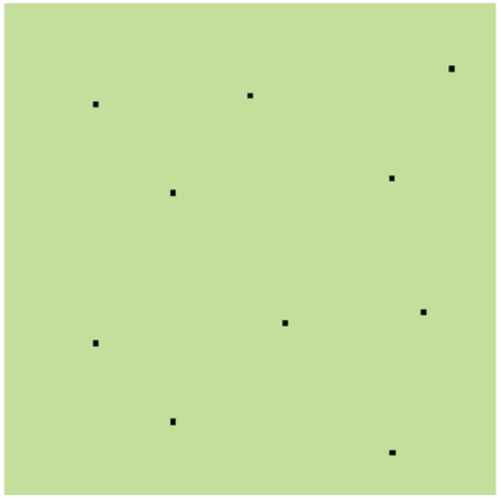


Illustration by Sara Jellicoe, October 2015.

Nova Scotia is not simply divided into "urban" and "rural". Rural areas are complex and varied. For instance, the University of Washington distinguishes between:

- large rural core, typically the destinations for work from other rural areas;
- outer large rural;
- small rural core,;
- outer small rural; and
- isolated rural (as cited in Rails to Trails Conservancy, 2011, p. 4).

Making these distinctions matters because some small communities can have quite robust AT. For example, in the United States, "Within small towns of 2,500 to 10,000 residents... people walk for work purposes... 3.7 percent of all trips, compared to 3.9 percent" in Urban Cores (Rails to Trails Conservancy, 2011, p. 5). Furthermore, people in small rural cores bicycle to work more than people in urban cores (p. 6). A study by the Toronto Coalition for Active Transportation found no relationship between population and AT rates (2010). Even small rural municipalities have the potential to foster strong AT use in their communities.

Small communities have strengths to draw on in the pursuit of new active transportation initiatives; by virtue of being small, they are often more flexible because ideas have fewer require bureaucratic approvals. They can draw support from retailers and organizations (Transport Canada, 2010).

Rural areas have much to gain from AT investment as walkability and bikeability can contribute to the charm of small rural communities, attracting tourism and encouraging economic development.

COORDINATION

Since both municipalities and the province have ownership over parts of transportation infrastructure, sometimes there are overlaps in jurisdiction and complex project approval processes (Federation of Canadian Municipalities, 2011). Coordination can be a challenge.

Objectives

The objectives of this report are to:

1. provide a standard **set of infrastructure indicators** for Nova Scotia,
2. collect and analyze a **2015 baseline inventory** of infrastructure data, and
3. produce a prototype **dissemination method** for this data.

Indicator Set

Method

This study estimates indicators for the 10 most populous municipalities in Nova Scotia. Indicator selection is based on:

- common infrastructure indicators in the literature,
- the ability to break indicator data down by mode, so that AT modes are explicitly represented and so that they can be compared with each other, and
- data availability in Nova Scotia.

The following diagram lists the indicators and highlights studies that recommended the use of these indicators.

Nova Scotia Transport Infrastructure Indicators

MODE	INDICATOR	REFERENCE STUDIES
	Road (km) Road (m) per capita	Dobranskyte-Niskota, et. al (2007); HRM (2014); EAC (2008); Kenworthy (2003); Stantec (2013); HRM (2014)
	Bike lane (km) Bike lane (m) per capita	Transportation Association of Canada (2010); EAC (2008); Stantec (2013)
	Sidewalk (km) Sidewalk (m) per capita Ratio of sidewalk to road (%)	Transportation Association of Canada (2010); HRM (2014); Ontario Professional Planners Institute (2009); EAC (2008); Curran (2006)
	Trail (km) Trail (m) per capita	Transportation Association of Canada (2010); HRM (2014); EAC (2008)

Inventory

Method

DATA COLLECTION

1. **Download** cartographic municipal boundaries data from Statistics Canada at <https://www12.statcan.gc.ca/census-recensement/2011/geo/bound-limit/bound-limit-eng.cfm>.
2. **Search** for contact information of municipalities.
3. **Call** municipalities and ask for redirection if necessary.
4. **Email** municipalities to follow up.
5. **Sign** data release forms.

MAPPING

1. **Create** Geodatabase in ArcMap
    a) Municipal boundaries,
    b) Roads,
    c) Sidewalks,
    d) Trails, and
    e) Bike lanes.
2. **Add** acquired shape files from municipalities and Statistics Canada:
3. **Organize** data into layers.

ESTIMATION

1. **Create** Excel spreadsheet for indicator data.
2. **Calculate** length of shape files for individual municipalities in ArcMap using the “clip” and “join” tools.
3. **Input** data, both that directly acquired from municipalities and that calculated in ArcMap, into Excel spreadsheet.

Data Sources

ROADS

The Nova Scotia Topographic Database has 1:10,000 data on roads. This was available through Dalhousie's GIS Centre, which gets the data from the **Provincial Department of Municipal Relations and Service Nova Scotia.**

BIKE LANES

Some municipalities were able to provide GIS files for bike lanes. This was primarily through **municipal planning and development departments**. Most municipalities did not have GIS files for bike lanes, but did have estimates of the number of kilometres.

SIDEWALKS

Currently in Nova Scotia, sidewalk data is available primarily through **municipal Public Works departments**, which are responsible for snow clearing. Most municipalities did not have GIS files for sidewalks, but did have estimates of the number of kilometres.

TRAILS

Trail data was primarily available through the **Provincial Department of Health and Wellness**. Some municipalities have their own trails which they maintain. This data was available through municipal Planning and Development departments.

Geography

TOP TEN MOST POPULOUS MUNICIPALITIES IN NOVA SCOTIA

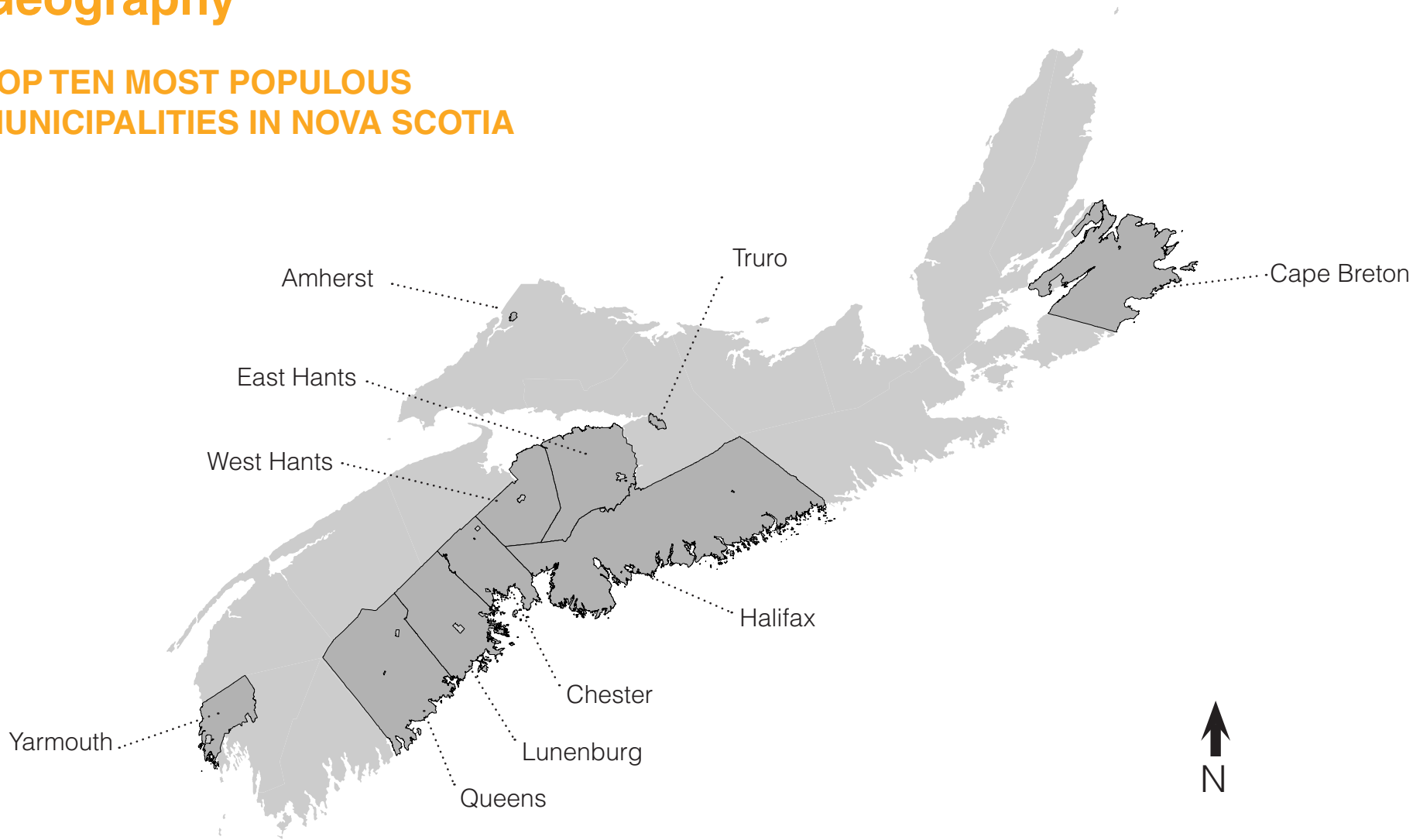


Image: Sara Jellicoe, 2015

Demographics

TYPE	NAME	AREA (sq km)	POPULATION (2011)	DENSITY (persons per sq km)
Regional Municipality	Halifax	5,590.28	390,095	71.1
Regional Municipality	Cape Breton	2,433.35	97,398	40.0
Municipality of District of	Lunenburg	1,759.64	25,118	14.3
Municipality of District of	East Hants	1,786.47	22,111	12.4
Municipality of District of	West Hants	1,241.95	14,165	11.4
Town	Truro	37.63	12,059	320.5
Regional Municipality	Queens	2,392.85	10,917	4.6
Municipality of District of	Chester	1,122.22	10,599	9.4
Municipality of District of	Yarmouth	585.75	10,105	17.3
Town	Amherst	12.02	9,717	808.4

Data source: Statistics Canada, 2011 Census

Population Density

The province's ten most populous municipalities each have a population larger than 9,000 people.
Population densities can vary widely, even for communities with similar populations.

The graph at right shows one regional municipality, one town and one district municipality compared to example municipalities in Canada with similar population size and varying population densities.

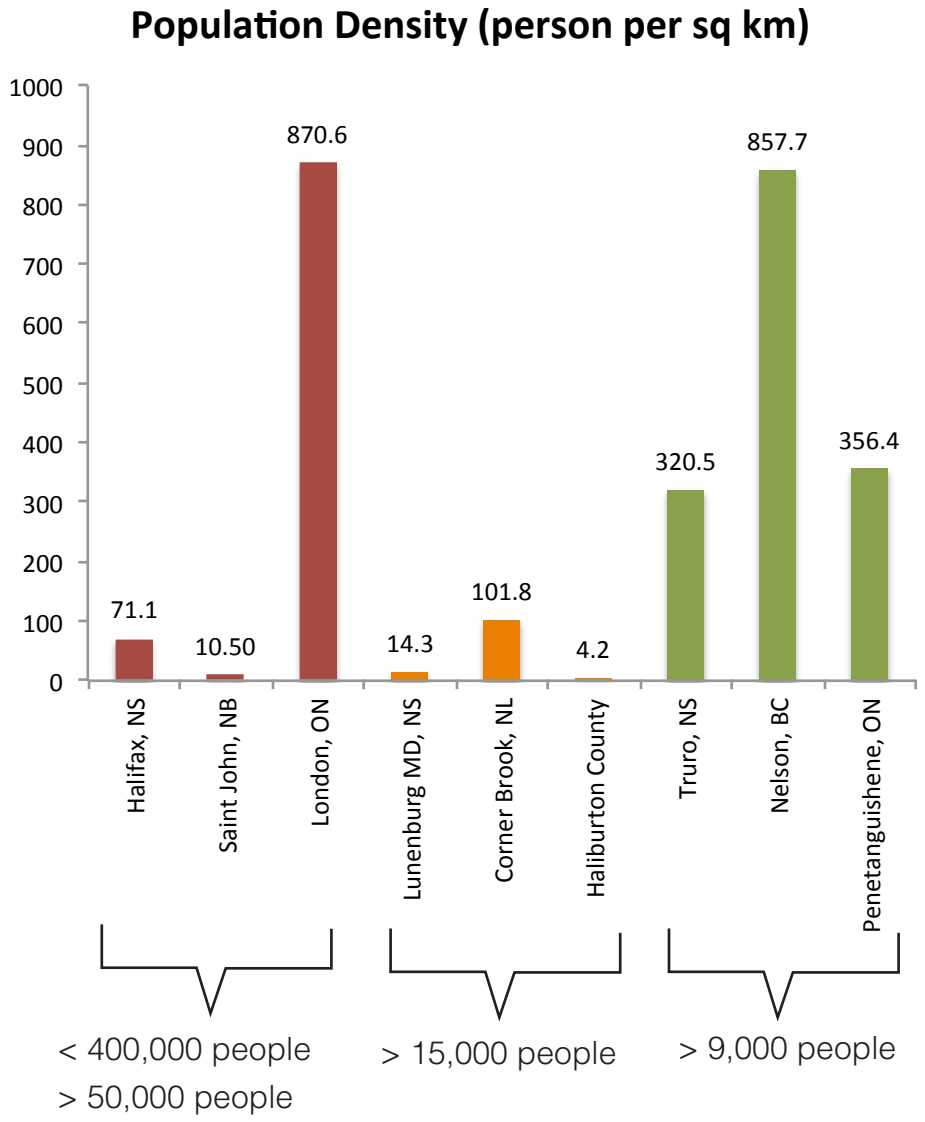


Image: Sara Jellicoe, 2015

Of the 10 municipalities in this study, all are less than 900 persons per square kilometre and are therefore what would be considered “suburban” or “rural” (Victoria Transport Policy Institute, 2015). As a point of reference, Halifax’s regional core has 6,000 persons per square km, making it “high density”.

Community Type	Persons per acre	Persons per square km
Rural	< 0.5	< 125
Suburban	0.5 - 5	125 - 1250
Suburban cluster	5 - 12	1250 - 3000
Compact urban	> 12	> 3,000
High density	> 20	> 5,000

(Adapted from VTPI, 2015)

Average Infrastructure per capita

TOP TEN MOST POPULOUS MUNICIPALITIES IN NOVA SCOTIA

If infrastructure were divided evenly among the population, an average person from one of the ten most populous municipalities in Nova Scotia has 144 metres of roads to themselves, a quarter of a metre of sidewalk, an eight of a metre of trail and two centimetres of bicycle lane.

These AT infrastructure amounts are lower, and road infrastructure amounts higher, than those found in cities, which is expected because the Nova Scotia estimates include large rural areas. Average amounts are not available for provinces for comparisons.

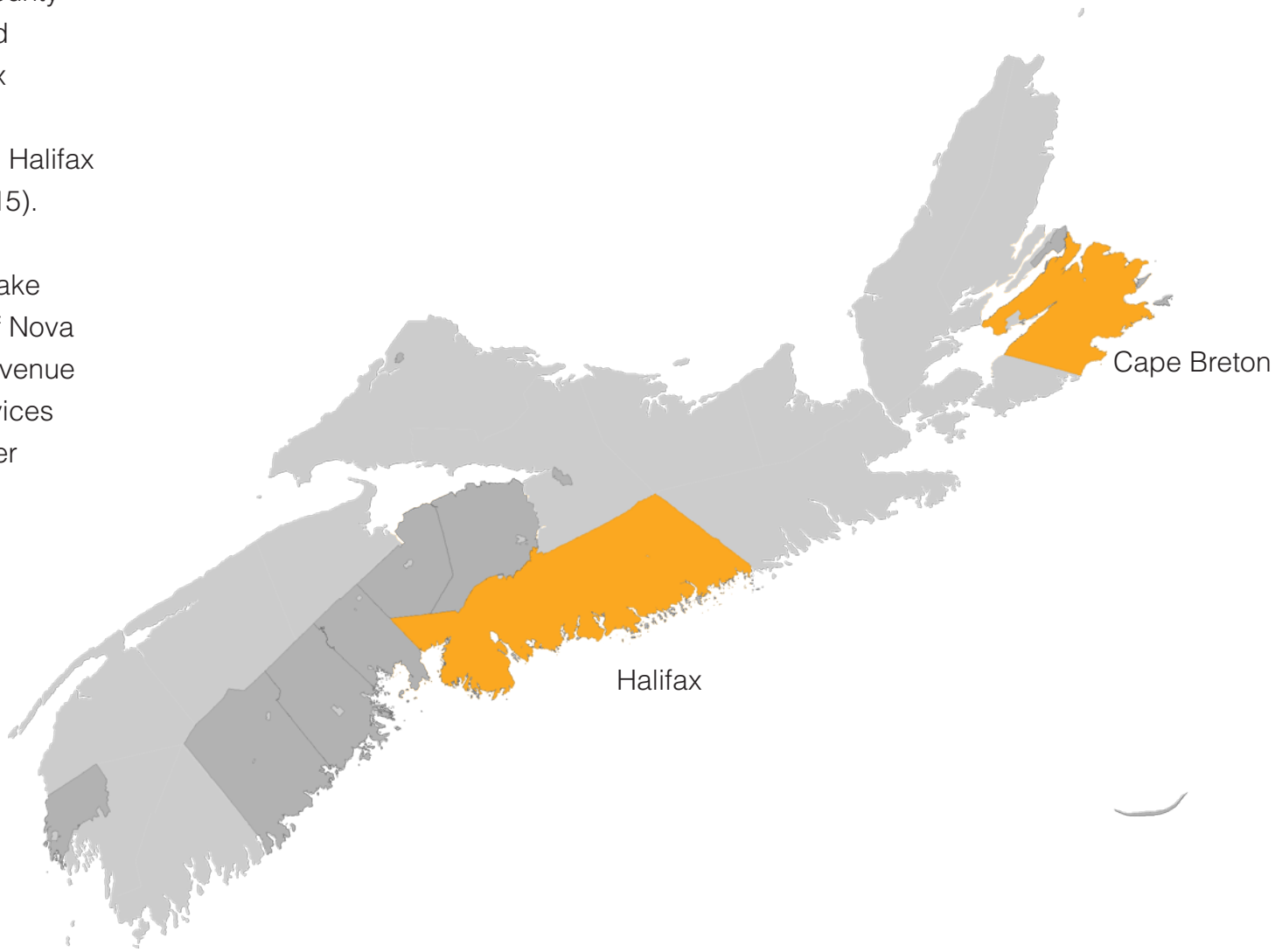
144.24 M	**OF ROAD**	e.g. City of Regina, SK	4.80m
0.25 M	**OF SIDEWALK**	e.g. City of Corner Brook, NL	2.51m
0.13 M	**OF TRAIL**	e.g. City of Dieppe, NB	2.36m
0.02 M	**OF BIKE LANE**	e.g. City of Victoria, BC	1.68m

http://l.rgbimg.com/cache1py2g7/users/m/mz/mzacha/600/mM4YpzQ.jpg

Regional Municipalities

Nova Scotia has two Regional Municipalities. In 1995 the former municipalities of Cape Breton County amalgamated (CBRM, 2015) and in 1996, the former city of Halifax amalgamated with the City of Dartmouth, Town of Bedford and Halifax County Municipality (Halifax, 2015).

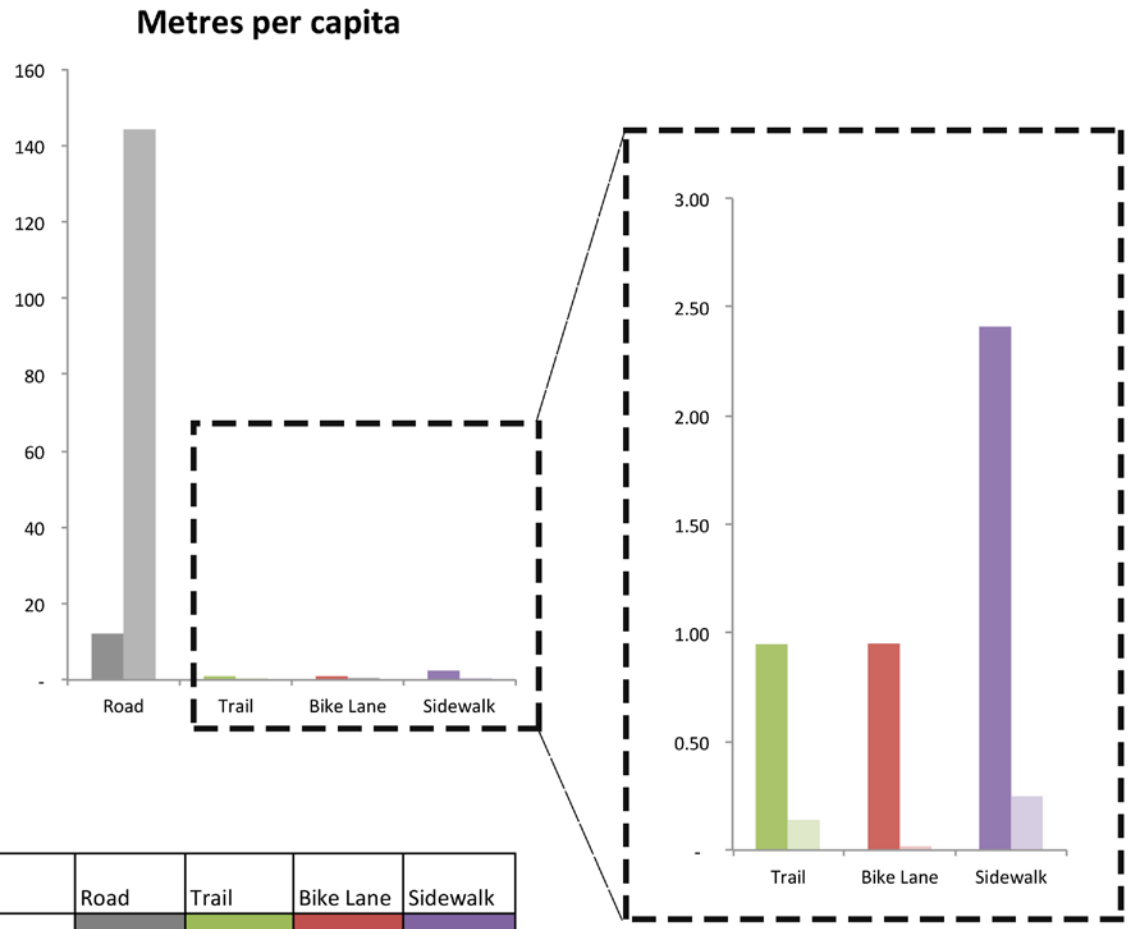
Together, these municipalities make up 53% of the total population of Nova Scotia, giving them higher tax revenue to fund municipal initiatives, services and infrastructure than most other municipalities have access to.



REGIONAL MUNICIPALITY

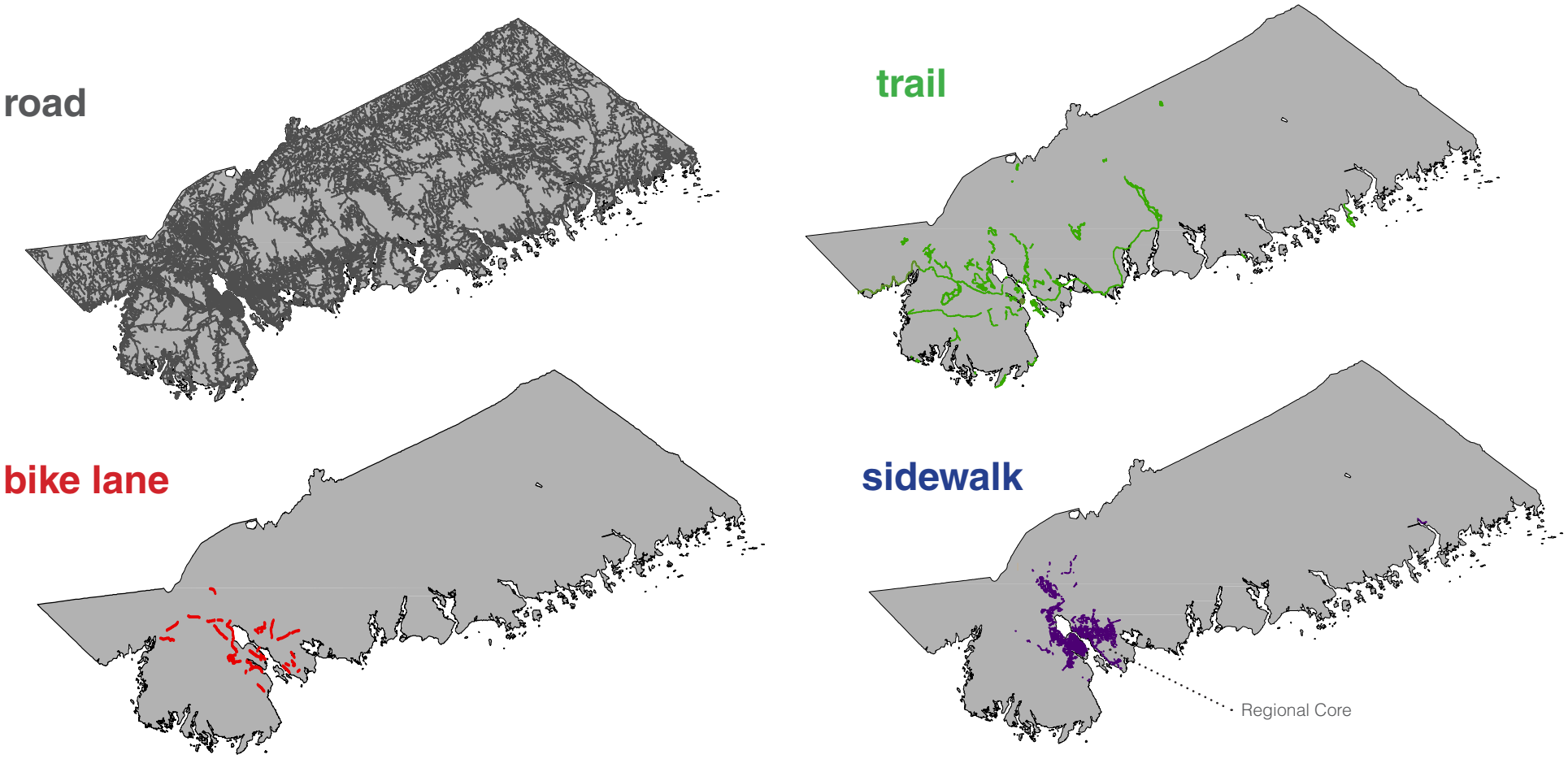
Halifax

Halifax Regional Municipality has more Active Transportation infrastructure (bicycle, trail and sidewalk) per capita than the average for the ten most populated municipalities in the province and has much less road infrastructure per capita than average.



MODE	Road	Trail	Bike Lane	Sidewalk
M per capita	12.15	0.95	0.95	2.41
AVERAGE M per capita	144.24	0.14	0.02	0.25
TOTAL KM	4,741.00	371.05	371.05	940.00
AVERAGE KM	3,194.09	80.28	11.33	149.97

Most sidewalks and bicycle infrastructure are near the regional core of Halifax.

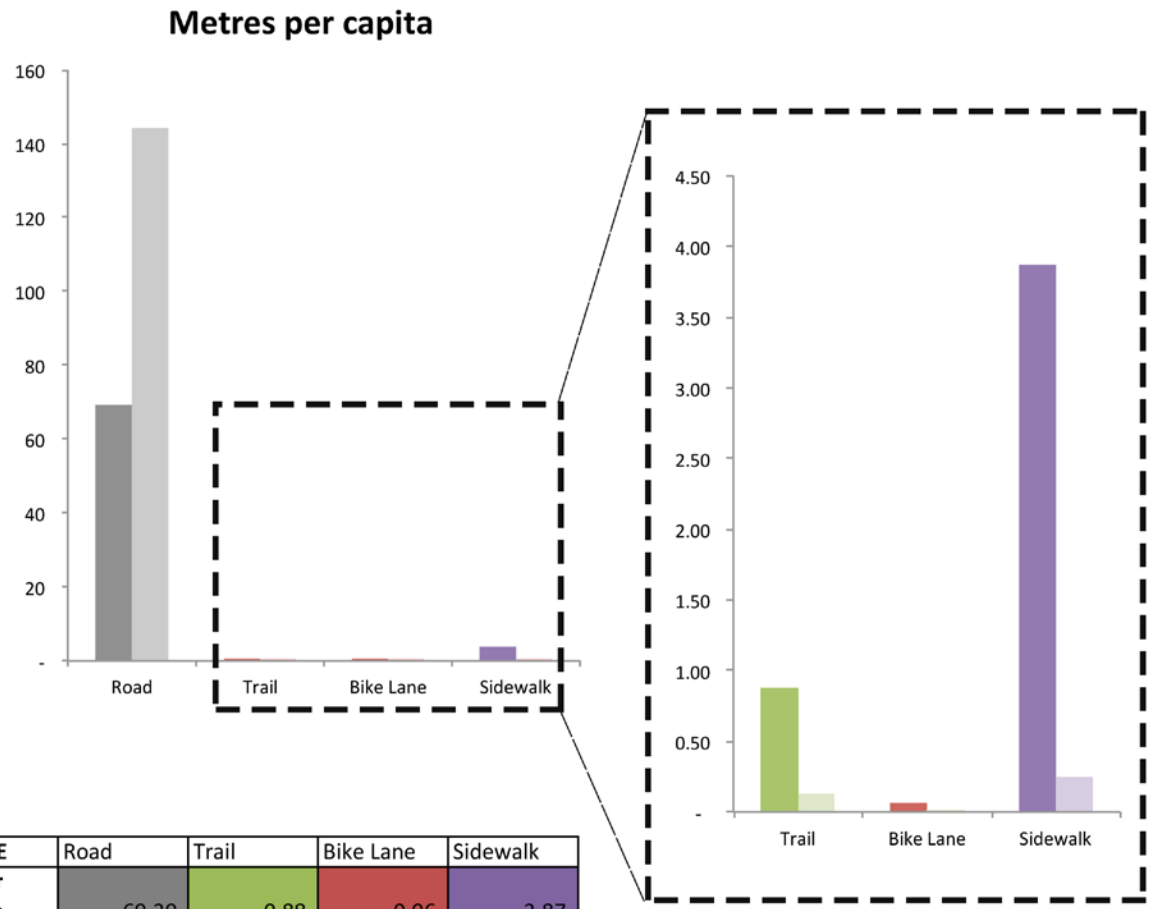


Scale: 1:375,000

REGIONAL MUNICIPALITY

Cape Breton

Cape Breton Regional Municipality has much more sidewalk infrastructure per capita than the average for the ten most populated municipalities in the province, slightly more trail and bicycle infrastructure, and less road infrastructure.

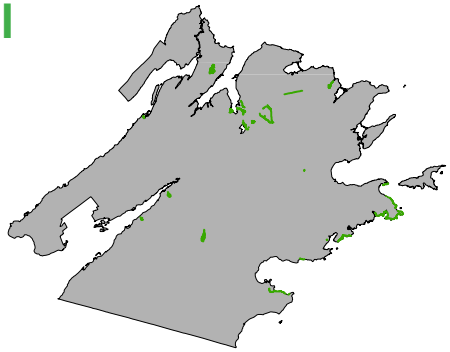


MODE	Road	Trail	Bike Lane	Sidewalk
M per capita	69.29	0.88	0.06	3.87
AVERAGE M per capita	144.24	0.14	0.02	0.25
TOTAL KM	6,749.15	85.29	6.30	377.18
AVERAGE KM	3,194.09	81.45	11.46	150.01

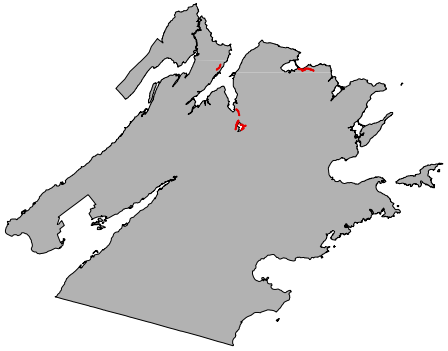
Most sidewalks and bicycle infrastructure are near the regional core of Sydney, with some sidewalks in Glace Bay area.

road

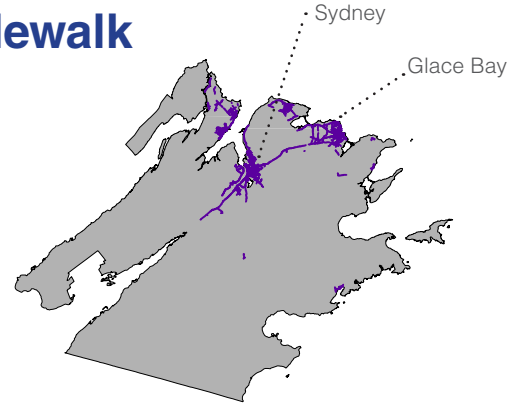
trail



bike lane



sidewalk



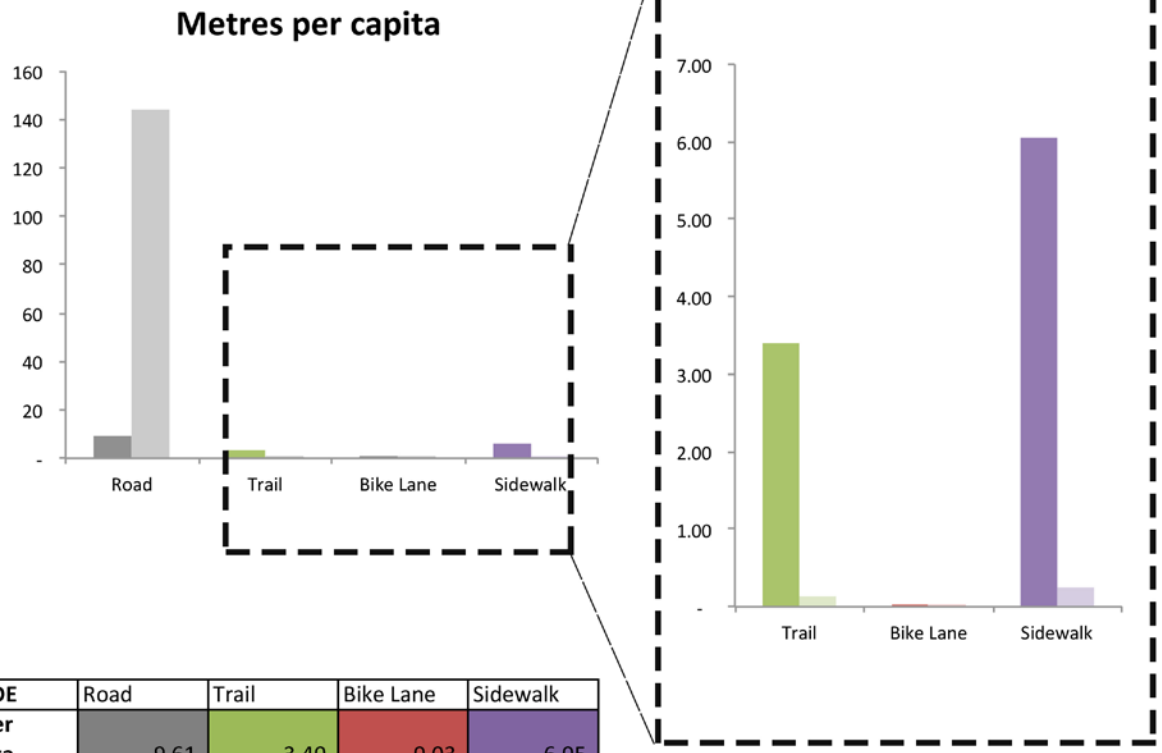
Scale: 1:375,000

Towns

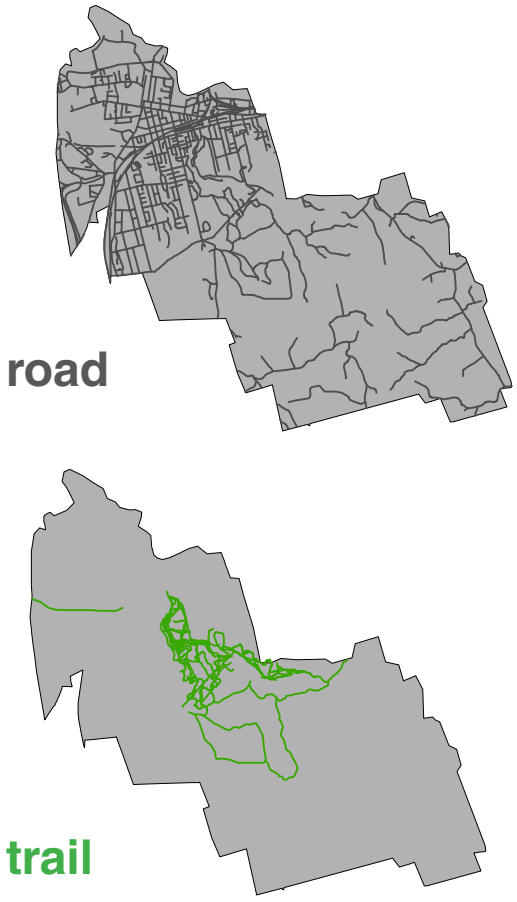
The two most populous towns in Nova Scotia are Truro and Amherst. Because of their small land area, they have the highest population density of those municipalities studied.

TOWN OF
Truro

There is much less road infrastructure and more AT infrastructure per capita than the average for the ten municipalities studied, but less than 1 kilometre of bike lane.



MODE	Road	Trail	Bike Lane	Sidewalk
M per capita	9.61	3.40	0.03	6.05
AVERAGE M per capita	144.24	0.14	0.02	0.25
TOTAL KM	115.87	41.00	0.34	73.00
AVERAGE KM	3,194.09	81.45	11.46	150.01

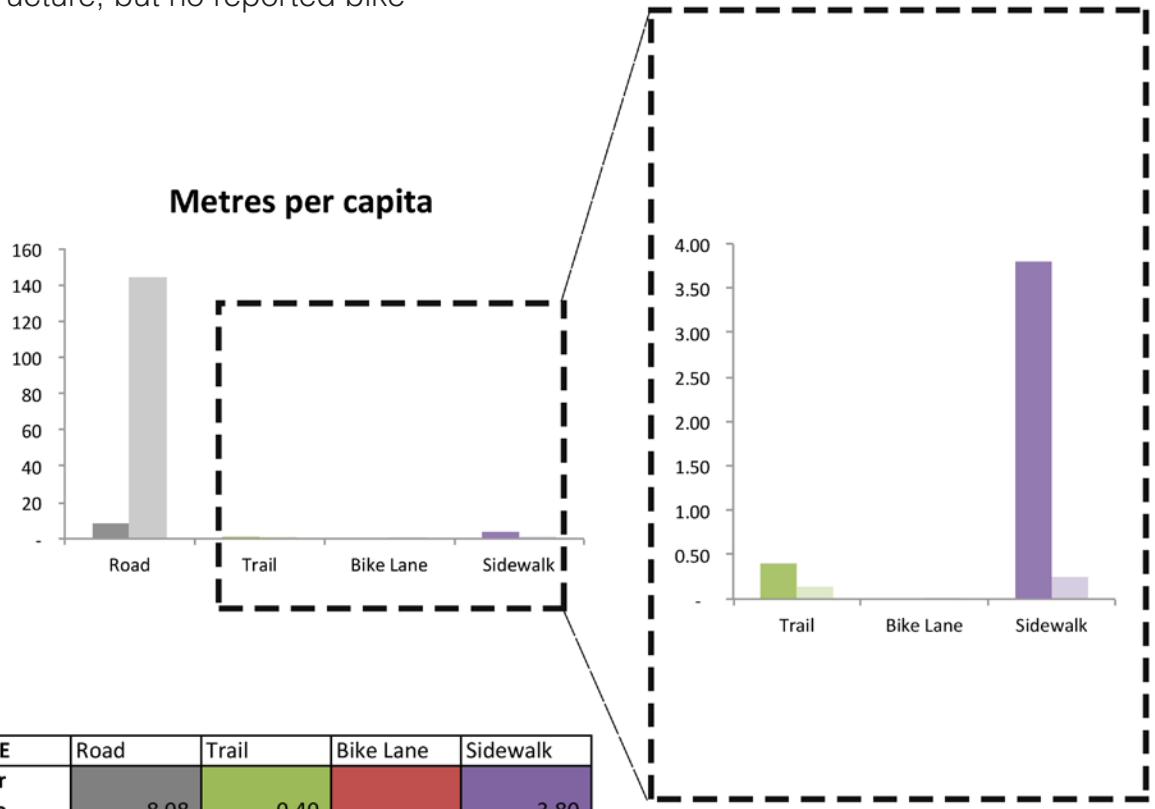


Scale: 1:37,500

TOWN OF

Amherst

There is more AT infrastructure per capita than the average for the ten municipalities studied, and less road infrastructure, but no reported bike lanes.



MODE	Road	Trail	Bike Lane	Sidewalk
M per capita	8.08	0.40	-	3.80
AVERAGE M per capita	144.24	0.14	0.02	0.25
TOTAL KM	78.51	3.91	-	36.93
AVERAGE KM	3,194.09	81.45	11.46	150.01

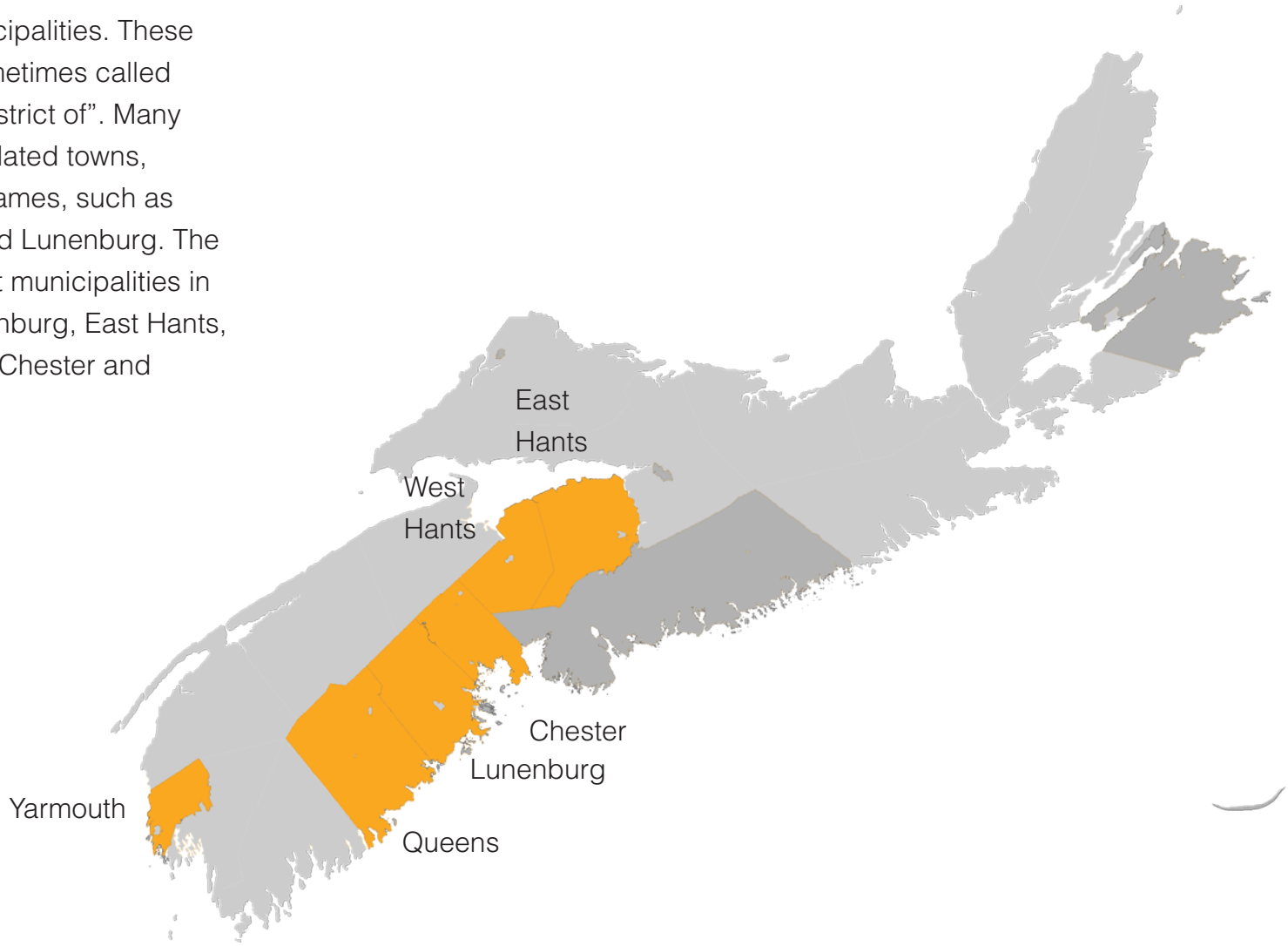
road

trail

Scale: 1:37,500

District Municipalities

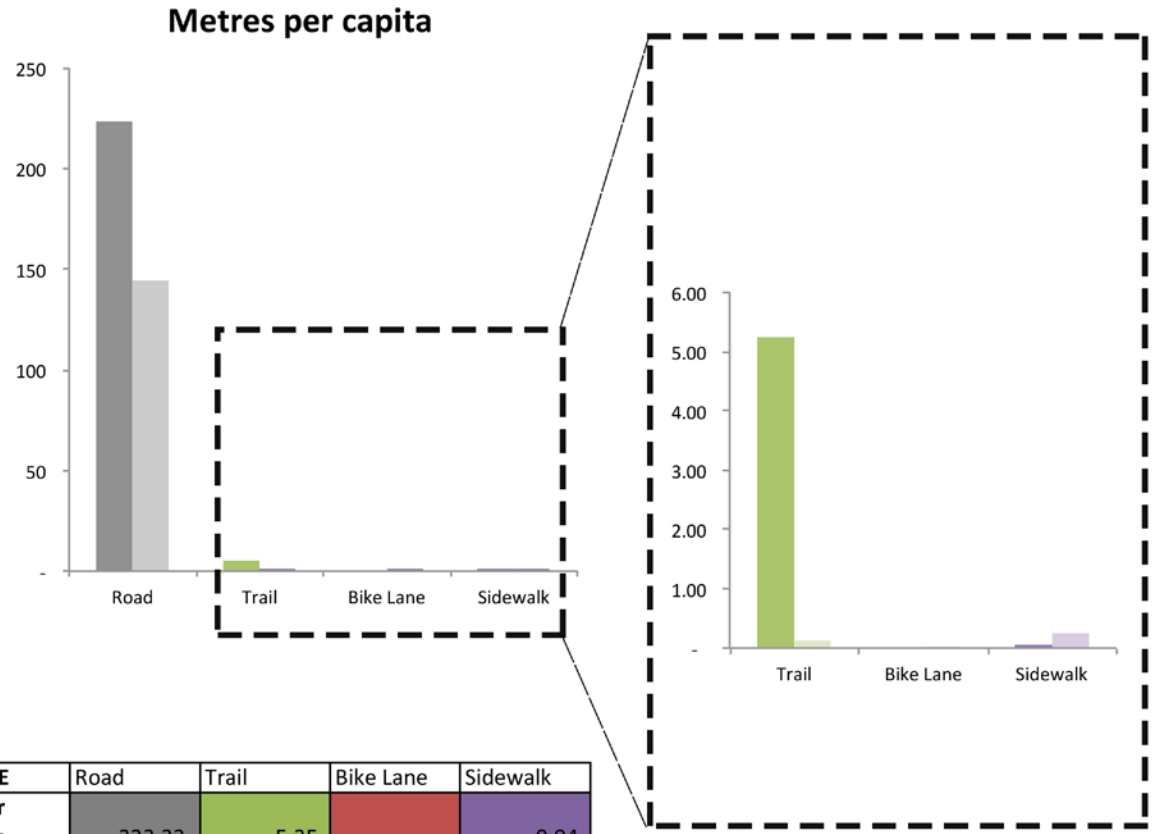
Many of Nova Scotia's counties are incorporated as municipalities. These municipalities are sometimes called "municipality of the district of". Many contain densely populated towns, often with the same names, such as Yarmouth, Chester and Lunenburg. The most populous district municipalities in Nova Scotia are Lunenburg, East Hants, West Hants, Queens, Chester and Yarmouth.



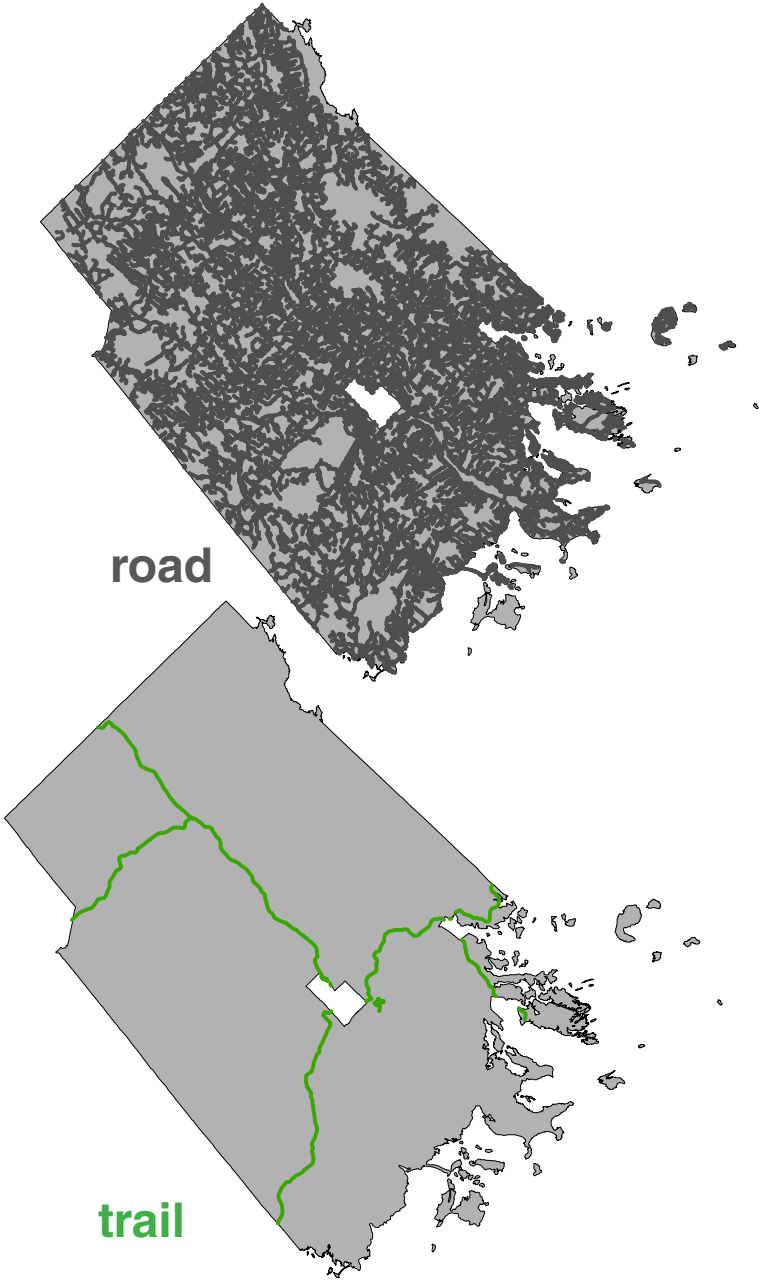
MUNICIPALITY OF THE DISTRICT OF

Lunenburg

Lunenburg has more road and trail infrastructure per capita than the average, and less sidewalk and bicycle.



MODE	Road	Trail	Bike Lane	Sidewalk
M per capita	223.33	5.25	-	0.04
AVERAGE M per capita	144.24	0.14	0.02	0.25
TOTAL KM	5,609.63	131.75	-	1.00
AVERAGE KM	3,194.09	81.45	11.46	150.01

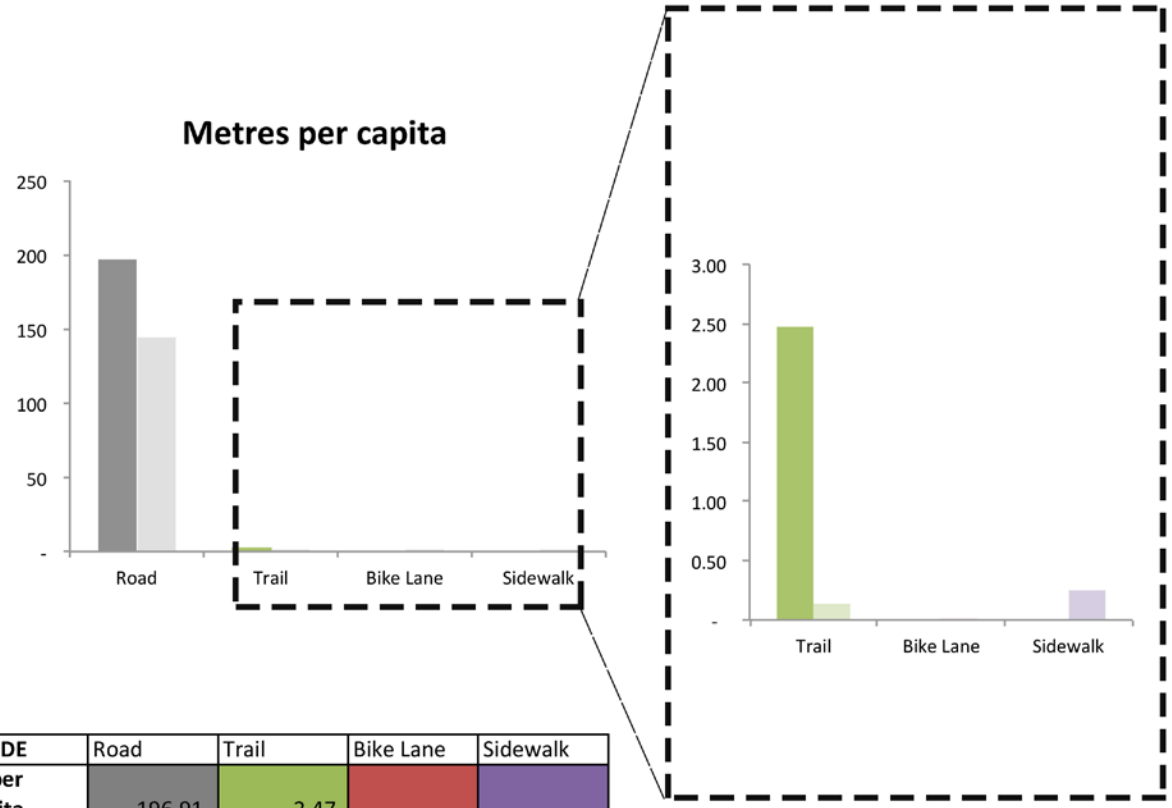


Scale: 1:750,000

MUNICIPALITY OF THE DISTRICT OF

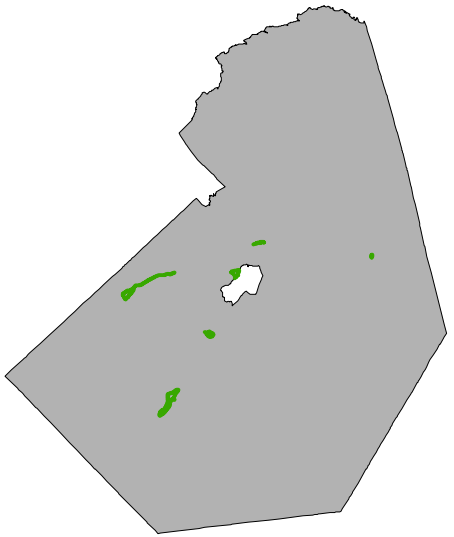
West Hants

West Hants has more road and trail infrastructure per capita than the average, and less sidewalk and bicycle.



MODE	Road	Trail	Bike Lane	Sidewalk
M per capita	196.91	2.47	-	-
AVERAGE M per capita	144.24	0.14	0.02	0.25
TOTAL KM	2,789.16	35.02	-	-
AVERAGE KM	3,194.09	81.45	11.46	150.01

road



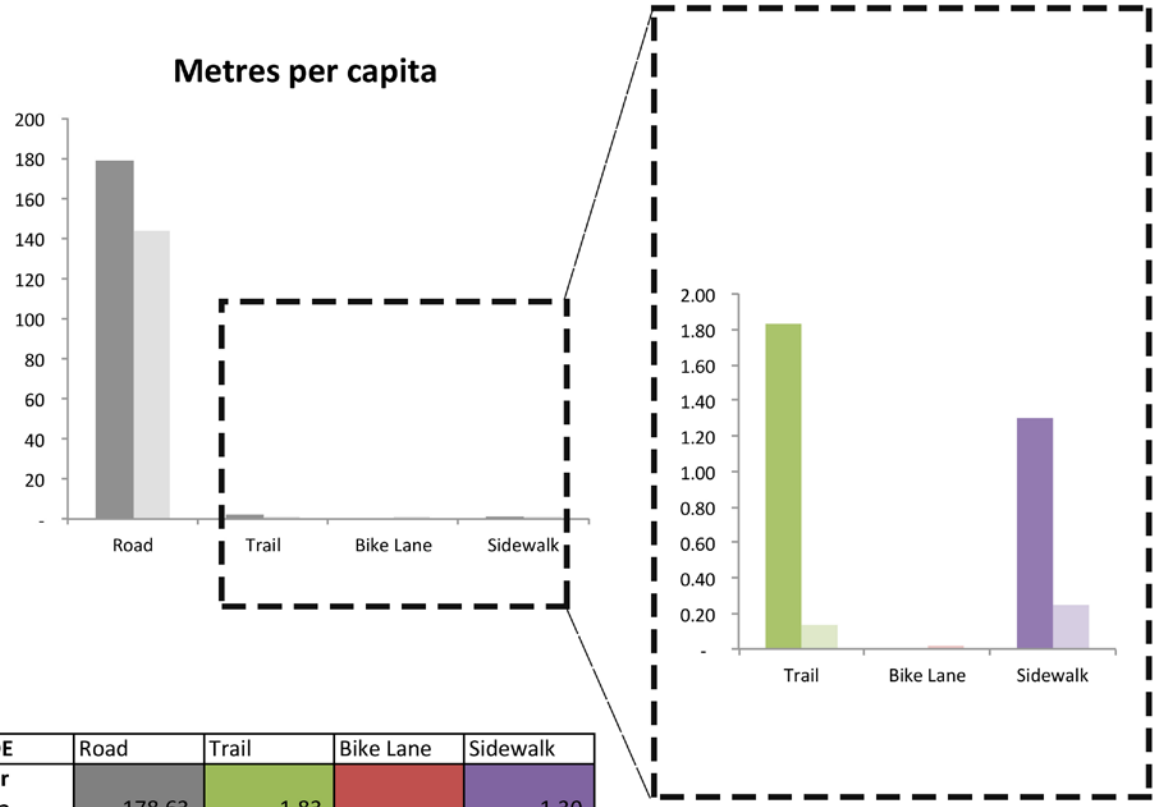
trail

Scale: 1:750,000

MUNICIPALITY OF THE DISTRICT OF

East Hants

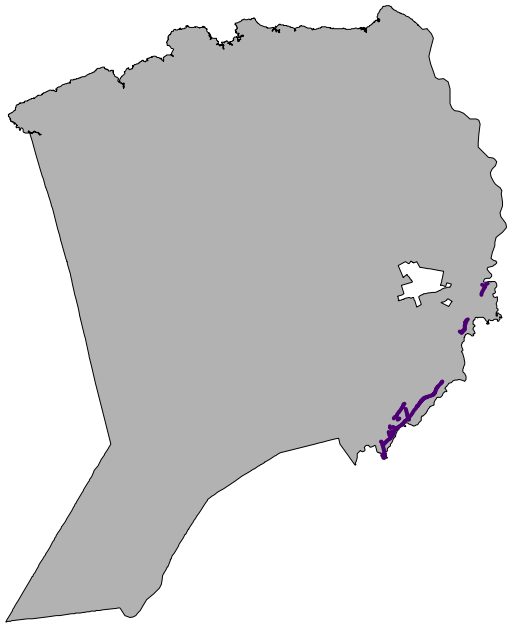
East Hants has more road, sidewalk and trail infrastructure per capita than the average, but no reported bike lanes.



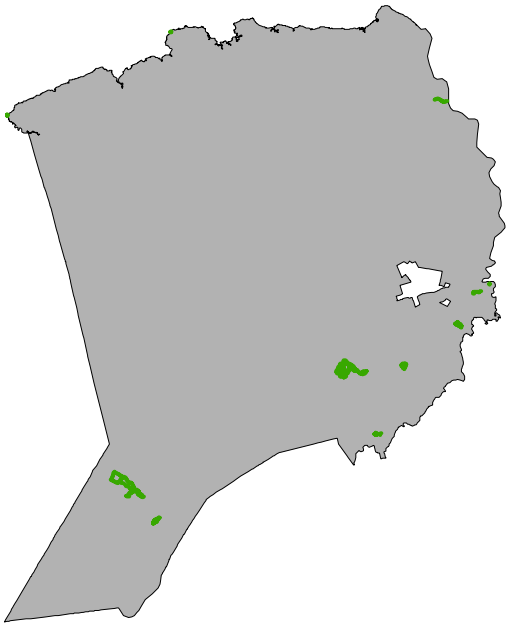
MODE	Road	Trail	Bike Lane	Sidewalk
M per capita	178.63	1.83	-	1.30
AVERAGE M per capita	144.24	0.14	0.02	0.25
TOTAL KM	3,949.71	40.40	-	28.73
AVERAGE KM	3,194.09	81.45	11.46	150.01

road

sidewalk



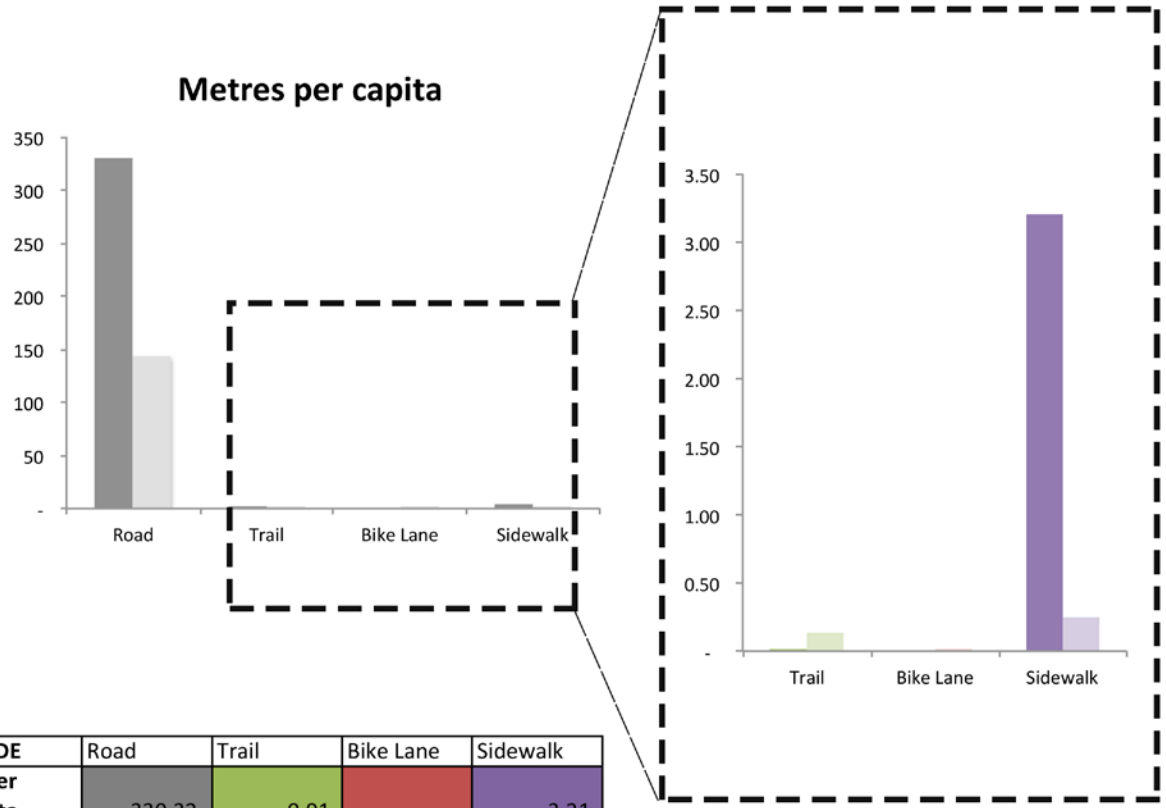
trail



Scale: 1:750,000

REGION OF
Queens
MUNICIPALITY

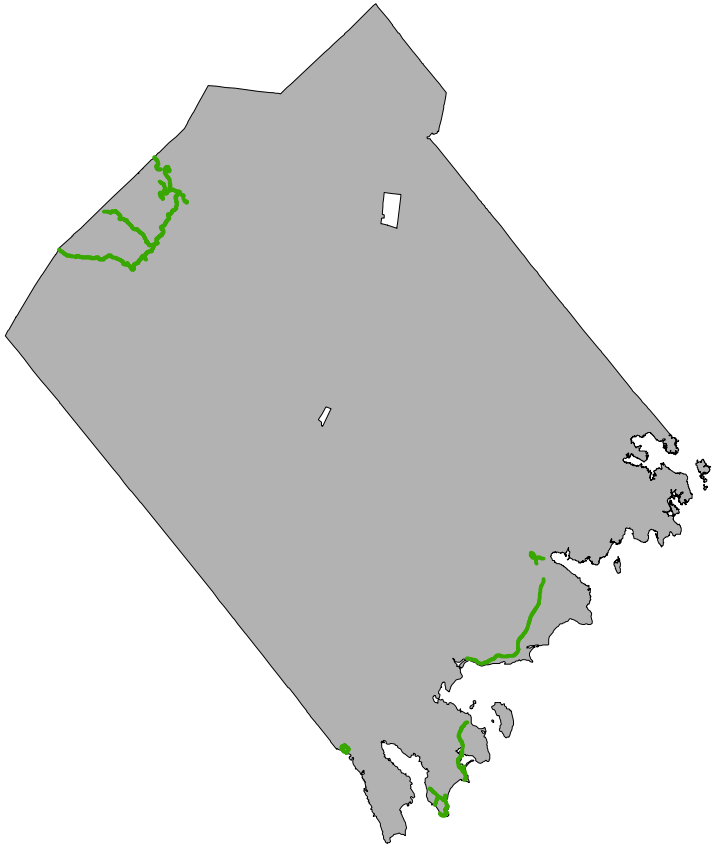
Queens has more road infrastructure and more sidewalk infrastructure per capita than the average, but less trail and bicycle infrastructure.



MODE	Road	Trail	Bike Lane	Sidewalk
M per capita	330.32	0.01	-	3.21
AVERAGE M per capita	144.24	0.14	0.02	0.25
TOTAL KM	3,606.09	0.12	-	35.00
AVERAGE KM	3,194.09	81.45	11.46	150.01

road

trail

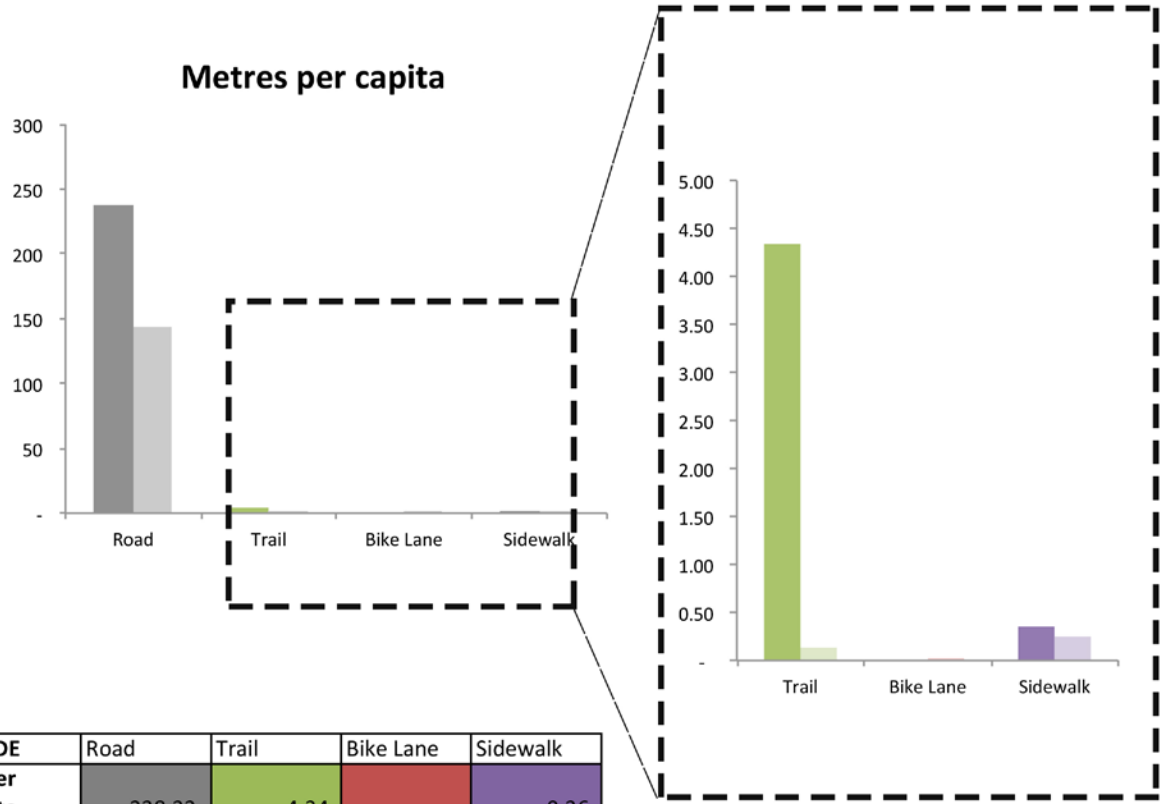


Scale: 1:750,000

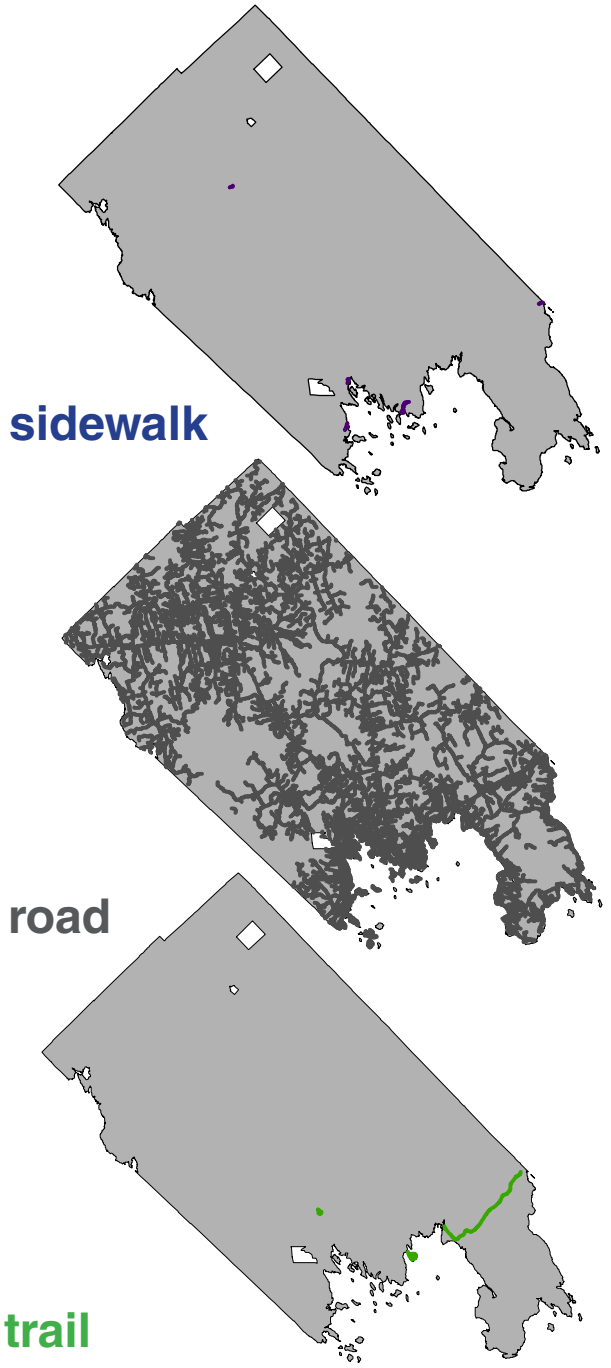
MUNICIPALITY OF THE DISTRICT OF

Chester

Chester has more road, sidewalk and trail infrastructure per capita than the average, but no bicycle infrastructure.



MODE	Road	Trail	Bike Lane	Sidewalk
M per capita	238.33	4.34	-	0.36
AVERAGE M per capita	144.24	0.14	0.02	0.25
TOTAL KM	2,526.06	46.00	-	3.77
AVERAGE KM	3,194.09	81.45	11.46	150.01

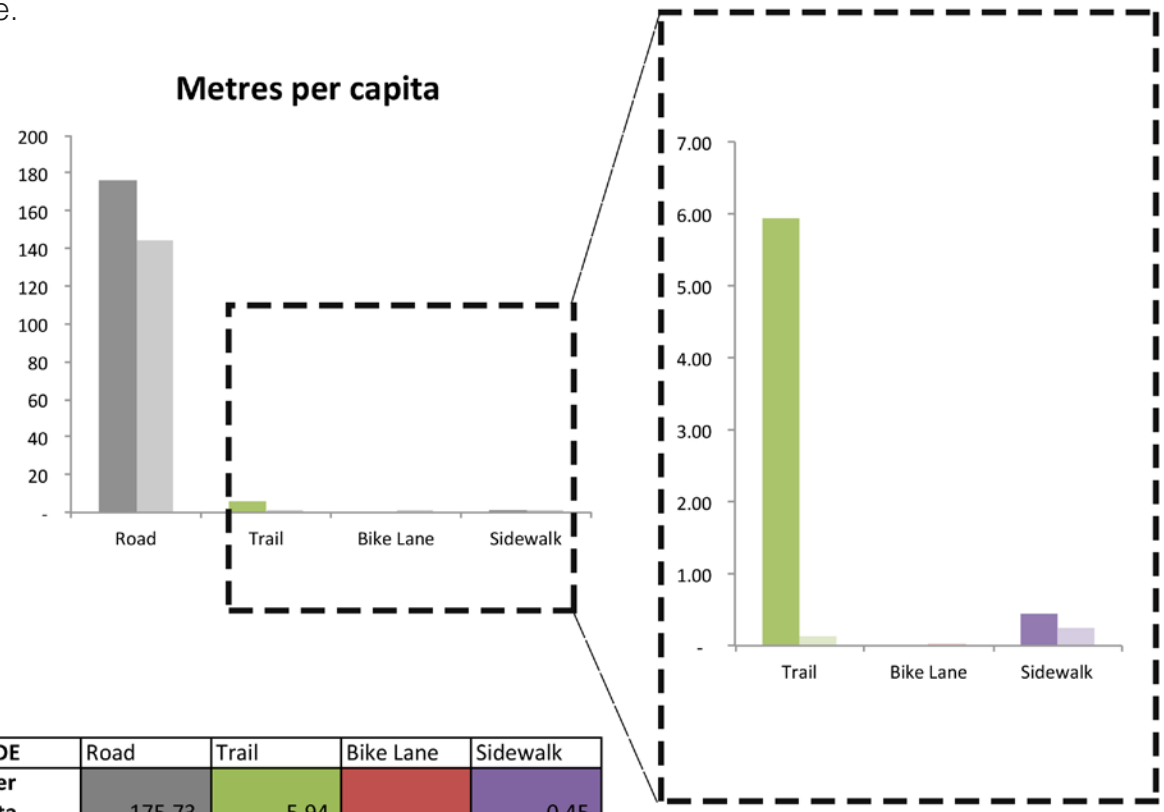


Scale: 1:750,000

MUNICIPALITY OF THE DISTRICT OF

Yarmouth

Yarmouth has more road, sidewalk and trail infrastructure per capita than the average, but no bicycle infrastructure.



MODE	Road	Trail	Bike Lane	Sidewalk
M per capita	175.73	5.94	-	0.45
AVERAGE M per capita	144.24	0.14	0.02	0.25
TOTAL KM	1,775.73	60.00	-	4.50
AVERAGE KM	3,194.09	81.45	11.46	150.01

Scale: 1:750,000

Analysis

Roads

The municipalities with the highest population are not necessarily those with the fewest roads per capita, as seen in the chart on the right.

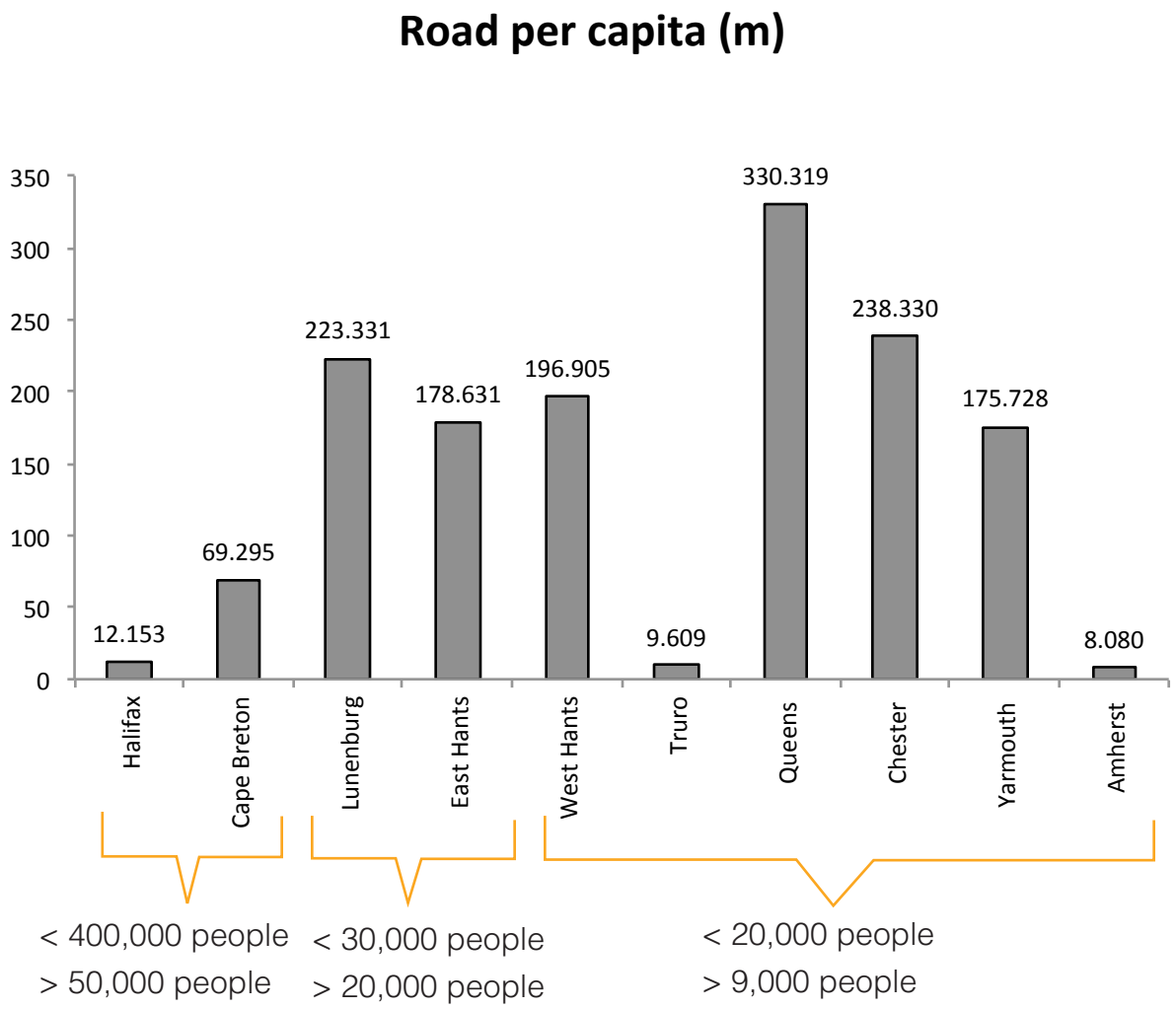


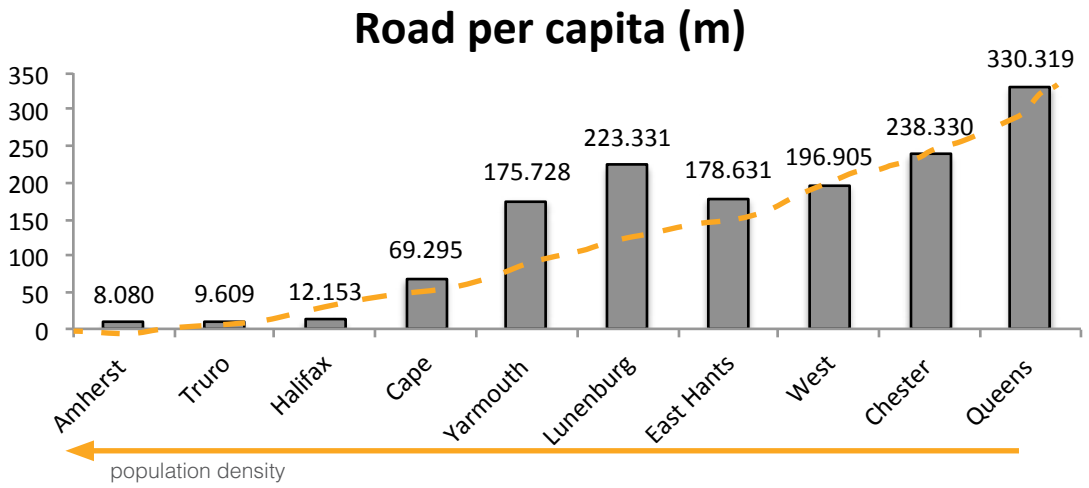
Image: Sara Jellicoe, 2015

Municipalities with higher population densities tend to have fewer roads per capita. The towns of Amherst and Truro have the least amount of road per capita. This is encouraging because it means that even municipalities with small populations can achieve efficient infrastructure usage by choosing to develop and invest in infrastructure in clustered areas. This could also allow for the preservation of larger areas of natural Nova Scotia wilderness and landscapes.

Sprawling patterns of development can require large amounts of road infrastructure, which is expensive. Transport Canada notes that “many towns are struggling with deteriorating downtowns that are being slowly replaced by new retail on the outskirts” (2011, p. 2).

This sprawling pattern is not unique to towns or rural areas. Many communities, including larger centres such as Halifax and Sydney, are also facing this problem. Strategic investments in infrastructure and development density can help prevent exorbitant costs.

Halifax Regional Municipality and the towns of Amherst and Truro have comparable road per capita ratios to the wwwhile the district municipalities are much higher (Regina, 2013; Corner Brook, 2015; Kingston, 2014).



Trails

With some exceptions, the municipalities with lower populations tend to have more kilometres of trails. This might mean that areas with lower populations have more attractive natural features to service.

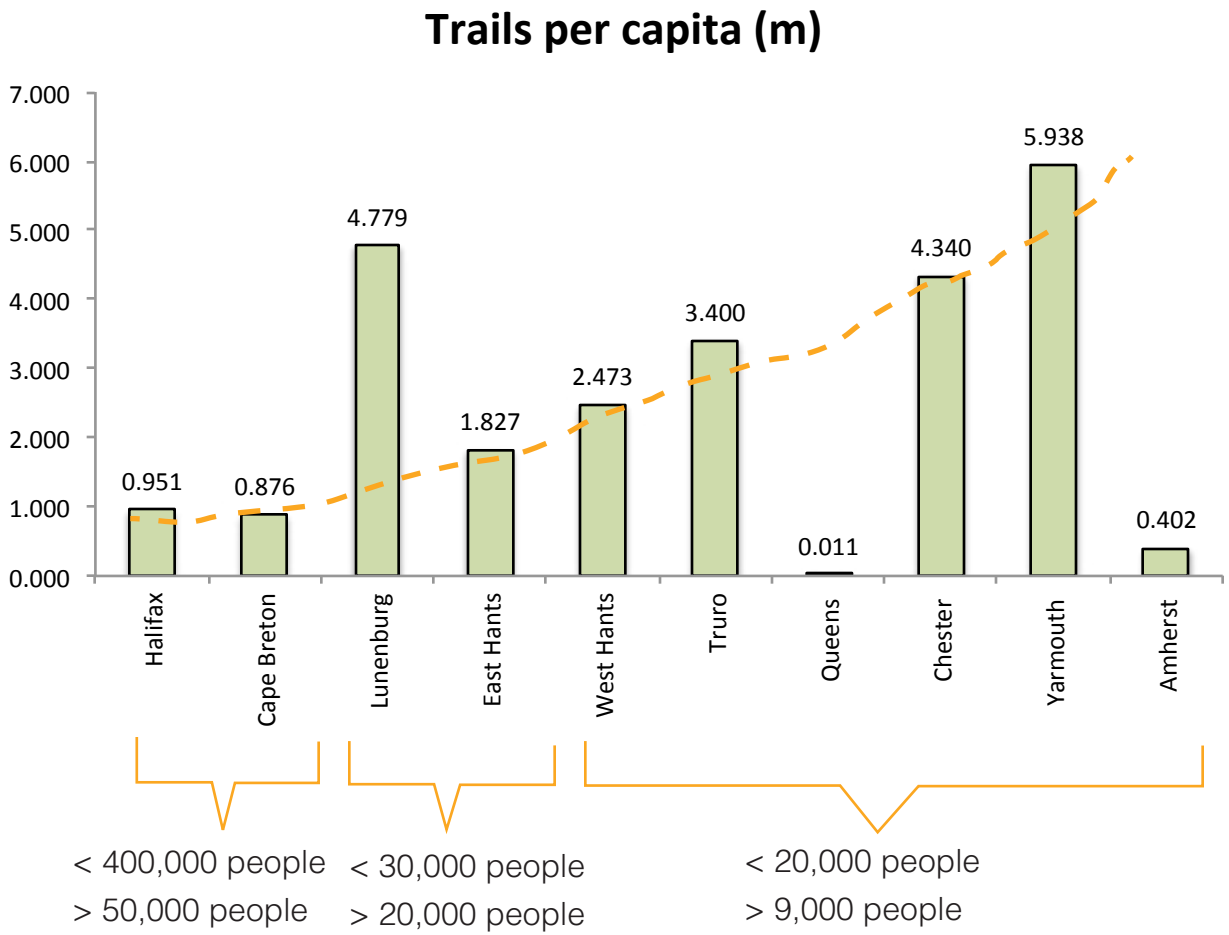


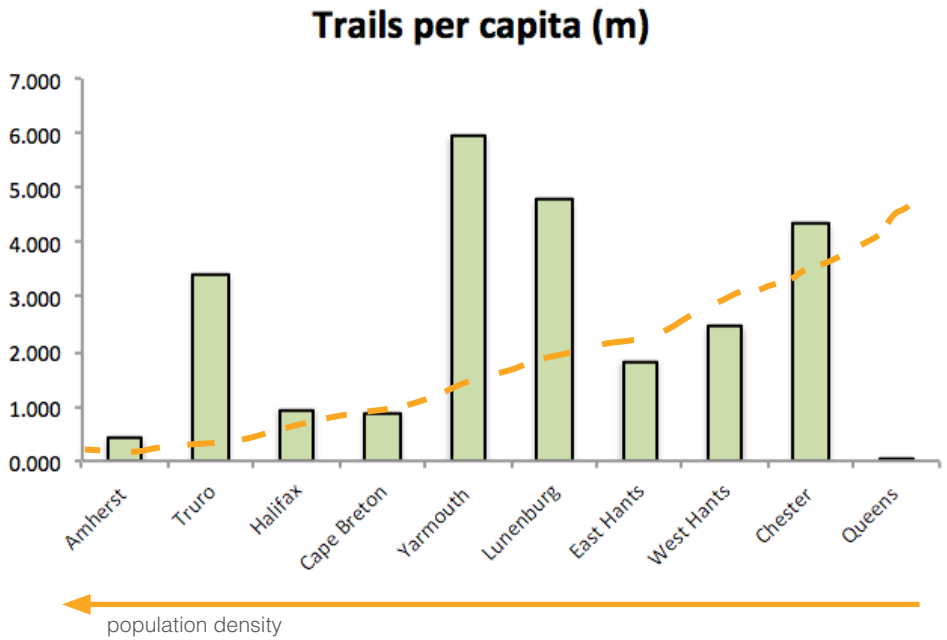
Image: Sara Jellicoe, 2015

With some exceptions, municipalities with higher population densities tend to have fewer trails per capita, as seen in the chart on the right. This pattern has more outliers than the chart on the previous page, which may indicate that population is more important than population density in predicting trails per capita.

There are many different ways of classifying trails, and not all trails may be suitable for commuting. The Nova Scotia Trail Federation (2015) talks about many types, including

- designated trails,
- established trails,
- managed trails,
- shared use trails, and
- single use trails.

These types, however, are not part of an established classification system for trails. These definitions are based on maintenance-type rather than condition. Condition could help indicate suitability for everyday commuting.



Bike Lanes

Halifax Regional Municipality has by far the most bike lanes per capita. Only Cape Breton and Truro have significant amounts, by comparison.

By comparison, Montreal, QC has 531 km of bike lane (more than 5 times as much as Halifax), and Kelowna, BC has 250.

Disaggregation of bike lane data by type of bike lane (e.g. painted, protect, or unpainted paved shoulder) would be more informative about whether the routes are actually suitable for commuting by bicycle.

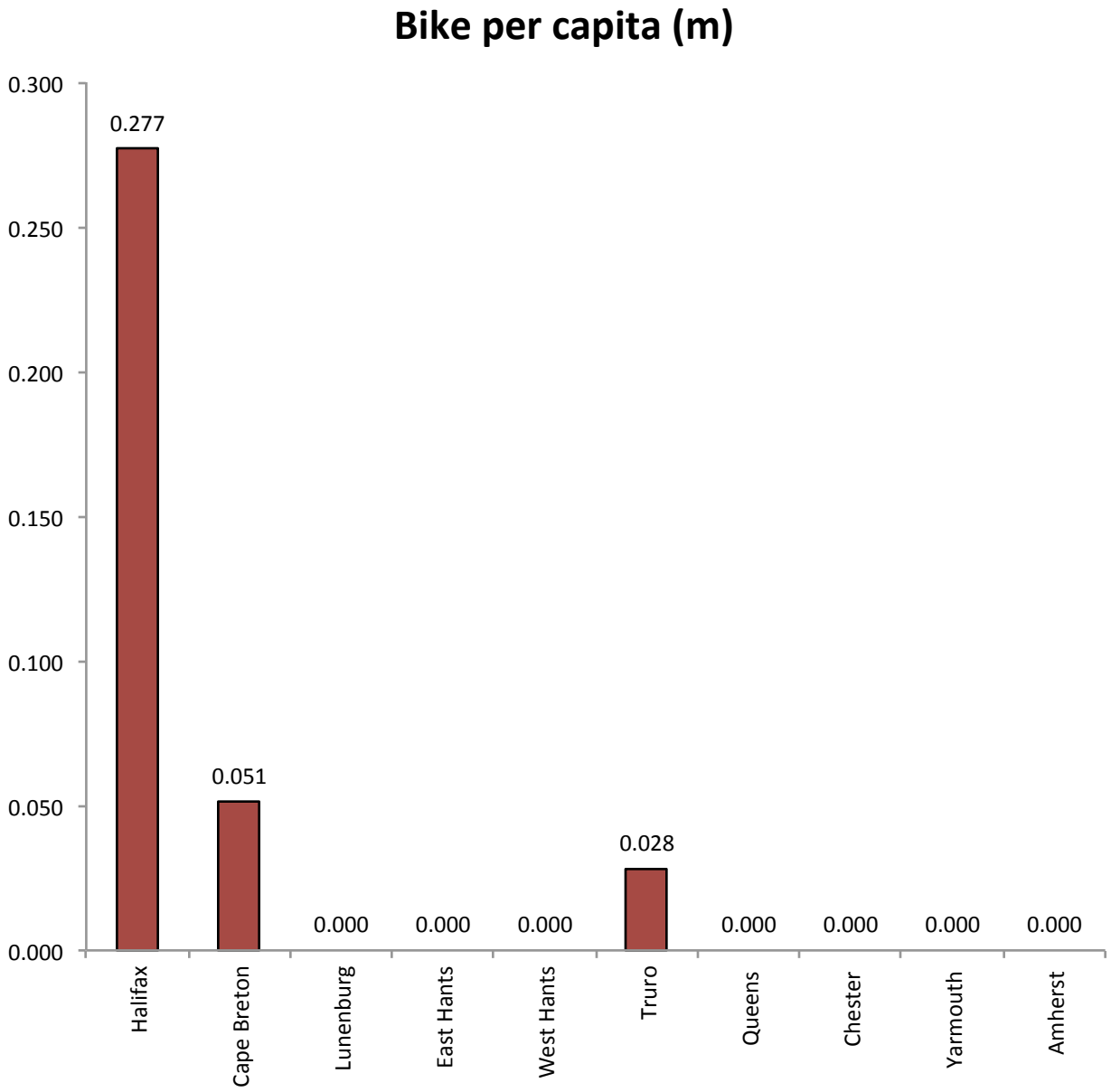


Image: Sara Jellicoe, 2015

Sidewalks

In the municipalities studied, overall population does not appear strongly related to per capita sidewalks. Instead, sidewalks tend to be concentrated in areas of higher population density, for example around Halifax's regional core and Sydney in Cape Breton Regional Municipality.

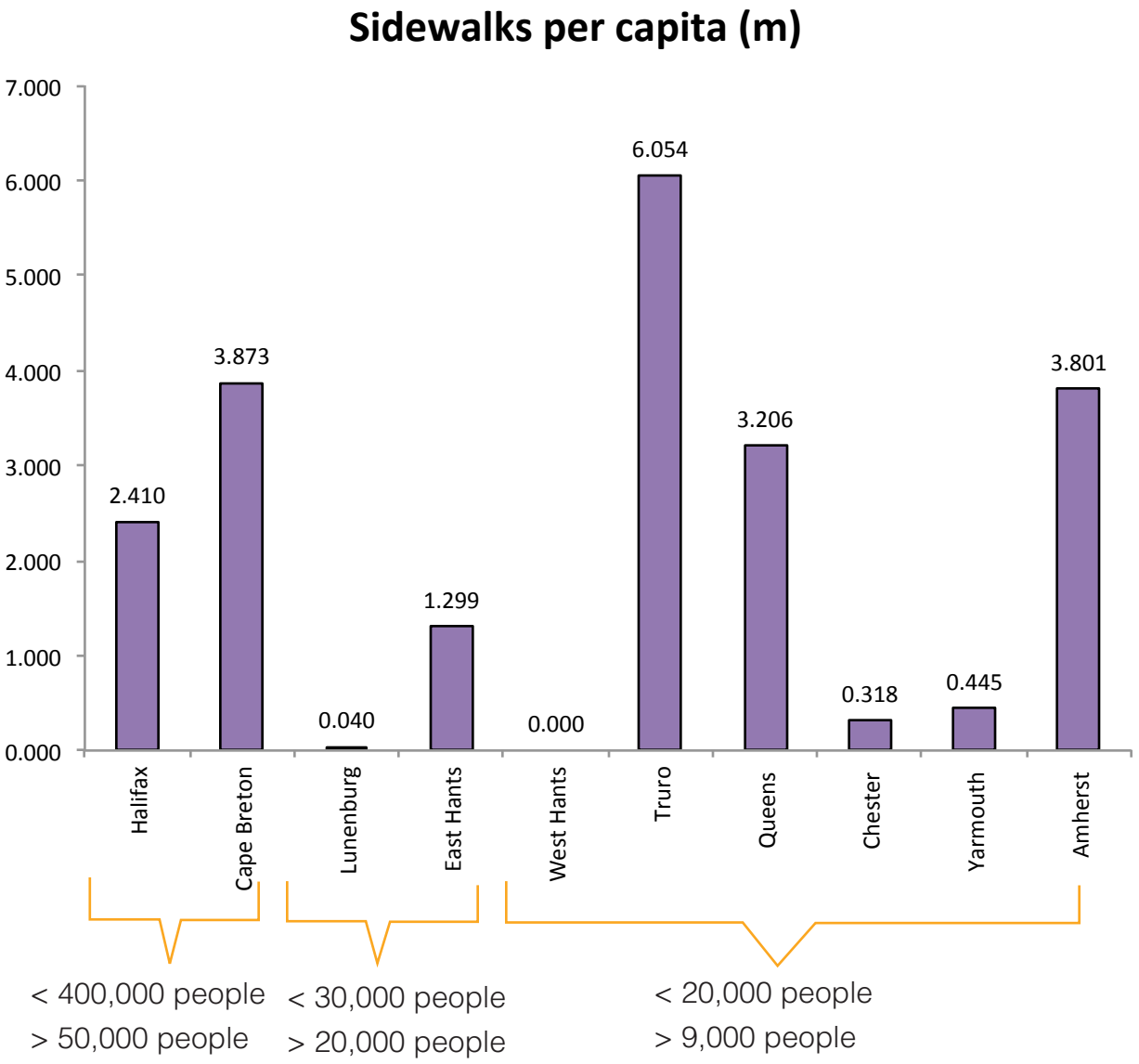
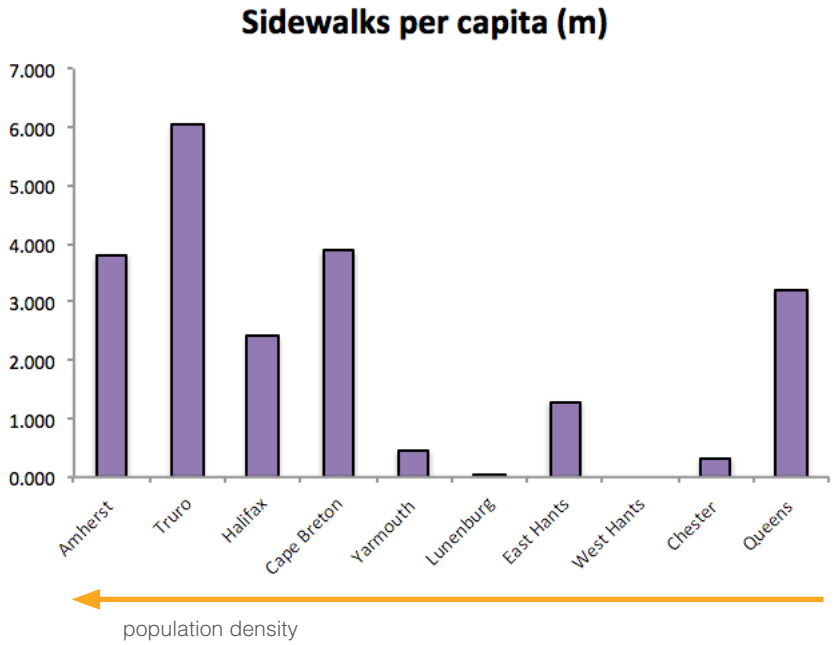


Image: Sara Jellicoe, 2015

Despite their relatively small populations, Truro and Amherst have large amounts of sidewalk per capita. This is consistent with Transport Canada's observation that "dispersed, very low-density land uses" in some rural areas can make active transportation difficult but "village cores" are often quite suitable for AT (2011, p. 2). Truro and Amherst, rural areas can maintain their rural charm and character while fostering sustainable transportation.



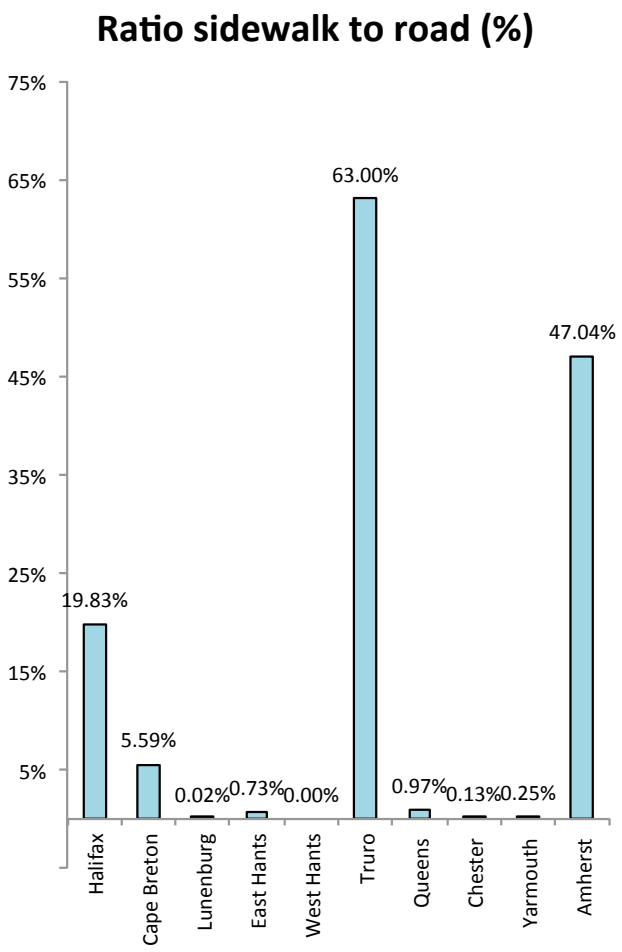
Victoria BC, which is comparable to Halifax economically (Halifax Partnership; Stantec, p. 10), has 5.80 metres of sidewalk per person. Victoria's high population density of over 16 people per acre may help to explain this difference. As other examples, the City of Cornerbrook (population 19,886) has 2.51m of sidewalk per person and the township of Otonabee-South Monaghan in Ontario (population 6,660) has 0.420m of sidewalk per person.

Most of the municipalities contacted had estimates of the amount of sidewalk, but no associated GIS file. This is not unusual; it is also typical among US cities (Brownson, Hoehner, Day, Forsyth & Sallis, 2009).

RATIO OF SIDEWALKS TO ROAD

Sidewalk coverage is a common indicator for sidewalks and is typically measured as the ratio of sidewalk length to road length (Brownson et al., 2009). In nine of the 10 municipalities studied, less than half of the roads in the municipality have sidewalks. The Town of Truro was the only exception.

In towns of between 2,000 and 9,000 in eastern Ontario, the ratio varies between 0% and 100%. For example, the township of Cavan Monaghan, with a population of 8601, has 40% of its roads with sidewalks. The census subdivision of Havelock-Belmont-Methuen, with only 4,523 people, and a population density of only 0.03 persons per acre, has 100% of its roads with sidewalks.

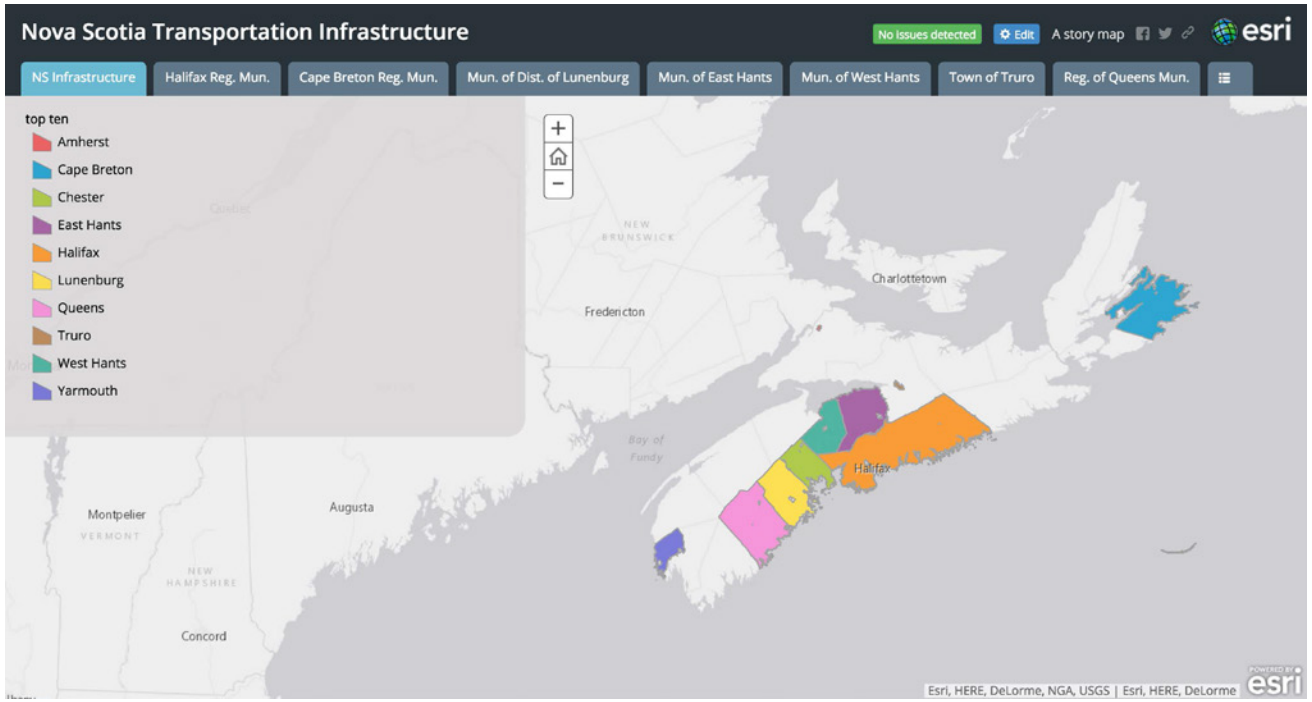


Dissemination

Open Source Map

I have produced a prototype for making infrastructure data publicly accessible, through the ArcGIS Online website, and the Story Map platform. This site allows for data upload and the inclusion of text and images to accompany dynamic map data. It is a user friendly interface with no coding or GIS skills required.

On this platform I have included charts for each of the ten municipalities studied. For the Municipality of the District of East Hants I was able to include trail and sidewalk data on the map, because that data is open source already, through the municipality's own website.

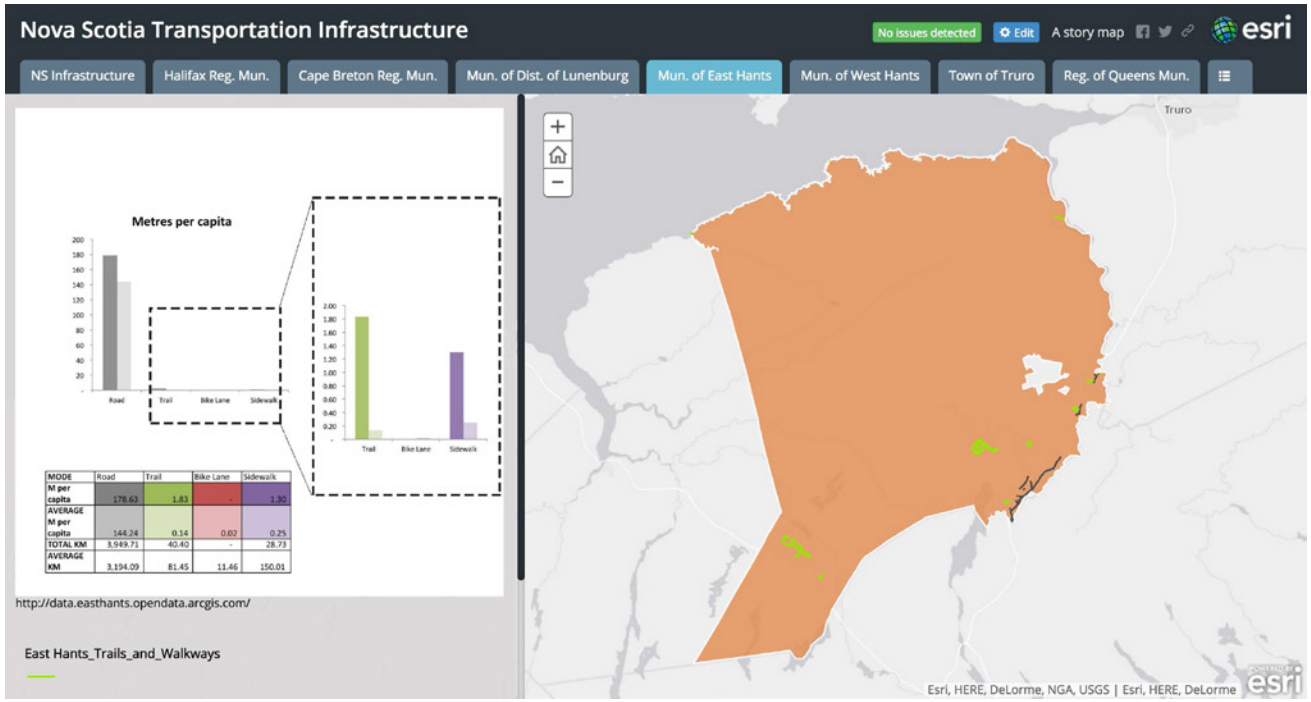


Screenshot of Story Map using ArcGIS Online, Sara Jellicoe, November 2015

In future all data could be uploaded to this platform to make for quick and easy comparisons and analysis by planners, other professionals, and the public.

The ArcGIS Online platform is not perfect. It has a few challenges:

- it only allows upload of shape files with 1000 features or less, which is too small to allow for all features in the Halifax Regional Municipality road shape file, for example; and
- it only allows upload of images which are already on the web (rather than on a computer), which means that an extra step is required.



Screenshot of Story Map East Hants tab, showing analysis and raw data, Sara Jellicoe, November 2015

Lessons Learned

1. Prioritization

This report presents an inventory of indicators. Such an inventory allows for prioritization of:

- planning,
- goals, and
- investment.

Effective prioritization should include criteria to determine where certain types and amounts of infrastructure are most appropriate.

For example, the District of Saanich (2015) in Victoria, BC has **pedestrian demand criteria** to use when selecting which sections of road to add sidewalk to, each year:

- density (persons per hectare)
- villages and centres designated in the Official Community Plan
- proximity to parks and community facilities
- proximity to transit

Municipalities should create criteria appropriate for their local context, referencing relevant plans and policies, amenities and services in their community.

Prioritization based on the indicator set in this report acknowledges the importance of a variety of modes of transportation, which is part of the Province's goals as expressed in multiple planning documents.

2. Investment

In Nova Scotia's most highly populated municipalities, investment in infrastructure for motor vehicles far outstrips investment in AT infrastructure. In order to increase mode share in AT transportation, higher investment in AT infrastructure is needed.

Investment in AT infrastructure can sometimes seem beyond the reach of small municipalities with limited budgets. There are mechanisms to help address this challenge. Expensive up-front costs can also pay dividends in the long term as AT infrastructure is less expensive to maintain than roads for motor vehicles (TCAT, 2012).

Investment in AT infrastructure in areas with lots of road infrastructure can help facilitate and work in tandem with other types of land development, to take full advantage of past investment. For example, the Victoria Transport Policy Institute recommends what they call "clustering": concentrating related amenities within walking distance so that transportation is easier (2015a). This could give communities a village feel, rather than dispersing settlement throughout a large rural area. This is, for instance, similar to a recommendation in the AT Plan for the Municipality of the District of Lunenburg that "For new developments, concepts known as cluster development... could be applied to ensure active transportation conducive densities." (2011, p. 54)

Nova Scotian municipalities contacted in 2013 by DalTRAC agreed that the province "should contribute significant cost-share infrastructure dollars for AT" (DalTRAC, 2013, p. 18). There was some confusion about the applicability of gas tax funding (p. 18), but praise for the NS Moves Funding from the Department of Energy. Municipalities expressed that funding needs to be consistent, not sporadic, in order to be useful. Provincial support and leadership can help significantly.

For example, in 2013, the Province of Manitoba announced its new Small Communities Transportation Fund, intended to support **rural municipalities** for projects such as sidewalks, bike racks and wheelchair ramps. In March 2015, three municipalities were awarded funding, This provincial fund was possible through the Gas Tax Fund from the federal government (Government of Canada, 2015). Annual funding of $200,000 is available for five years, starting in 2014 (Manitoba, 2015).

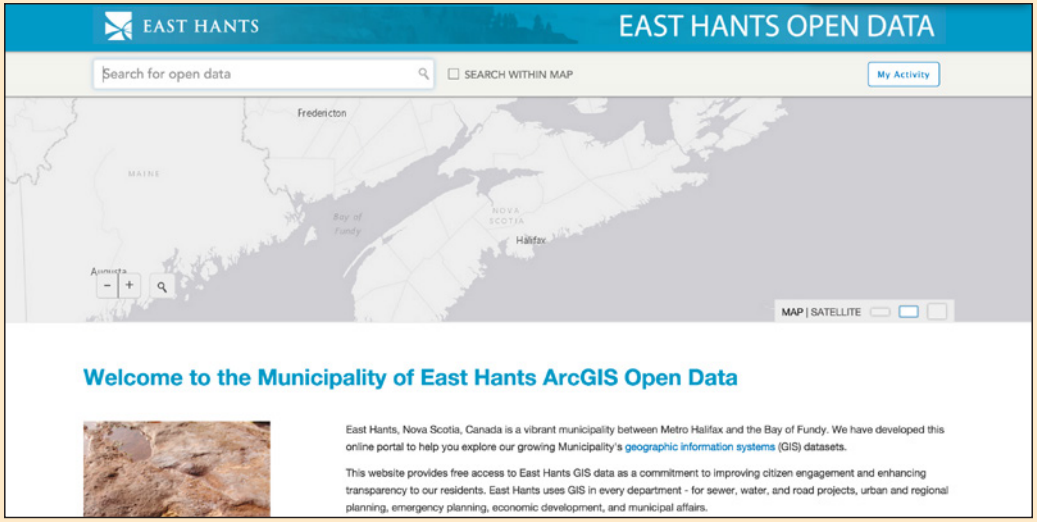
3. Data Archiving

This report would not have been possible without municipal data collection tracking infrastructure. Data collection should continue.

Furthermore, inventory data should be made public and open access. Data was not readily available and had to be sourced through individual contact with municipal and provincial staff. Each municipality is in the best position to collect and disseminate data on their own region.

Data could be made public as merely a list on the Planning and/or Public Works section of a municipal website. Or it could be through a mapping platform such as ArcGIS Online, as shown in this report. GIS can be a great resource, not just for individual researchers to use as a tool, but also for engaging the public and for making open data available.

Some excellent examples of accessible online data dissemination can be seen on the following page: recreational trail data from the Province of Nova Scotia, open data download from the municipality of East Hants, and nationwide bicycle infrastructure data for the United States.

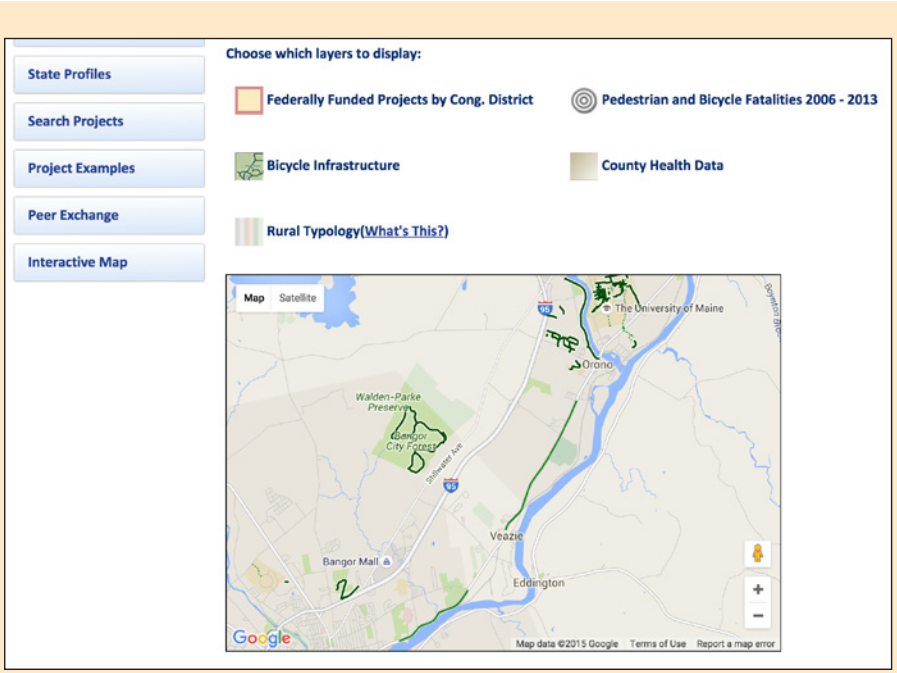


East Hants Open Data site, screenshot October 2015, Sara Jellicoe.

The Nova Scotia Department of Health and Wellness has an excellent resource for its trails. The maps are not interactive and dynamic, but there are a large number of them and navigation is intuitive.

http://www.trails.gov.ns.ca/SharedUse/Images/shared_index.html

Similarly, the Rails to Trails Conservancy in the US has an excellent, dynamic, interactive online map which displays bicycle infrastructure and federally funded projects nationwide, as well as a rural typology proposed by the University of Washington, so that rural communities are recognized for their unique identities.



http://trade.railstotrails.org/community_data

4. Tracking Progress

This report continues the work in tracking progress towards sustainable transportation in Nova Scotia. The process should continue, through ongoing analysis of indicator inventories and comparison to planning goals.

Screenshot from http://novascotia.ca/sustainabletransportation/tracking-progress.asp

Future Research

Quality

Future indicator inventory collection in Nova Scotia should include qualitative indicators. It does not matter how many kilometres of infrastructure exist if they are poorly maintained or inaccessible. Litman (2004) and Dobranskyte-Niskota, et. al (2007) also recommend quality indicators in their comprehensive studies of transportation indicators.

For example, Peterborough, Ontario (2014), included various indicators to assess quality of sidewalks, including:

- the percentage of sidewalks immediately beside the road with no buffer zone,
- the distance between traffic signals on arterial roads,
- the percentage of sidewalks with shade tree coverage,
- the number of pedestrian refuge islands, and
- the average crossing time by traffic signals.

Supportive Infrastructure

There are many other aspects to transportation infrastructure than just land devoted to routes. Some examples of supportive infrastructure include

- parking lots,
- bicycle parking,
- secure bicycle storage,
- pedestrian traffic signals,
- bicycle traffic signals,
- transit vehicles,
- vehicle garages, and
- transit traffic signals.

Such infrastructure should be included in future infrastructure inventories in Nova Scotia.

For example, Stantec (2013) included "parking spaces per central business district employee" in their set of indicators for Halifax and the Genuine Progress Index (2008), included parking area in their indicator of "land area consumed by cars" (p. 28).

Public Transit

Currently in Nova Scotia there is no infrastructure designated solely for public transportation, with the exception of some short (less than 1 km) queue jump lanes for advance passage through intersections, in Halifax Regional Municipality. Future reports should include indicators for such infrastructure, should more be built.

For example, Kenworthy's study of indicators for millennium cities included "total length of public transit lines per capita" (2003, p. 52).

Bidirectionality

Roads are typically measured from centrelines and presumed to be two lane equivalents for the purposes of simplicity. For consistency, sidewalks and are treated the same way. This is a simplification. Bike lanes are so infrequent currently that they are almost never bidrectional, when provided. Thus, unidirectional bike lanes are counted in this report. In future data collection, bike lane criteria should be defined, standardized and specified.

Municipalities

This project reports on only the ten most highly populated municipalities in Nova Scotia because:

- data is most readily available,
- some smaller municipalities do not have any active transportation infrastructure with which to compare indicators, and
- this project is intended as a pilot study, and a starting point for consistent continued data collection and monitoring.

Although some of the patterns observed may be generalizable to other parts of Nova Scotia, future research should inventory all municipalities in Nova Scotia, as each has its own unique challenges.

Collecting data on all municipalities is especially important in the case of incorporated town municipalities which are surrounded entirely by district municipalities. The transportation systems in the Municipality of the District of Lunenburg, for example, are influenced heavily by the presence of the towns of Bridgewater, Lunenburg and Mahone Bay. It would be short sighted to presume that the transportation infrastructure of these towns is independent of the municipalities surrounding them, and vice versa.

Although analyzed separately in this report, municipalities do not function independently from one another. Transportation systems link municipalities and many linkages exist due to proximity of municipalities to each other.

Land Consumption

Many transportation indicator studies recommend estimating total land consumption of infrastructure (Dobranskyte-Niskota et al.; GPI Atlantic, 2008; Haghshenas and Vaziri, 2012; Kind, 2001; Litman, 2004; Santos and Ribeiro, 2013). Length can serve as a proxy, but more detailed width information from municipalities, or polygon GIS shape files, can provide more accurate estimations of land consumption by infrastructure.

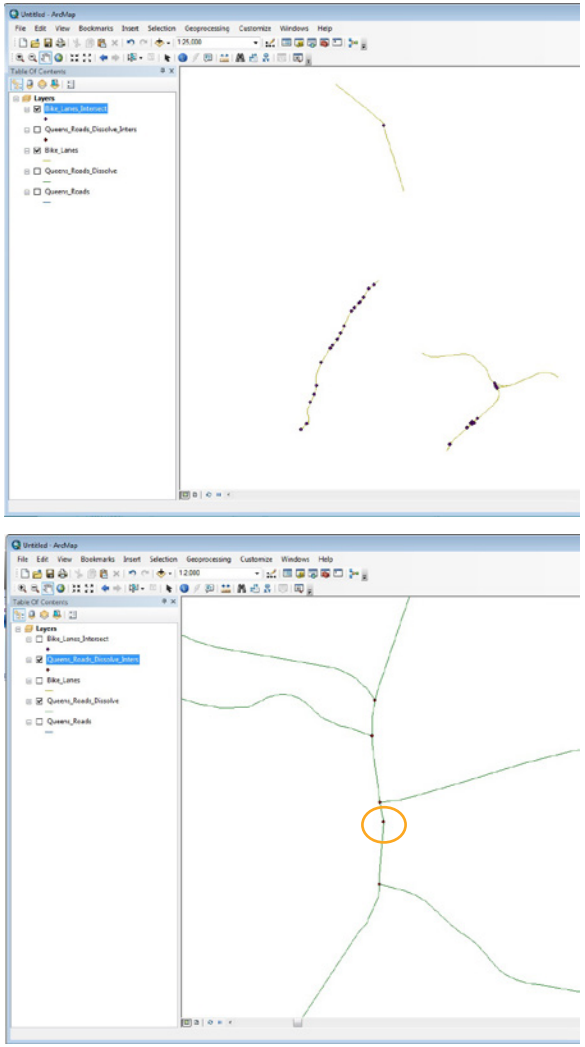
Connectivity

Some indicator reports (Province of Ontario, 2006, p. 25) include a measure of connectivity, usually expressed as number of intersections per square kilometre (or hectare). In the academic literature it is referred to as intersection density, and common in studies of pedestrian routes (Brownson, Hoehner, Day, Forsyth & Sallis, 2009). The province of Ontario recommends “street intersection density of greater than 0.3 intersections per hectare, with higher street intersection densities of over 0.6 intersections per hectare in mixed-use nodes and corridors” (2006, p. 25).

The tools in ESRI ArcMap to estimate intersections per area are:

- Dissolve, and
- Intersect.

As shown in the images at right, when using these tools sometimes intersections are correctly identified, but if infrastructure lines are broken into sections with different names, intersections will be identified between them. This indicates that datasets are not adequately formatted for this command to function properly. Each individual road should be uniquely identified with a name, and only one name. Some datasets had many entries entitled only “track”, or left blank. Future data collection should ensure neat datasets with accurate naming.



Sara Jellicoe ArcMap map production with example of error circled.

Conclusion

Nova Scotia's most highly populated municipalities have many types of transportation infrastructure, but are dominated by infrastructure supporting motor vehicles.

Continued monitoring, strategic planning and provincial investment can help support infrastructure for a wider range of transportation modes.

Making data more openly available can strengthen planning initiatives. Plans are already open source, available on the web for anyone, professionals and the public, to read and appreciate. Our next step can be to extend that openness to our understanding of data, so that our visions of the future can be more highly informed.

Photograph at "Switch 2015" event in Dartmouth, Nova Scotia, image credit Sara Jellicoe.

References

Active Transportation Summit (2015). *Active Transportation Summit Final Report.* Draft retrieved in personal communication with Janet Barlow, October 8, 2015.

Brownson, R., Hoehner, C., Day, K., Forsyth, A., & Sallis, J. (2009). Measuring the Built Environment for Physical Activity: State of the Science.*American Journal of Preventive Medicine,* 36(4 Suppl), S99–123. Retrieved from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2844244/ November 30, 2015.

Cape Breton Regional Municipality (2015). *Municipal Planning and Land Use By-Laws.* Retrieved from: http://www.cbrm.ns.ca/municipal-planning.html October 15, 2015.

Cornerbrook (2015). *Snowclearing FAQs*. Retrieved from: http://www.cornerbrook.com/pdf/images/Residents/FAQ's%20Snow%20Clearing%20Jan%2022-13%20(3).pdf October 16, 2015.

Curran, Andrew (2005). *Measuring the Built Environment for Healthy Communities*. Retrieved from: http://theoryandpractice.planning.dal.ca/_pdf/health_built_environment/acurran_thesis.pdf October 7 2015.

City of Kelowna (2009). *Linear Parks Master Plan*. Retrieved from: http://apps.kelowna.ca/CityPage/Docs/PDFs/Parks/2009-11-18_Linear_Parks_Master_Plan_TrailDefinitions.pdf November 30, 2015.

DalTRAC (2015). *Nova Scotia Sustainable Transportation Indicators: Summary Report*. Draft retrieved in personal communication with Ahsan Habib, September 26, 2015.

DalTRAC (2014). *Active Transportation and Community Transit: Assessing the State of Practice, and Level of Commitment and Awareness in Nova Scotia Municipalities.* Draft retrieved in personal communication with Ahsan Habib, October 1, 2015.

DalTRAC (2013). *A targeted review of issues relating to advancing Active Transportation in Nova Scotia*. Retrieved from: http://www.dal.ca/content/dam/dalhousie/pdf/sites/share-the-road/DalTRAC_AT_FINAL-1.pdf October 7, 2015.

Department of Municipal Affairs (2014). *Annual Report of Municipal Statistics.* Retrieved from: http://novascotia.ca/dma/pdf/mun-2014-annual-report-of-municipal-statistics.pdf OCtober 12, 2015.

Department of Transportation and Infrastructure Renewal (2014). *2014-2015 Statement of Mandate.* Retrieved from: http://novascotia.ca/government/accountability/2014-2015-TIR-Statement-of-Mandate.pdf October 1 2015

District of Saanich (2015). *Sidewalks in Saanich.* Retrieved from: http://www.saanich.ca/services/roads/sidewalks.html October 7, 2015.

Dobranskyte-Niskota, A., Perujo, A. & Pregl, M. (2007). *Indicators to Assess Sustainability of Transport Activities. European Commission Joint Research Centre Scientific and Technical Reports.* Retrieved from: http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/10416/1/indicators%20report_green%20template.pdf, March 15.

Ecology Action Centre (2010). *Municipalities for Green Mobility: A Guide to Action on Sustainable Transportation for Nova Scotia.* Retrieved from: https://www.ecologyaction.ca/files/images-documents/file/Transportation/MGM_Toolkit_5Nov2010.pdf October 7, 2015.

Ecology Action Centre (2008). *Green Mobility Strategy for Nova Scotia.* Retrieved from: https://www.ecologyaction.ca/files/images-documents/file/Transportation/GMG.pdf October 7, 2015.

Explore HRM (nd). Retrieved from: http://maps.halifax.ca/website/ExploreHRM/viewer.php November 30, 2015.

Federation of Canadian Municipalities (2011). *Active Transportation in Canada: A Resource and Planning Guide.* Retrieved from: https://www.fcm.ca/Documents/tools/GMF/Transport_Canada/ActiveTranspoGuide_EN.pdf November 30, 2015.

Federation of Canadian Municipalities (2009). *Research Report: Transportation Sector*. Retrieved

from: https://www.fcm.ca/Documents/reports/GMF/2009/Research_Report_Transportation_Sector_EN.pdf October 8, 2015.

Federation of Canadian Municipalities (2008). *Sample environmental indicators and measurement approaches for sustainable transportation projects*. Retrieved from: http://www.fcm.ca/Documents/tools/GMF/Sample_Environmental_Indicators_and_Measurement_Approaches_for_Sustainable_Transportation_Projects_EN.pdf October 7 2015.

Federation of Canadian Municipalities (2002). *Developing Indicators and Benchmarks: a best practice by the national guide to sustainable municipal infrastructure*. Retrieved from: https://www.fcm.ca/Documents/reports/Infraguide/Developing_Indicators_and_Benchmarks_EN.pdf October 8, 2015.

Fraser Basin Council (2009). *Transportation Demand Management: A Small and Mid-Size Communities Toolkit.* Retrieved from: http://www.fraserbasin.bc.ca/_Library/CCAQ/toolkit_tdm_2009.pdf October 7, 2015.

Genuine Progress Index Atlantic (2008). Retrived from http://www.gpiatlantic.org/pdf/transportation/hrmtransportation.pdf October 1 2015.

Government of Canada (2015). *Three local governments to benefit from the small communities transportation fund thanks to the federal gas tax fund.* Retrieved from http://news.gc.ca/web/article-en.do?mthd=tp&crtr.page=1&nid=952949&crtr.tp1D=1 October 7 2015.

Haghshenas, H. & Vaziri, M. (2012). Urban sustainable transportation indicators for global comparison. *Ecological Indicators* 15, pp. 115-121.

Halifax (2015). *History of Halifax.* Retrieved from: https://www.halifax.ca/community/history.php October 15, 2015.

Hanson, T., Allaire, F., MacEacheron, C. (2015). *Issues and Opportunities for enhancing active transportation*

among rural and urban areas: lessons from a New Brunswick study. Retrieved from: ctrf.ca October 7, 2015.

Infrastructure Canada (2014). *Administrative Agreement on the Federal Gas Tax Fund.* Retrieved from: http://www.infrastructure.gc.ca/alt-format/pdf/gtf-fte-ns-20140703-eng.pdf, October 12, 2015.

Kenworthy, J. (2003). *Sustainable Urban Transport and Land Use Patterns for More Sustainable Cities in Australia: Some Key Policy Implications from An International Comparative Study. Parliament of Australia.* Retrieved from: http://www.aph.gov.au/parliamentary_business/committees/ March 15, 2015.

Kind, V. (2001). *Measuring progress towards sustainable transportation* (Master's Thesis). Retrieved from ProQuest. (0-612-66425-2) pp. 189.

Kingston (2014). *Snow Plowing*. Retrieved from: https://www.cityofkingston.ca/residents/roads-and-traffic/snow-removal October 16, 2015.

Litman, T. (2014). *Well measured: developing indicators for sustainable and livable transport planning*. Victoria Transport Policy Institute. Retrieved from: http://www.vtpi.org/wellmeas.pdf, March 15, 2015.

Manitoba (2015). *Small Communities Transportation Fund.* Retrieved from http://www.gov.mb.ca/ia/bldgcomm/sctf.html October 7, 2015.

Municipality of the District of Lunenburg (2011). *Active Transportation Plan.* Retrieved from: http://www.modl.ca/component/docman/doc_download/2388-active-transportation-plan November 30, 2015.

Nova Scotia Trails Federation (2015). *Profile of the Trails Movement in Nova Scotia.* Retrieved from: http://www.novascotiatrails.com/images/PDF/Profile%20of%20the%20Trails%20Movement%20in%20NS%20-%202015-04-09.pdf November 30, 2015.

Ontario Professional Planners Institute (2009). *Planning by design: healthy communities handbook.* Retrieved from: http://ontarioplanners.ca/PDF/Healthy-Communities/2009/Healthy-

Communities-Handbook.aspx October 7, 2015.

Peterborough (2014). *Active Transportation and Health: Indicators Report.* Retrieved from: http://www.peterborough.ca/Assets/City+Assets/TDM/Documents/indicators+report.pdf October 7, 2015.

Province of Nova Scotia (2013). *Choose How You Move: Sustainable Transportation Strategy*. Retrieved from: http://novascotia.ca/sustainabletransportation/docs/Sustainable-Transportation-Strategy.pdf October 12, 2015.

Province of Nova Scotia (2013b). *Choose How You Move: Exploring Sustainable Transportation in Nova Scotia, A companion document to the sustainable transportation strategy.* Retrieved from: http://novascotia.ca/sustainabletransportation/docs/Exploring-Sustainable-Transportation.pdf OCtober 12, 2015.

Province of Nova Scotia (2012). *Thrive! A Plan for a Healthier Nova Scotia.* Retrieved from: https://thrive.novascotia.ca/sites/default/files/Thrive-Strategy-Document.pdf October 7, 2015.

Province of Ontario (2006). *Performance Indicators for the growth plan for the greater golden horseshoe, 2006.* Retrieved from: http://www.mah.gov.on.ca/AssetFactory.aspx?did=10849 November 30, 2015.

Rails to Trails Conservancy (2011). *Active Transportation Beyond Urban Centers: Walking and Bicycling in Small Towns and Rural America.* Retrieved from http://www.railstotrails.org/resourcehandler.ashx?id=4141 October 7, 2015.

Regina (2013). *State of Roadways Infrastructure.* Retrieved from: http://open.regina.ca/dataset/616b2570-d8bd-4684-8572-df49e82bdbfb/resource/f6e5051d-9d35-40d7-b735-06dabada86d6/download/stateofroadwaysinfrastructure2013.pdf October 16, 2015.

Rural Healthy Communities (2013). *Healthy Rural Communities: Strategies and Models of Practice.* Retrieved from: http://www.ruralhealthycommunities.

ca/Rural_Healthy_Communities/Literature_Review_files/Rural%20Communities%20Lit%20Review.pdf October 7, 2015.

Santos, A., & Ribeiro, S. (2013). The use of sustainability indicators in urban passenger transport during the decision-making process: the case of Rio de Janeiro, Brazil. *Current opinion in environmental sustainability* 5, pp. 251-260.

Statistics Canada (2011). *Focus on Geography Series, 2011 Census: Province of Nova Scotia.* Retrieved from: http://www12.statcan.gc.ca/census-recensement/2011/as-sa/fogs-spg/Facts-pr-eng.cfm?Lang=Eng&GC=12 October 13, 2015.

Toronto Coalition for Active *Transportation (2012). The Economic Impacts of Active Transportation.* Retrieved from: http://www.tcat.ca/wp-content/uploads/2014/10/Economic-Impacts-of-Active-Transportation-Backgrounder.pdf October 16, 2015.

Transport Canada (2009). *Improving Travel Options in Small and Rural Communities.* Retrieved from: https://www.fcm.ca/Documents/tools/GMF/Transport_Canada/ImprovingTravelSmallRural_EN.pdf October 7, 2015.

Transport Canada (2010a). *Wheel 2 Work in Whitehorse.* Retrieved from: http://data.tc.gc.ca/archive/eng/programs/environment-utsp-wheel2work-268.htm October 7, 2015.

Transport Canada (2010b). *Sustainable transportation in small and rural communities.* Retrieved from: http://data.tc.gc.ca/archive/eng/programs/environment-utsp-smallnruralcomms-1012.htm October 7, 2015.

Transport Canada (2011). *Active transportation in Canada: A resource and planning guide.* Ottawa. Retrieved from: http://www.tc.gc.ca/media/documents/programs/atge.pdf, March 15, 2015.

Union of Nova Scotia Municipalities (2015). *Active Transportation.* Retrieved from: http://www.unsm.ca/active-transportation.html October 8, 2015.

UNSM Municipal Sustainability Office (2010). *Where it's AT: exploring issues to advancing active transportation in Nova Scotia.* Retrieved from: http://www.sustainability-unsm.ca/active-transportation-video.html March 23, 2015.

Velo Cape Breton (2015). *Getting around CBRM: A Cyclist's Handbook.* Retrieved from: http://velocapebreton.ca/node/819 October 16, 2015.

Victoria Transport Policy Institute (2015a). *Land Use Density and Clustering.* Retrieved from: http://www.vtpi.org/tdm/tdm81.htm October 13, 2015.

Victoria Transport Policy Institute (2015b). *Rural Transportation Management.* Retrieved from: http://www.vtpi.org/tdm/tdm87.htm November 30, 2015.

Appendix A

JELLICOE 2015 DATA SPREADSHEET

Population Density (person per sq km)	Population density (person per acre)	Population (2011)	Type of Municipality	Community	Area	Year	Sidewalk (km)	Sidewalks per capita (m)	Sidewalk land consumption (assuming average width 1.5m)	Trail (km)	Trails per capita (m)	Bike (km)	Bike per capita (m)	Road (km)	Road density (km per km2)	Road per capita (m)	Road land consumption (assuming average width 8m)	Ratio of sidewalk to road (%)
71.1	0.287732	390,095	RGM	Halifax	5,490.28	2012	940.001	2.410	0.03%	371.048	0.951	108	0.277	4741.001	0.863526	12.153	0.69%	19.83%
40	0.161875	97,398	RGM	Cape Breton	2,433.35	2015	377.175	3.873	0.02%	85.292	0.876	5	0.051	6749.146	2.773603	69.295	2.22%	5.59%
14.3	0.05787	25,118	MD	Lunenburg	1,759.64	2015	1	0.040	0.00%	120.029	4.779	0	0.000	5609.628	3.187941	223.331	2.55%	0.02%
12.4	0.050181	22,111	MD	East Hants	1,786.47	2015	28.731	1.299	0.00%	40.395	1.827		0.000	3949.709	2.210901	178.631	1.77%	0.73%
11.4	0.046134	14,165	MD	West Hants	1,241.95	2015		0.000	0.00%	35.024	2.473		0.000	2789.163	2.245793	196.905	1.80%	0.00%
320.5	1.297019	12,059	Town	Truro	37.63	2015	73	6.054	0.29%	41	3.400	0.34	0.028	115.872	3.079245	9.609	2.46%	63.00%
4.6	0.018616	10,917	RGM	Queens	2,392.85	2015	35	3.206	0.00%	0.124	0.011	0	0.000	3606.092	1.507028	330.319	1.21%	0.97%
9.4	0.038041	10,599	MD	Chester	1,122.22	2015	3.37	0.318	0.00%	46	4.340		0.000	2526.056	2.250945	238.330	1.80%	0.13%
17.3	0.070011	10,105	MD	Yarmouth	585.75	2015	4.5	0.445	0.00%	60	5.938	0	0.000	1775.729	3.031548	175.728	2.43%	0.25%
808.4	3.271484	9,717	Town	Amherst	12.02	2015	36.93	3.801	0.46%	3.91	0.402		0.000	78.51	6.531614	8.080	5.23%	47.04%

Appendix B

2014 DALTRAC MUNICIPAL REPORTING SURVEY SPREADSHEET

Municipality	Council Approved Active Transportation Plan	KM Designated Bike Lanes				Bike Lane Comments
		UNSM Survey		May-15		
		Estimated	Calculated	Estimated	Calculated	
Town of Amherst	Yes	NP	NP			(UNSM Survey: 3.4km calculated of other bicycle lanes)
Town of Digby		NP	NP			
Town of Middleton		~	0	~	0	
Town of Port Hawkesbury	Yes	NP	NP	~	0	
Town of Annapolis Royal		NP	NP	~	0	(UNSM Survey: 5km other bicycle lanes)
County of Annapolis	Yes	0.4	~	0.4		(UNSM Survey: 500km other bicycle lanes)
Town of Hantsport		NP	NP			
Town of Mulgrave						
Town of Shelburne	No					
District of Shelburne	No	~	0	~	0	(UNSM Survey: 1.2 km calculated of other bicycle lanes) (1km designated lanes with painted lines in the Town of Shelbourne)
Town of Antigonish						
County of Antigonish		NP	NP	~	0	
Town of Kentville		~	0			
Town of New Glasgow		6	~	~	0.96	*Use the calculated value for 2015 for both years.
Town of Stellarton						
Town of Berwick	No	~	4.2	~	4.2	
Town of Lockeport	No	~	0	~	0	Only 19 km by road from the 103. The rural/coastal pace of life makes it bikeable
Town of Oxford		~	0	~	0	
Town of Stewiacke		NP	NP	~	0	No bike lanes in Stewiacke
Town of Bridgewater	Yes	~	0	~	0	We have shared bicycle lanes and multi-use trails but no dedicated bicycle lanes as described in this survey
Town of Lunenburg	Yes					
District of Lunenburg		~	0	~	0	(UNSM Survey: 120km other bicycle lanes)
Town of Parrsboro	No	~	0	~	0	
Town of Trenton	Yes	NP	NP	~	3.8	(UNSM Survey: 5km estimated of other bicycle lanes) (Share the Road Designated)
District of Barrington		~	0	~	0	
Town of Clark's Harbour		10	~	10	~	
Town of Mahone Bay	No	~	0	~	0	
County of Pictou						
Town of Pictou		~	0	~	0	Do not have designated bike lanes, working on a share the road program
Town of Truro			0	~	0.34	(UNSM Survey: 3km estimate of other bicycle lanes)
District of Argyle		NP	NP	~	0	We don't have any official Bike lanes, but we do have wider shoulders in two section adjacent to sidewalks. These areas are approximately 6 feet wide and approximately
County of Cumberland		NP	NP	~	0	
County of Inverness				~	0	
Town of Windsor	Yes					
County of Kings	No			0.25	0	On the bridge
Town of Wolfville	No	~	6.64	~	6.64	3.32km East-West and 3.32km West-East. This is on Main Street from Town Line to Town line with a gap in the downtown core.
Cape Breton Regional Municipality	Yes	~	5	~	5	
District of Guysborough				~	0	
Town of Yarmouth	Yes					
District of Yarmouth	Yes	~	0	~	0	There are no designated bike lakes in the entire County of Yarmouth
District of Chester		~	0			
District of Clare	Yes	NP	NP	~	0	
Halifax Regional Municipality	Yes	~	108		108	
County of Colchester	Yes	~	0	~	0	There are some paved shoulders on provincial roads, but no designated bike lanes.
District of East Hants		~	0			
District of West Hants	Yes	~	0	0	~	
Region of Queens Municipality		~	0	~	0	We do not have any designated bike lanes
County of Richmond		~	0			(UNSM Survey: 70km estimated of other bicycle lanes)
District of St. Mary's		NP	NP	~	0	
County of Victoria	Yes					
Town of Westville						
District of Digby						

2014 DALTRAC MUNICIPAL REPORTING SURVEY

KM Designated Trails				Trail Comments
UNSM Survey		May-15		
Estimated	Calculated	Estimated	Calculated	
3.4	~	3.4		
4	~	4		
25	~	25	~	
15	~	~	10	*Use the calculated value for 2015 for both years
8	~	7.7	1	We have 7.7 km of dedicated walking trails within Town limits, and this figure does not include sidewalks. There is approximately 1 km of sidewalk on Upper St George St that is designated as shared use for pedestrians and cyclists.
79	~	79		
NP	NP			**MERGED WITH THE MUNICIPALITY OF WEST HANTS**
6	~	~	6	(3.5km calculated in the Town of Shelbourne)
NP	NP	~	93.46	9 Separate Trail Netorks. Each Rated Easy, Moderate, or Difficult
0.3	~	0.3		
16	~	~	9	
~	2.2	~	2.2	1 former Rail line that runs through Berwick
~	4	~	4	3.2 loop across old rail tracks plus a small trail through the park (about 4 km total) along the rail trail
10	~	10	~	
4	~	5 (see note)	0	No specific commuting trails. We have 3 different recreastion trails which total to approx. 5km's
~	10.12	~	10.12	Trails included: Centennial Trail – 9.15 km, Riverside Walk – 0.55 km, Riverside Park – 0.18 km, Hollingsworth Trail – 0.24 km . We also have a number of nature trails in some of our parks that are not at the standard described above.
120	~	120	~	
5	~	5	~	
~	6.5	~	2.5	TCT Connector Route (No vehicles allowed). As they are both calculated values - there was a decrease in 4km of trails
41	~	41	~	
~	0	~	0	
~	3.6	~	3.6	Owned by Prov. NS and maintained by Bay-to-Bay Trail Assoc. @ 2.8 km and Dynamite Trail Assoc. @ 0.8 km
~	4	~	4	Registered Trans Canada Trail (partial paved and gravel bed)
0	~	41	~	
~	50	~	55.5	We have 47km of rails to trails. There are 5 other trails totaling 8.5km.
50	~	~	40	Cape Chignecto has 40km of hiking trails (wilderness trails). We have 40km of old rail line - part of our TCT portion.
		~	92	The 92 km trail is a former rail line and is first leg of the Trans Canada Trail on Cape Breton Island. The newly named Celtic Shores Coastal Trail has been developed and maintained by five volunteer community trail clubs along the trail and has been designated by Tourism Nova Scotia as a destination trail targeting cyclists.
		~	6	Mainly corwallis river greenway, Lots of promise for the pipeline to expand the trail network
2	~	2	~	Currently 2km of Rail Trail with new rail trail section to be completed this fall to take the trail to the western edge of town. Another 0.6km of trail is frequently used for AT and recreation but not built to a standard that would work for those with mobility issues. Total trail distance for recreational traileds that are owned by the Town and Acad
11	~	11	~	
		65	~	Gusborough Tans Canada Trail and Nature Trails (65+)
60	~	60	~	There is approximately 60km of multiuse trail in the District of Yarmouth. Users are walking, running, bike, ATVing, skidooing and using horses on the trail. 60 km is a rough estimate. There is almost 100 km between the Town, Mun of Yarmouth and Mun of Argyle
~	46		46	
~	45	~	45	
~	168		168	
~	0	~	18	6km Butter Trail (part of Shoreline Trail and TCT) in Tatamagouche - rail trail with crusher dust surface, 8-10ft. wide. 10km Cobequid Trail (rail trail section, Truro to Old Barns) - crusher dust surface, 8-10 ft. wide. 2km Cobequid Trail (Dalhousie Agricultural Campus and Bible Hill Recreation Park sections) - cursher dust surface, 8-10 ft. wide.
43	~	43		
~	0	35	~	
				No new trail development since 2014 (just need the value)
70	~	70		
NP	NP	~	40	Recreational and Hiking trails