

THE FEDERATION OF CANADIAN MUNICIPALITIES
QUALITY OF LIFE REPORTING SYSTEM



The FCM Quality of Life
Reporting System

Ecological Footprints of
Canadian Municipalities
and Regions



Federation
of Canadian
Municipalities

Updated January 2005

Ecological Footprints of Canadian Municipalities and Regions

Prepared for:

The Canadian Federation of Canadian Municipalities

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NOTE: Updated January 2005

Erratum

Since the release of the Ecological Footprint report September 29, 2004, errors in the original Statistics Canada data for household incomes for the Regional Municipalities of Halton, Peel, Waterloo and York was identified necessitating recalculations of the ecological footprints of these respective communities. This revised report reflects these changes in both the ecological footprint estimates for these respective communities and their relative ranking, vis-à-vis other Canadian municipalities assessed in this study.

The nature of the error was incorrect household income data for the Regional Municipalities of Halton, Peel, Waterloo and York, which was used to complete the ecological footprint analysis. Our original analysis drew on what we believed to have been **median household income** (used to calculate ecological footprint for communities without household consumption expenditure data) from Statistics Canada's on-line Community Profiles database. Unfortunately we learned only after the September 29, 2004 release of the original FCM Ecological Footprint report, that the income data was actually **average household income**, not median household income. Due to the large discrepancy between median and average income figures and the sensitivity of ecological footprint analysis to household income, changes to the ecological footprint estimates resulted. The newly revised ecological footprint estimates for the Regional Municipalities of Halton, Peel, Waterloo and York are based on the correct median household income figures.

As a result of these changes the following tables, charts, and text have been revised from the original September 29, 2004 report. Page numbers referenced correspond to the same page numbers in the September 29, 2004 edition of this report; this January 2005 version uses the same page numbers:

Page 6: New figure titled: *Canadian Municipal Ecological Footprints from Vancouver to Halifax*

Page 6: How much nature do we consume?

- Sentence 2 now reads: "*Calgary, Edmonton and Halton RM* have the highest ecological footprints..."

Page 16 & 17: Table 2: Summary of FCM Municipal Ecological Footprint Estimates and Indicators Used to Estimate Footprints. Data in columns for Waterloo (p. 16), Halton, Peel and York (p. 17) should be replaced with the new data.

Page 20. 3. Canadian municipal ecological footprint results

- Sentence 1, third paragraph now reads: "Our analysis of 20 municipal footprints across Canada, reveals a wide range of footprints from a low of 6.87 hectares per capita in Greater Sudbury to a high of 9.86 hectares for *Calgary (CMA)*."

Page 21:

- New figure titled: "Figure 1: Municipality Ecological Footprint Totals (Ranked)"
- Sentence 1, first paragraph now reads "While the majority of municipalities in this study fall within 6% either below or above the Canadian average ecological footprint of 7.25 hectares, *York (114%)*, *Ottawa (119%)*, *Halton RM (123%)*, *Edmonton (130%)*, and *Calgary (136%)* have ecological footprints at least 10% greater than the Canadian average."

Page 22:

- New figure titled: “Figure 1: Percentage Difference Versus Canadian Average Ecological Footprint”
- Sentence 2, first paragraph now reads: “In general, municipalities with larger footprints have higher household incomes (e.g., Calgary, Halton).”

Page 23: New figure titled: “Figure 3: Ecological Footprint vs. Median Household Income per capita, 2001.”

Page 24: New table titled: “Table 4: Ecological Footprint Results by Land/Area Category (Gha/person)”

Page 25:

- Sentence 3, first paragraph now reads: “Ottawa (CMA) had the highest **forest land footprint** while Niagara RM and Greater Sudbury had the lowest.”
- Sentence 5 & 6, first paragraph now reads: “Halton RM, York RM and Peel RM had the highest **pasture area footprint** while Saskatoon had the lowest. Hamilton (CMA) had the highest **sea space footprint** while several Prairie cities, including Edmonton, Calgary, Saskatoon, Regina, and Winnipeg, had the smallest footprint.”

Page 26: New figure titled: “Figure 5: Energy Footprint (Gha/person)”

Page 28. Crop Land:

- Sentence 3, first paragraph now reads: “The crop land footprint of studied municipalities ranges from a low of 1.22 hectares per person in Saskatoon to a high of 1.70 hectares per person in York RM, Peel RM and Halton RM.”
- New figure titled: “Figure 7: Crop Land Footprint (Gha/person)”

Page 30: New figure titled: “Figure 8: Pasture Land Footprint (Gha/person)”

Page 31: New figure titled: “Figure 9: Sea Space Ecological Footprint (Gha/person)”

Page 32: New figure titled: “Figure 10: Forest Land Footprint (Gha/person)”

Page 39: Table 9, new data in first column “Total ecological footprint, ha”

Page 41: Sentence 2, first paragraph original sentence reading “Examining income data, only Saskatoon....” has been deleted.

About this Report

This report, completed by Anielski Management Inc., was commissioned by the Federation of Canadian Municipalities (FCM) to develop the first Canadian estimates of the ecological footprint of each of the major Canadian municipalities/regions within the FCM family of member communities contributing to the FCM Quality of Life Indicators reporting system.

This report examines the following issues.

- 1) What is the ecological footprint? How can it be used to measure sustainable living in Canadian municipalities?
- 2) How large are Canada's municipal and regional ecological footprints? How do municipalities measure up and compare across the country?
- 3) How does the average ecological footprint per citizen in each municipality compare with Canada's average and other benchmark regions of the world?
- 4) What are the major contributors to the ecological footprint?
- 5) How does the ecological footprint compare to the carrying capacity of Canada's land and resources to meet our demands for nature's goods and services?
- 6) How does the ecological footprint break down according to energy, food, transportation, and housing? What does the analysis tell us about sustainable living?
- 7) What is the relationship between ecological footprint, income and consumption?
- 8) What can citizens and municipalities do to reduce their ecological footprint?
- 9) How can the ecological footprint be applied to create more sustainable communities throughout Canada?

The Federation of Canadian Municipalities (FCM) gratefully acknowledges the financial and technical support of Human Resources Development Canada in the development of the Quality of Life Reporting System (QOLRS) and in publishing this series of reports. Developed by FCM, the QOLRS measures, monitors and reports on the quality of life in Canadian urban municipalities using data from a variety of national and municipal sources.

The Federation of Canadian Municipalities (FCM) has been the national voice of municipal governments since 1901. The organization is dedicated to improving the quality of life in all communities by promoting strong, effective, and accountable municipal government. Members range from Canada's largest cities to small towns and rural municipalities, as well as the 19 major provincial and territorial municipal associations.

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Summary

“The world is no longer divided by the ideologies of ‘left’ and ‘right,’ but by those who accept ecological limits and those who don’t.”

—Wolfgang Sachs 2003¹

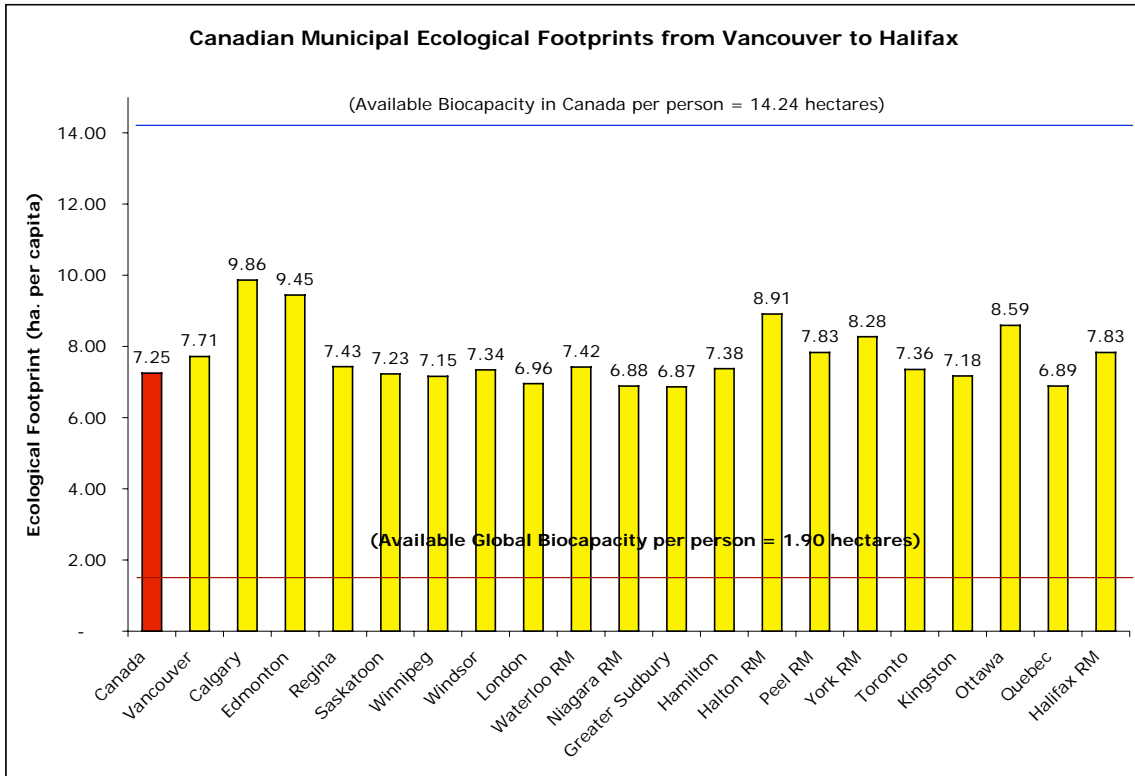
Mark Anielski and Jeff Wilson of Anielski Management Inc. have estimated the ecological footprints of Canada’s 20 largest municipalities and urban regions. The ecological footprint, or EF, developed by Drs. William Rees (UBC) and Mathis Wackernagel (Redefining Progress, Oakland) is a measure of people’s demand on nature’s goods and services — the amount of land area and water bodies (seas, lakes and rivers) we consume to meet our needs — relative to the biologically productive land and sea area that supplies nature’s goods and services.

The ecological footprint is a tool for monitoring progress towards sustainability. It is one of the few measures that can easily communicate the comparison of human consumption directly to nature’s limited productivity. It is an attractive tool for communicating, teaching, and planning for sustainability using ecological minimum criteria for sustainability.²

Ecological footprint analysis (EFA) converts the consumption of food, energy, and other materials (using personal consumption expenditure data as a proxy for physical material consumption) to the equivalent area of biologically productive land that would be required to produce the food, energy and other materials to meet human consumption demands.

What is an ecological footprint? An ecological footprint (EF) is a measure of the demands humans place on nature. The ecological footprint measures what we consume from nature, for individuals, organizations, cities, regions, nations or humanity as a whole. It shows how much biologically productive land and water we occupy to produce all the resources we consume and to absorb our waste.³ By measuring the present footprint, and then calculating the footprints for various household lifestyle or government policy options, more efficient ways of meeting human needs can be evaluated and implemented. Thus, the EF is not only relevant for estimating the situation with regard to the areas needed to sustain humanity today, but also for testing different strategies for the future.⁴

What does ecological footprint analysis mean? Everyone has an impact on the planet. This is not a bad or regrettable thing. But it does mean that in order to live, people consume what nature offers. Ecological footprint analysis is a tool for assessing the sustainability of the community of households, businesses and other organizations. In essence, it accounts for the relationship of our *demands* on nature and the *supply* of the Earth’s goods and services. The footprint tells us something about whether or not we are running a current “deficit” or enjoying a “surplus” in relationship with nature’s wealth. A healthy ecological footprint would be one where a household or business within a community is living within the natural bio-capacity of the land, sea and water that it uses. This requires being more attentive to the demands we place on nature. Sustainable living might be described as achieving a high quality yet eco-efficient lifestyle, mindful of the ecological limits of nature in our day-to-day activities.



How much nature do we consume? Our analysis reveals that the average Canadian consumes 7.25 hectares of land and sea to sustain our current life needs and wants. That means it takes 7.25 hectares of land and sea throughout the world to support each Canadian. Calgary, Edmonton, and Halton RM have the highest municipal footprints while Greater Sudbury and Niagara Regional Municipality have the lowest. Footprints range from as low as 6.87 hectares/person in Greater Sudbury to a high of 9.86 for Calgary (CMA). The primary difference is due to consumption expenditure levels and the kind of energy we consume to power our lifestyles.

How much nature do we have? The good news is that Canadians are fortunate in having a surplus of natural capital. Canada's available biocapacity is significant with 14.24 hectares per capita given our vast land mass and sea space. This represents a biocapacity almost 7.5 times what is available to the other six billion people on Earth. Compared to our demands on nature (our ecological footprint) Canadians currently enjoy a healthy surplus of nature's capital of 7.0 hectares per capita, the difference between their ecological footprint (demand on nature) and nature's biocapacity (supply).

How do Canadians compare internationally? According to the most recent (2002) international comparisons, the average Canadian has the third largest ecological footprint in the world. Unfortunately, the planet only has 1.9 hectares of nature (productive land and sea) available to meet the needs of each person. That means that Canadians are consuming a disproportionately large share (almost four times!) the Earth's natural capital capacity.

What does a large ecological footprint mean? A large footprint, in excess of the global carrying capacity of the Earth, suggests we are consuming nature at a rate that is globally unsustainable. Even if Canadians enjoy a domestic surplus of natural capital. In plain language, it means that Canadians are living off a larger portion of the “interest” of the Earth’s biological capacity (“capital”) than other global citizens. One reason for Canada’s large footprint is due to our cold climate and respective energy demands and our levels of consumption of other natural capital.

What contributes most to our ecological footprint? Ecological footprints, in general, vary according to both the average household income (per capita) and the size and nature of the energy consumption component of the footprint. In general, the higher the household income the higher the footprint. Energy is the other critical factor: larger footprints are generally associated with higher energy consumption and more carbon-intensive fuel sources for electricity and heating. Canadians’ energy demands make up the largest portion of our footprint (55%). The largest portion of energy demands on nature is due to energy consumed by industry (38%), transportation (35%), residential (15%) and commercial/businesses (12%). The next largest components of the footprint include the consumption of crop land (19%), forest land (16%), built area (5%), pasture land (3%), and sea space (2%).

What can Canadians do reduce their footprint? Individual household and municipal footprints can be reduced in many ways without compromising Canada’s high quality of life. Lifestyle choices including the mode of transportation (e.g., walking, biking or taking public transit versus the car) or where we shop (e.g., purchasing from local merchants and farmers’ markets) or what we buy (e.g., organic versus non-organic produce and products). Footprints can also be reduced through more efficient use of nature’s resources, especially energy, the largest component of Canadians’ footprint. We can choose to protect and better manage our ecological assets just as we manage our infrastructure and other manufactured capital assets.

The good news is that many Canadians are beginning to adopt more sustainable lifestyles (e.g., LOHAS – Lifestyles of Health and Sustainability). There are a number of ways Canadians can reduce their footprint, including:

- Driving less;
- Walking, cycling, carpooling or taking public transit;
- Eating more organically, locally-grown food;
- Retrofitting homes or businesses to be more energy efficient or exploring renewable energy alternatives;
- Buying “green” power from local utilities;
- Buying a more fuel efficient, low polluting vehicle; and,
- Choosing a home closer to work.

How should municipalities interpret their ecological footprint and what can they do to encourage household and business footprint reduction? The ecological footprint can be used in combination with other environmental indicators being developed at the municipal level and by the FCM as part of the Quality of Life Indicators system to measure the sustainability of a municipality. The footprint provides a macro measure of sustainable living that is relevant at the individual, household, business or community/municipal scale because it accounts for all aspects of the consumption patterns of a community of households and businesses. The measure provides a reminder that living a sustainable life style means living more consciously of the importance of nature’s capital assets that are being consumed by communities from sources somewhere else on the planet. Benchmarking municipal household and business footprints should point to examples

of best practices or models of efficient energy, transportation, waste disposal, water and local food policies that yield smaller footprints.

Municipalities might consider using the footprint in the following ways.

- Consider the ecological footprint as a key measure of progress towards a municipal/urban sustainability vision.
- Use the EF to track returns on investment (i.e., reduced footprint) from sustainable transportation, green infrastructure and other sustainability capital investments.
- Encourage municipalities and Statistics Canada to begin tracking the stocks and flows of energy and material goods and services in and out of their municipalities.
- In strategic business planning and budgeting, consider the implications (outcomes) of municipal spending on achieving a “balanced ecological budget” where sustainable living means living within the means of nature that supports the urban community.
- Educate and inform citizens about the value of living in a sustainable relationship with nature and with each other in our communities.
- Encourage community or neighbourhood sustainability lifestyle action plans.
- Encourage citizens and businesses to calculate their own footprint by tracking energy consumption and thinking about buying locally, and supporting local enterprise.
- Offer incentives for “green” buildings.
- Encourage or mandate renewable energy infrastructure investment by households and businesses through building codes, issuing renewable energy bonds or other ecological tax incentives.
- Put ecological footprint estimates on household and business utility bills.
- Support locally grown, organic and sustainable agriculture and food industries.

1. What is the ecological footprint?

The “ecological footprint” is the impact that each and every one of us has on nature and the planet through our daily lifestyles. Ecological footprinting is a tool to help us think more clearly about our relationship to the planet, and hence, to future generations.⁵ It is thus a good tool for measuring progress towards sustainability by communities. Sustainability in this context therefore means achieving a satisfying life without going beyond the regenerative capacities of the planet.⁶

By using ecological footprint analysis (EFA) it is possible to estimate the area of land that would be necessary to sustain current consumption levels of individuals and households. In more technical terms, EFA measures how much nature, expressed in the common unit of “bioproductive space with world average productivity”, is used exclusively for producing all the resources a given population consumes and absorbing the waste they produce, using prevailing technologies.⁷

“Sustainability, or satisfying lives for all within the means of nature, depends on making sure people do not use more ecological services than nature can regenerate. As human pressure is already exceeding the globe’s ecological capacity, the sustainability challenge becomes how to reduce overall human pressure. Certainly, we cannot succeed with this challenge if we do not reduce the pressure in a way that is fair to all.”

Mathis Wackernagel, 2001
What We Use and What We Have: Ecological Footprint and Ecological Capacity, Redefining Progress, San Francisco

The ecological footprint of a municipality (or any given population) is the biologically productive area required to produce the food, fibers, wood, energy and all the other items that humans consume, to give room for infrastructure, and to absorb the wastes, carbon dioxide and other

pollutants that result from human activity. To give results in comparable units of measure, all components are adjusted for their biological productivities and expressed in global hectares (GHA).^{*} (Throughout this report, a hectare is assumed to be a global hectare unless otherwise specified.) Since the resources we consume come from all corners of the planet and the wastes we generate affect distant places, ecological footprint analysis considers the sum of all our ecological impacts no matter where they occur on the planet.^{8,9,10}

How can EFA be used to measure progress towards sustainability?

Ecological footprint analysis (EFA) gives policy makers and citizens a tool and a reporting system for measuring progress towards sustainability. It does so by accounting for and comparing human consumption directly to nature's limited productivity. In other words, it compares our "demand for nature's goods and services" to nature's "supply" or biocapacity of natural capital goods and services. In essence it measures the efficiency of consumption of nature's capital resources and services.

EFA can guide individual or household lifestyles by providing a kind of sustainability audit of household operations and lifestyle choices. On the community scale, EFA helps communities understand how efficiently they are using nature's capital assets in support of a high quality of life. For policy makers, EFA provides a good tool for assessing and reporting on sustainability to the community as a whole.

Footprint analysis also empowers citizens to engage in a more informed dialogue about sustainability and quality of life with their own EFA. EFA provides an "ecological reality check" that leads to a fundamental personal examination: "What can I do today to live a more sustainable lifestyle, within Earth's capacity, while improving my quality of life?"

EFA at the Municipal Level

For municipal governments, the EFA can be a tool for measuring and reporting on progress towards sustainability of the community as a whole. EFA could be one of several performance indicators for measuring community sustainability, combined with other quality of life and environmental indicators. EFA could be used as an environmental accounting tool to assess community sustainability within a larger systems-based sustainability framework.

Municipalities can use the EFA to shape government priorities, and to plan and budget for issues such as transportation, housing, development, food, energy, infrastructure, taxation, and environmental regulations.¹¹ In addition, municipalities can use the ecological footprint as an education and awareness tool to help community members reduce their individual ecological footprints.

^{*} Global hectares, as defined by Redefining Progress (www.rprogress.org), are the measures used for the Ecological Footprint. One global hectare corresponds to one hectare of biologically productive space adjusted to equal world-average productivity. This ensures that all ecological footprints are being measured and expressed in compatible units. It also acknowledges that our ecological impacts occur in distant places and subsequently draw on the natural capital and productivity of these places regardless of the land productivity in our immediate surroundings.

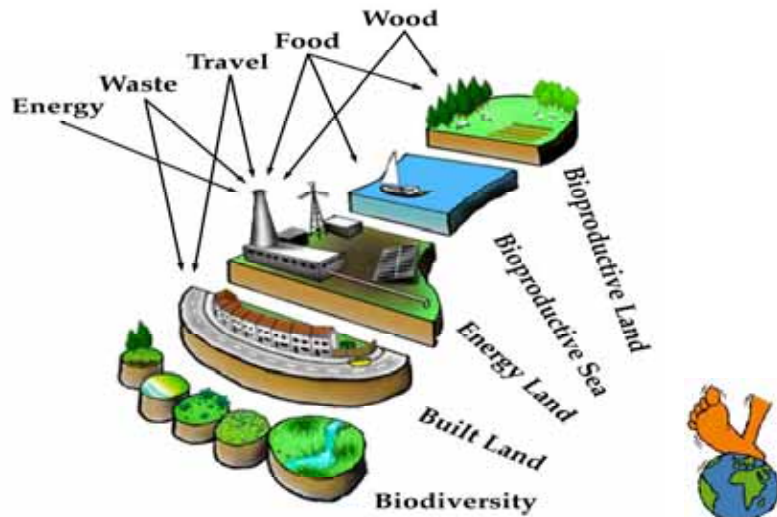
2. Methodology

An ecological footprint is a way of measuring a population's demand on nature. It is a measure of the land area required to produce all of the products and resources consumed by a population and to process all of the wastes created by the population. A footprint measurement can be made for a single activity (e.g., a car trip) or for a group of activities (e.g., household operations).

The EF of any individual or household is the sum of six separate components¹² (See illustration).

1. **Energy Land:** The area of forest that would be required to absorb the CO₂ emissions resulting from that individual's energy consumption.¹³
2. **Crop Land:** The area of cropland required to produce the crops that the individual consumes.
3. **Pasture Land:** The area of grazing land required to produce the necessary animal products.
4. **Forest Land:** The area of forest required to produce the wood and paper.
5. **Sea Space:** The area of sea required to produce the marine fish and seafood.
6. **Built Area:** The area of land required to accommodate housing and infrastructure.

Ecological Footprint Model



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The sum of the land requirements for the six individual land categories represents the community's ecological footprint — the total area “appropriated” from nature for the provision, maintenance and disposal of every consumer good.¹⁴ The EF is expressed in land “area units” (in hectares) where each area unit corresponds to one hectare of biologically productive space with world-average productivity. As described by Sustainable Calgary,

*The concept was originally developed in 1996 by William Rees and Mathis Wackernagel at the University of British Columbia, Canada. In their book *Our Ecological Footprint: Reducing Human Impact on the Earth* (1996), they have the reader imagine how long a community could survive if it were covered by a glass or plastic hemisphere that let light in but did not let materials in or out. Being cut off from trade and waste sinks it is unlikely the community would survive for very long. The ecological load of the community would quickly surpass the carrying capacity of the area within the hemisphere. Additional areas for growing food, producing energy and absorbing wastes would be required to allow the community to live within the hemisphere on an ongoing basis. Ecological Footprints try to work out how much this total area is.*¹⁵

Our FCM ecological footprint analysis builds on the original Wackernagel-Rees ecological footprint methodology as well as the new methodological advances by Mathis Wackernagel at Redefining Progress (see www.rprogress.org) and presented in the *Living Planet Report*¹⁶ of the WWF (World Wide Fund for Nature), in cooperation with the United Nations Environmental Program.¹⁷ The footprint methodology is continually subjected to peer review, analysis and refinement through each application.

Because the ecological footprint is a measurement of people's demand on nature, the footprint measurement takes stock of all land (by area) anywhere in the world used for crops, roads, grazing, building, growing trees for wood products, as well as waters for fishing. We might call this stock of land and sea space the “supply of nature's capital.”

We then calculate the “demand” for nature's capital from human demands, measured in terms of a nation's consumption of materials, energy and other goods, based on available consumption statistics. All footprint analysis begins by first calculating a nation's consumption of materials, energy and goods starting with national statistics of domestic production of goods and services. We then add the nation's imports of materials, energy and other goods and subtract the nation's exports. Therefore, domestic production + imports – exports = consumption. Typically, over 250 categories of production, imports, and exports — items such as oil, coal, corn, timber, fishmeal, and cotton — are tabulated for each nation to calculate its consumption.¹⁸

Accounting for domestic demand, imports, and exports (all the items we consume or trade like oil, wheat, corn, timber, fish and cotton) is possible at the national level because most countries carefully track this data to monitor the state of their economy. However, at the regional or community level there is no system of tracking the stocks and flows (consumption) of materials, goods, and services that we consume and export. It is possible that a municipality could begin to track the goods and services it produces and trades and track everything that enters and leaves its jurisdiction consistent with national level accounting.

To estimate local or community footprints, researchers start with the national footprint estimate and then adjust it using relevant and available local indicators such as population, household income, household expenditures, average house size, vehicle kilometers driven, electricity usage, sales of merchandise, waste production and paper consumption statistics (if they are available).¹⁹ For the purposes of the FCM ecological footprint analysis we begin with the most recent estimates of the Canadian ecological footprint by Wackernagel, based on detailed national consumption accounting balance sheets maintained by Redefining Progress as of June 2003.²⁰ Their methodology is simply an accounting framework that tracks consumption at the national scale.

How did we calculate the municipal ecological footprints?

The land area required to support it is an indicator of a region's consumption. For example, how much agricultural land area does it take to support the amount of food, fibers, cotton, jute, rubber, and tobacco a region consumes? EFA therefore is an accounting tool that measures sustainability through calculations of how much productive land there is and how much productive land we use to support our consumption demands.²¹

For the FCM municipal footprint estimates, we start with Canada's national footprint estimates, based on detailed national consumption statistics (not available at the municipal or provincial scale).¹² The Canadian ecological footprint uses over 250 categories of production, import, and export commodities. These include items such as oil, coal, corn, timber, fishmeal, and cotton.²²

To calculate the municipal footprints we use the Canadian national average per capita footprint data and estimates as the starting point, then estimate the local municipal footprints using a variety of variables including the following variables:

- Household personal consumption expenditures;
- Income per capita;
- Average household size;
- Population and population density;
- Energy consumption; and
- Commuting distances.

¹ Dr. Mathis Wackernagel was the first to apply a top-down calculation approach in his ecological footprint of Santiago, Chile Study (1998). Wackernagel notes, "Regional or municipal footprints can be extracted from the national footprint by comparing to what extent the consumption in the region or municipality differs from the national average and adjusting the footprint accordingly."¹ Chambers et al in their book, *Sharing Nature's Interest*, also support this type of approach: "Where specific data about a city are not known then its footprint can be estimated by apportioning the per capita impact".¹ Jeff Wilson has also used variations of this approach to calculate the ecological footprint for Nova Scotia (2001) and Alberta (2001).¹ Redefining Progress and Wackernagel have since refined regional ecological footprint methodology in their Sonoma California ecological footprint study (2002) and are actively promoting the ecological footprint at the local level to help direct local planning and policy decisions and promote more sustainable lifestyle choices.¹ In addition, the framework behind regional ecological footprint applications is based on the same premise applied in the widely used personal ecological footprint calculators.¹

² This is consistent with other community footprint estimates by Dr. Mathis Wackernagel in the case of estimating the Ecological Footprint for Sonoma County, California in 2002. Our own estimates for Canadian municipalities in fact improve on the Sonoma County methodology.

These variables reflect the local variations in lifestyles and consumption levels and thus help to reveal the local variations in ecological footprints across Canada. Not all of the above data is available for all FCM municipalities/regions. For example only some municipalities reporting Census Metropolitan Area (CMA) data have household expenditure data available from Statistics Canada. The challenge of the availability of local consumption data is consistent with the experience in estimating municipal footprints in Europe.³

The primary factor used to estimate municipal footprints is from Statistics Canada CMA-reported household consumption expenditure data (2001 Census) that we then translate into the equivalent physical material and energy demands or flows. However, expenditures do not necessarily translate into physical quantities such as liters of gasoline, kilograms of butter or meters of cloth. We apportion the national ecological footprint estimates for each municipality by differences in per capita consumption expenditures (where CMA household expenditure data is collected by Statistics Canada).

For those non-CMA municipalities who lack Statistics Canada household expenditure data, we use other variables including per capita income as the next best proxy for consumption (See text box). See Table 1 for a list of municipalities with and without personal consumption expenditure data.

Municipalities Lacking Expenditure Data

For several municipalities in this study there was no personal consumption expenditure data available. These municipalities include: Windsor, London, Waterloo RM, Niagara RM, Sudbury, Hamilton, Halton, York RM, Peel RM, and Kingston. Consumption expenditure data was used to calculate the pasture footprint (food), cropland footprint (food, clothing, etc.), sea space footprint (fish and other marine products), and forest footprint (newspaper, wood products, etc.). The pasture, crop land, sea space, and forest footprint equal 3.08 hectares per Canadian or 42% of the average Canadian ecological footprint.

Where consumption expenditure data was not available we compared income data adjusted by Market Basket Measure (MBM) thresholds (cost of living data) with provincial averages or with a city of similar size located in the same province.

The authors of this report encourage FCM to lobby Statistics Canada to begin collecting consumption expenditure data for all large urban areas to ensure more accurate ecological footprint calculations in the future.

³ See http://www.prosus.uio.no/english/sus_dev/tools/oslows/1.htm

Table 1: Municipalities With CMA Expenditure Data and Not

Municipalities with Personal Consumption Expenditure Data	Municipalities Without Personal Consumption Expenditure Data
Vancouver (CMA)	Windsor (CMA)
Calgary (CMA)	London (CMA)
Edmonton (CMA)	Kingston (CMA)
Regina (CMA)	Waterloo Regional Municipality (CD)
Saskatoon (CMA)	Niagara Regional Municipality (CD)
Winnipeg (CMA)	Halton Regional Municipality (CD)
Toronto (CMA)	Peel Regional Municipality (CD)
Ottawa (CMA)	York Regional Municipality (CD)
Quebec (CMA)	Greater Sudbury (CMA)
Halifax Regional Municipality (CMA)	Hamilton (CMA)

The **energy footprint** was calculated using data from the Office of Energy Efficiency, Energy Use Databases, and Natural Resources Canada’s report, *Canada's Emissions Outlook: 1997-2020*. For municipalities, where Statistics Canada consumption expenditure data and adequate 2001 Census data was not available, estimates were made using a series of custom algorithms and key assumptions that attribute a correlation between consumption, income, and cost of living data. These municipalities include Windsor, London, Waterloo RM, Niagara RM, Greater Sudbury, Hamilton, Halton RM, Peel RM, York RM, and Kingston.

Table 2 provides a summary of the data input used to estimate ecological footprints of 20 Canadian municipalities.⁴ The yellow highlighted row shows the ecological footprint estimates. (For purposes of this report financial data is presented in 2001 Canadian dollars and all hectares are global hectares unless otherwise specified.)

⁴ For very detailed data and calculations used in deriving the municipal ecological footprints please contact Mark Anielski (anielski@telus.net) or consult the MS Excel Spreadsheets “FCM Ecological Footprint” available from the FCM office in Ottawa on www.fcm.ca website. This data includes details of each municipality’s footprint data components, detailed energy consumption statistics, CMA-based household expenditures, and more.

Table 2: Summary of FCM Municipal Ecological Footprint Estimates and Indicators Used To Estimate Footprints

	<i>Canada</i>	Vancouver (CMA)	Calgary (CMA)	Edmonton (CMA)	Regina (CMA)	Saskato on (CMA)
Population, 2001	<i>30,007,094</i>	1,986,985	951,395	937,845	192,800	225,827
Land Area, km squared	<i>9,093,507</i>	2,879	5,083	9,419	3,408	5,192
Population density, per square km	<i>3.2</i>	690	187	100	57	44
Average household size (person)	<i>2.6</i>	2.6	2.6	2.6	2.5	2.5
Median income per capita, \$2001	<i>\$17,982</i>	\$19,208	\$22,639	\$19,879	\$19,103	\$20,535
Total expenditures per capita, \$2001	<i>\$22,208</i>	\$24,972	\$28,378	\$25,393	\$22,691	\$21,654
Total current consumption expenditures per capita, \$2001	<i>\$15,823</i>	\$17,058	\$20,457	\$19,319	\$17,187	\$16,377
Median commuting distance, km	<i>7.2</i>	7.6	7.7	7.6	4.5	4.8
Average number of rooms per dwelling	<i>6.3</i>	6.0	6.6	6.5	6.5	6.6
Provincial agriculture land, square km/capita	<i>0.022</i>	0.006	0.068	0.068	0.264	0.264
Provincial forest cover, square km/capita	<i>0.124</i>	0.181	0.132	0.132	0.275	0.275
Provincial urban population density (persons/ square km)	<i>799</i>	881	651	651	472	472
Pasture land footprint	<i>0.21</i>	0.23	0.24	0.22	0.19	0.18
Crop land footprint	<i>1.39</i>	1.53	1.62	1.48	1.29	1.22
Forest land footprint	<i>1.14</i>	1.18	1.42	1.35	1.19	1.14
Sea space footprint	<i>0.14</i>	0.21	0.10	0.10	0.10	0.10
Built area (non-hydro)	<i>0.33</i>	0.31	0.41	0.41	0.44	0.44
Total hydro reservoir footprint	<i>0.04</i>	0.05	0.04	0.04	0.03	0.03
Energy footprint	<i>4.00</i>	4.21	6.03	5.85	4.18	4.11
Total Ecological Footprint	<i>7.25</i>	7.71	9.86	9.45	7.43	7.23
% difference between municipality and Canadian average		106%	136%	130%	103%	99%

Table 2 (continued)

	<i>Canada</i>	Winnipeg (CMA)	Windsor (CMA)	London (CMA)	Waterloo RM	Niagara RM
Population, 2001	<i>30,007,094</i>	671,274	307,877	432,451	438,515	410,574
Land Area, km squared	<i>9,093,507</i>	4,152	1,023	2,333	1,369	1,863
Population density, per square km	<i>3.2</i>	162	301	185	320	220
Average household size (person)	<i>2.6</i>	2.4	2.6	2.5	2.7	2.5
Median income per capita, \$2001	<i>\$17,982</i>	\$22,684	\$20,939	\$19,210	\$21,227	\$18,890
Total expenditures per capita, \$2001	<i>\$22,208</i>	\$23,328	N/A	N/A	N/A	N/A
Total current consumption expenditures per capita, \$2001	<i>\$15,823</i>	\$17,910	N/A	N/A	N/A	N/A
Median commuting distance, km	<i>7.2</i>	6.0	8.6	5.4	4.5	4.8
Average number of rooms per dwelling	<i>6.3</i>	5.9	6.5	6.6	6.6	6.5
Provincial agriculture land, square km/capita	<i>0.022</i>	0.063	0.005	0.005	0.005	0.005
Provincial forest cover, square km/capita	<i>0.124</i>	0.255	0.051	0.051	0.051	0.051
Provincial urban population density (persons/ square km)	<i>799</i>	711	1,015	1,015	1,015	1,015
Pasture land footprint	<i>0.21</i>	0.21	0.21	0.20	0.21	0.19
Crop land footprint	<i>1.39</i>	1.45	1.45	1.33	1.43	1.31
Forest land footprint	<i>1.14</i>	1.27	1.12	1.03	1.11	1.01
Sea space footprint	<i>0.14</i>	0.10	0.15	0.15	0.15	0.15
Built area (non-hydro)	<i>0.33</i>	0.34	0.28	0.28	0.28	0.28
Total hydro reservoir footprint	<i>0.04</i>	0.05	0.04	0.04	0.04	0.04
Energy footprint	<i>4.00</i>	3.73	4.09	3.95	4.20	3.92
Total Ecological Footprint	<i>7.25</i>	7.15	7.34	6.97	7.42	6.90
% difference between municipality and Canadian average		99%	101%	96%	102%	95%

Table 2 (continued)

	<i>Canada</i>	Greater Sudbury (CMA)	Hamilton (CMA)	Halton RM	Peel RM	York RM
Population, 2001	<i>30,007,094</i>	155,601	662,401	375,229	988,948	729,254
Land Area, km squared	<i>9,093,507</i>	3,536	1,372	967	1,242	1,762
Population density, per square km	<i>3.2</i>	44	483	388	796	414
Average household size (person)	<i>2.6</i>	2.4	2.6	2.8	3.2	3.2
Median income per capita, \$2001	<i>\$17,982</i>	\$18,836	\$20,302	\$27,462	\$22,175	\$24,277
Total expenditures per capita, \$2001	<i>\$22,208</i>	N/A	N/A	N/A	N/A	N/A
Total current consumption expenditures per capita, \$2001	<i>\$15,823</i>	N/A	N/A	N/A	N/A	N/A
Median commuting distance, km	<i>7.2</i>	6.5	8.2	16.6	N/A	N/A
Average number of rooms per dwelling	<i>6.3</i>	6.2	6.5	7.1	6.7	7.4
Provincial agriculture land, square km/capita	<i>0.022</i>	0.005	0.005	0.005	0.005	0.005
Provincial forest cover, square km/capita	<i>0.124</i>	0.051	0.051	0.051	0.051	0.051
Provincial urban population density (persons/ square km)	<i>799</i>	1,015	1,015	1,015	1,015	1,015
Pasture land footprint	<i>0.21</i>	0.19	0.23	0.25	0.25	0.25
Crop land footprint	<i>1.39</i>	1.30	1.50	1.70	1.70	1.70
Forest land footprint	<i>1.14</i>	1.01	1.09	1.43	1.16	1.27
Sea space footprint	<i>0.14</i>	0.15	0.15	0.18	0.18	0.18
Built area (non-hydro)	<i>0.33</i>	0.28	0.28	0.28	0.28	0.28
Total hydro reservoir footprint	<i>0.04</i>	0.04	0.04	0.04	0.04	0.04
Energy footprint	<i>4.00</i>	3.91	4.03	5.03	4.23	4.56
Total Ecological Footprint	<i>7.25</i>	6.88	7.31	8.91	7.83	8.28
% difference between municipality and Canadian average		95%	102%	123%	108%	114%

Table 2 (continued)

	<i>Canada</i>	Toronto (CMA)	Kingston (CMA)	Ottawa (CMA)	Quebec (CMA)	Halifax (CMA)
Population, 2001	<i>30,007,094</i>	4,682,897	146,838	1,063,664	682,757	359,183
Land Area, km squared	<i>9,093,507</i>	5,903	1,907	5,318	3,154	5,496
Population density, per square km	<i>3.2</i>	793	77	200	216	65
Average household size (person)	<i>2.6</i>	2.8	2.4	2.5	2.3	2.5
Median income per capita, \$2001	<i>\$17,982</i>	\$21,251	\$19,991	\$23,604	\$18,202	\$18,776
Total expenditures per capita, \$2001	<i>\$22,208</i>	\$25,054	N/A	\$33,228	\$22,958	\$23,073
Total current consumption expenditures per capita, \$2001	<i>\$15,823</i>	\$16,038	N/A	\$20,358	\$16,932	\$16,628
Median commuting distance, km	<i>7.2</i>	9.2	5.4	7.8	6.8	6.3
Average number of rooms per dwelling	<i>6.3</i>	6.1	6.4	6.4	5.7	6.4
Provincial agriculture land, square km/capita	<i>0.022</i>	0.005	0.005	0.005	0.005	0.019
Provincial forest cover, square km/capita	<i>0.124</i>	0.051	0.051	0.051	0.088	0.018
Provincial urban population density (persons/ square km)	<i>799</i>	1,015	1,015	1,015	791	525
Pasture land footprint	<i>0.21</i>	0.22	0.20	0.23	0.24	0.20
Crop land footprint	<i>1.39</i>	1.48	1.38	1.55	1.59	1.35
Forest land footprint	<i>1.14</i>	1.14	1.07	1.60	1.17	1.24
Sea space footprint	<i>0.14</i>	0.19	0.15	0.15	0.17	0.13
Built area (non-hydro)	<i>0.33</i>	0.28	0.28	0.28	0.32	0.35
Total hydro reservoir footprint	<i>0.04</i>	0.04	0.04	0.04	0.05	0.03
Energy footprint	<i>4.00</i>	4.05	4.06	4.74	3.35	4.52
Total Ecological Footprint	<i>7.25</i>	7.39	7.18	8.59	6.89	7.82
% difference between municipality and Canadian average		102%	99%	119%	95%	108%

Of our municipal footprint calculations, the more robust or accurate estimates are based on personal consumption expenditure (household) data collected by Statistics Canada at the CMA level (see Table 3). Even without translation of expenditures into footprint area equivalents, Table 3, alone, reveals interesting differences in how citizens of these CMA communities allocate their disposable income on various expenditure categories. The expenditure profiles provide a more complete accounting of the material goods and services purchased (food, shelter, transportation, etc.) by households. While monetary expenditures do not necessarily translate into physical quantities of materials and energy (e.g., liters of gasoline, kilograms of butter or meters of cloth), they do nevertheless provide a finer filter to estimate the municipal footprints beginning from the national footprint calculation.

Generally, higher the household expenditures correspond with higher material and energy consumption. For example, municipalities with higher household expenditure profiles, like Calgary and Ottawa, tend to have higher footprints (though Calgary's footprint is relatively

higher than Ottawa's because Calgary's electricity fuel source is coal compared to hydro electricity for Ottawa).

In an ideal ecological footprint accounting system we would want to account for both household expenditures, as Statistics Canada does at the CMA level, as well as the actual material and energy consumption profiles of those same households (and businesses), including a distinction between imports and local production. Unfortunately Statistics Canada does not collect material and energy flow data at the municipal level. Moreover, they only collect personal consumption expenditure data at the CMA level.

Table 3: Expenditure Data for Selected FCM Municipalities, \$2001 per capita²³

	<i>Canada</i>	Vancouver	Calgary	Edmonton	Saskatoon	Regina	Winnipeg	Toronto
Total expenditures	\$22,208	\$24,972	\$28,378	\$25,393	\$22,520	\$22,691	\$23,328	\$25,054
Total current consumption expenditures	\$15,823	\$18,087	\$19,517	\$17,967	\$16,103	\$15,684	\$16,477	\$17,642
Food	\$2,476	\$2,868	\$2,799	\$2,565	\$2,285	\$2,236	\$2,547	\$2,599
Fish and other marine products	\$57	\$84	\$39	\$54	\$39	\$39	\$54	\$73
Shelter	\$4,225	\$5,250	\$5,082	\$4,568	\$4,158	\$4,154	\$4,215	\$5,259
Household operation	\$1,007	\$1,099	\$1,213	\$1,182	\$1,118	\$1,086	\$1,034	\$1,100
Household furnishings and equipment	\$637	\$585	\$867	\$810	\$663	\$631	\$664	\$688
Clothing	\$922	\$1,042	\$1,184	\$1,060	\$918	\$971	\$986	\$1,116
Transportation	\$2,922	\$3,109	\$3,527	\$3,321	\$3,147	\$3,004	\$3,111	\$3,330
Health care	\$546	\$688	\$769	\$710	\$494	\$418	\$482	\$421
Personal care	\$369	\$389	\$438	\$437	\$385	\$417	\$400	\$419
Recreation	\$1,328	\$1,548	\$1,871	\$1,700	\$1,360	\$1,449	\$1,439	\$1,268
Reading materials and printed matter	\$106	\$107	\$135	\$130	\$111	\$110	\$118	\$108
Education	\$345	\$479	\$439	\$501	\$457	\$334	\$400	\$590
Tobacco products and alcoholic beverages	\$505	\$490	\$620	\$541	\$574	\$476	\$575	\$366
Games of chance	\$103	\$90	\$134	\$115	\$120	\$112	\$145	\$90
Personal income taxes	\$4,699	\$5,079	\$6,626	\$5,530	\$4,452	\$5,044	\$4,849	\$5,706

Note: Bolded rows represent expenditure categories used in FCM municipality ecological footprint calculations. For complete data sets, sources, and assumptions, see spreadsheet files. Individual municipal summary sheets are available in Appendix B. Bolded rows include expenditure indicators that were used to directly calculate ecological footprint estimates.

Table 3 (continued)

	<i>Canada</i>	Ottawa	Quebec	Halifax
Total expenditures	\$22,208	\$33,228	\$22,958	\$23,073
Total current consumption expenditures	\$15,823	\$21,172	\$15,714	\$16,462
Food	\$2,476	\$2,852	\$2,855	\$2,389
Fish and other marine products	\$57	\$73	\$59	\$51
Shelter	\$4,225	\$5,726	\$3,910	\$4,667
Household operation	\$1,007	\$1,335	\$849	\$1,149
Household furnishings and equipment	\$637	\$1,079	\$602	\$703
Clothing	\$922	\$1,212	\$901	\$968
Transportation	\$2,922	\$4,184	\$2,953	\$2,854
Health care	\$546	\$595	\$684	\$548
Personal care	\$369	\$430	\$402	\$407
Recreation	\$1,328	\$1,968	\$1,309	\$1,366
Reading materials and printed matter	\$106	\$179	\$93	\$120
Education	\$345	\$529	\$220	\$354
Tobacco products and alcoholic beverages	\$505	\$463	\$575	\$528
Games of chance	\$103	\$73	\$81	\$109
Personal income taxes	\$4,699	\$9,412	\$5,711	\$4,764

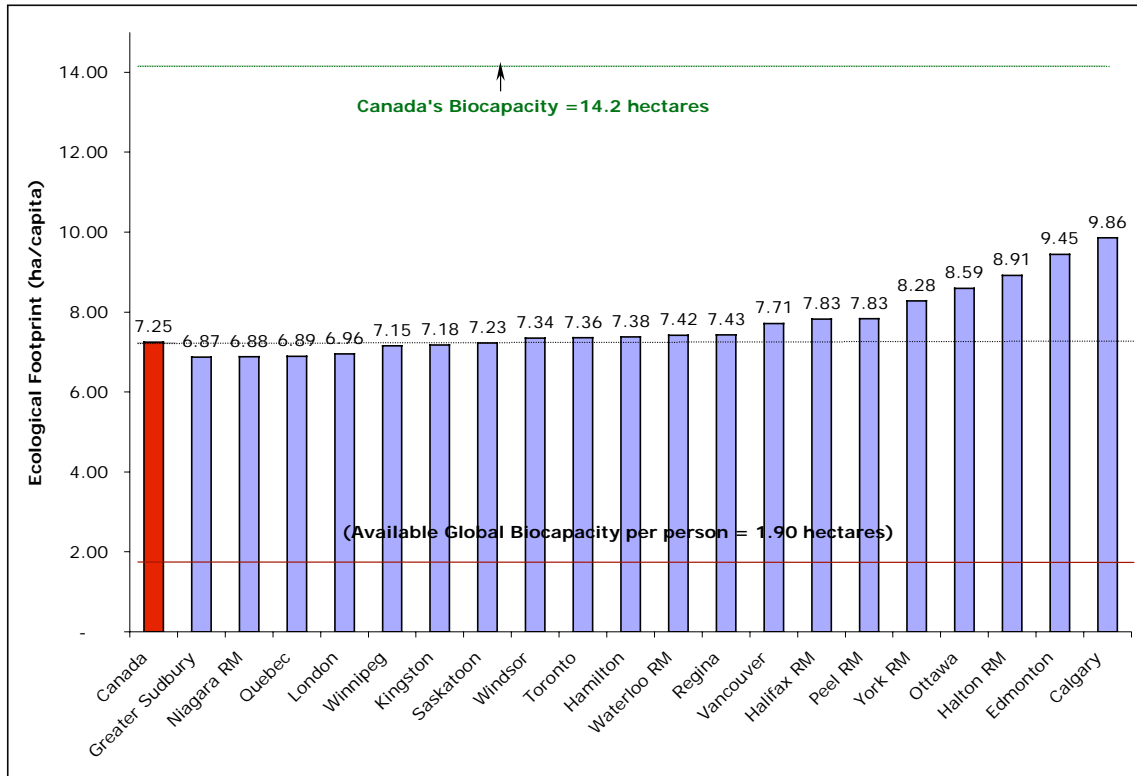
3. Canadian municipal ecological footprint results

The footprint analysis results reveal that, on average, Canadians' demand on nature's goods and services is roughly 7.25 hectares (about 18 acres) per person (See Figure 1). This tells us that it takes 7.25 hectares of land and sea throughout the world to support each Canadian. Unfortunately the Earth only has 1.90 hectares of available land and sea biocapacity to meet the demands on nature of all six billion human beings. The average global citizen has a footprint of only 2.8 hectares, much smaller than the average Canadian. The good news is that Canada is land and sea resource-rich with a biocapacity of 14.24 hectares per capita.

By comparison, the average ecological footprint for the United States in this report is 9.7 hectares (23.5 acres) per person.²⁴ The Sonoma County, California ecological footprint, using a similar methodology to this report, totaled 9.1 hectares (22.4 acres) per person

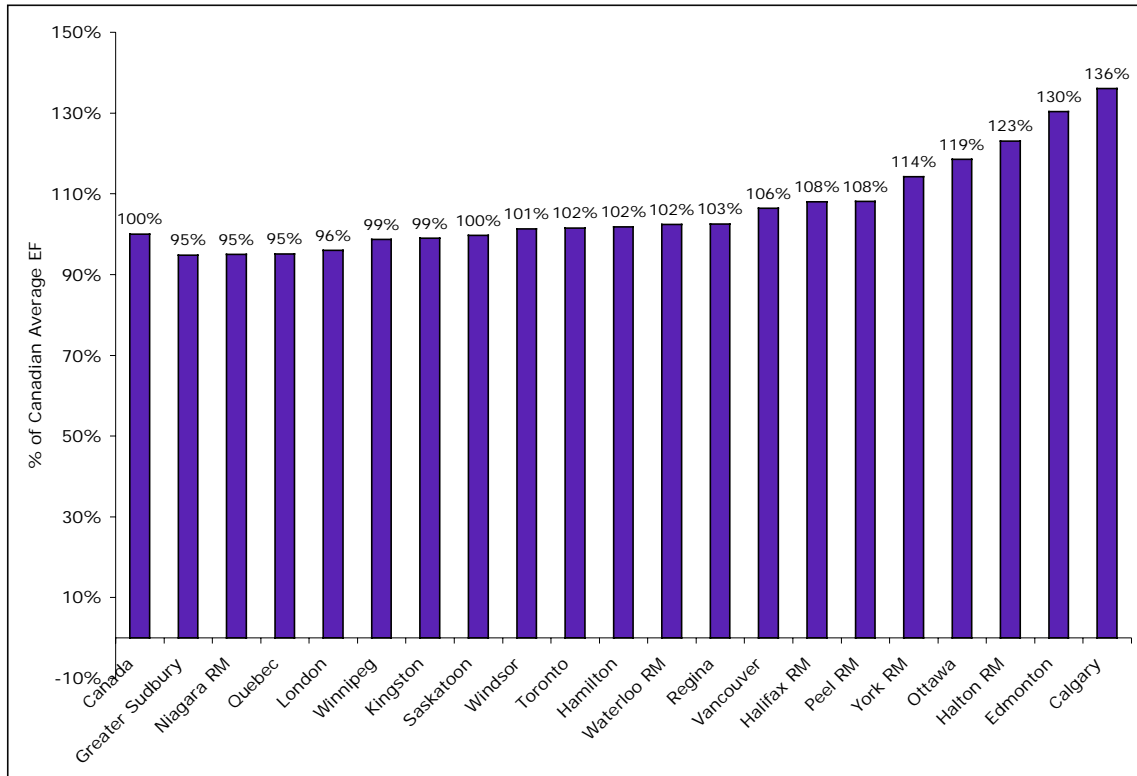
Our analysis of 20 municipal footprints across Canada, reveals a wide range of footprints from a low of 6.87 hectares per capita in Greater Sudbury to a high of 9.86 hectares for Calgary (CMA). Figure 1 shows the ranking from low to high footprints. The majority of municipal footprints are clustered around 6.87 to 7.43, from Greater Sudbury (at the low end) to Regina (in the median range). A detailed breakdown of each municipality's footprint components is shown in Table 3.

Figure 2: Municipality Ecological Footprint Totals (Ranked)



While the majority of municipalities in this study fall within 6% either below or above the Canadian average ecological footprint of 7.25 hectares, York (114%), Ottawa (119%), Halton RM (123%), Edmonton (130%), and Calgary (136%) have ecological footprints at least 10% greater than the Canadian average. Figure 2 compares the percentage difference in ecological footprint size of the municipalities and Canadian average.

Figure 3: Percentage Difference Versus Canadian Average Ecological Footprint

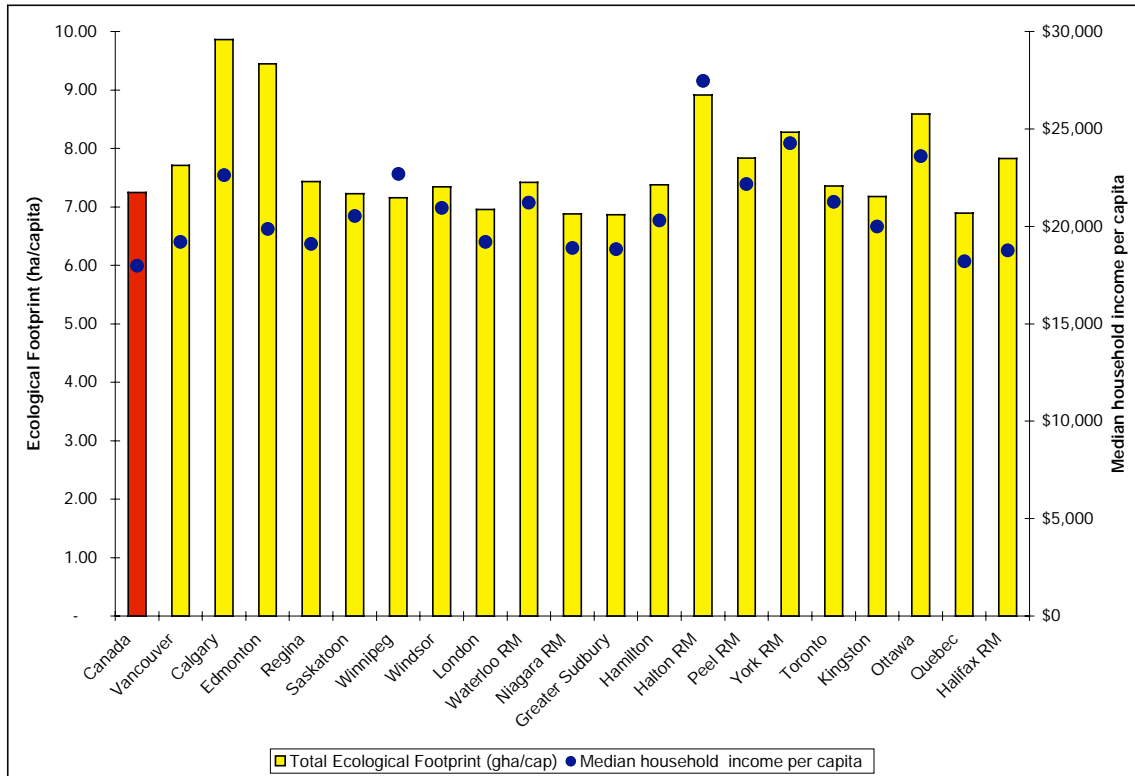


Note: 100% = Canadian average ecological footprint of 7.2 hectares per person.

The differences in footprints across Canada tell us a lot about the purchasing power (real disposable income) of individuals and households and how they choose to expend their income on goods and services that place demands on nature’s goods and services. In general, municipalities with larger footprints have higher household incomes (e.g., Calgary, Halton). (See Figure 3) Our analysis shows a relatively strong correlation between median household income and ecological footprint, a correlation coefficient of 0.75. (Note: a correlation coefficient of 1.0 signifies the highest possible relationship between income and ecological footprint.) This strong correlation makes sense since, in general, households with higher incomes have higher expenditure profiles (a correlation coefficient of 0.78). Yet, higher incomes can provide for a higher quality of life by having greater purchasing power to choose a lifestyle of good health and sustainability.

Figure 3 reveals household income is not the only driver of the footprint. Larger footprints are also associated with more carbon-intensive energy consumption whether for electricity, heating or transportation. For example, Edmonton and Calgary have higher footprints than other municipalities with the same average household income (e.g., Hamilton) because both cities rely on coal-fired electricity. Municipalities with smaller footprints (e.g., Greater Sudbury, Niagara RM, and Quebec City) are characterized by both lower household income per capita and smaller energy footprints due to reliance on hydroelectric power as the primary source of electricity.

Figure 4: Ecological Footprint vs. Median Household Income per capita, 2001



In the following sections we provide a more detailed analysis of the individual footprint components.

Ecological footprint components

The FCM ecological footprint study examined four major categories of consumption: energy consumption (residential, transportation, industrial, and commercial), food, goods, and services. This data was converted to the six land/area categories used in ecological footprint calculations.

The EF of any individual or household are broken down by their separate components.

1. **Energy Land:** The area of forest that would be required to absorb the CO₂ emissions resulting from that individual's energy consumption.²⁵
2. **Crop Land:** The area of cropland required to produce the crops that the individual consumes.
3. **Pasture Land:** The area of grazing land required to produce the necessary animal products.
4. **Forest Land:** The area of forest required to produce the wood and paper.
5. **Sea Space:** The area of sea required to produce the marine fish and seafood.
6. **Built Area:** The area of land required to accommodate housing and infrastructure.

Table 4 illustrates examples of ecological footprint results broken down by land/area category, ranked in order from the largest footprint (York) to the smallest (Greater Sudbury). Figure 4 and

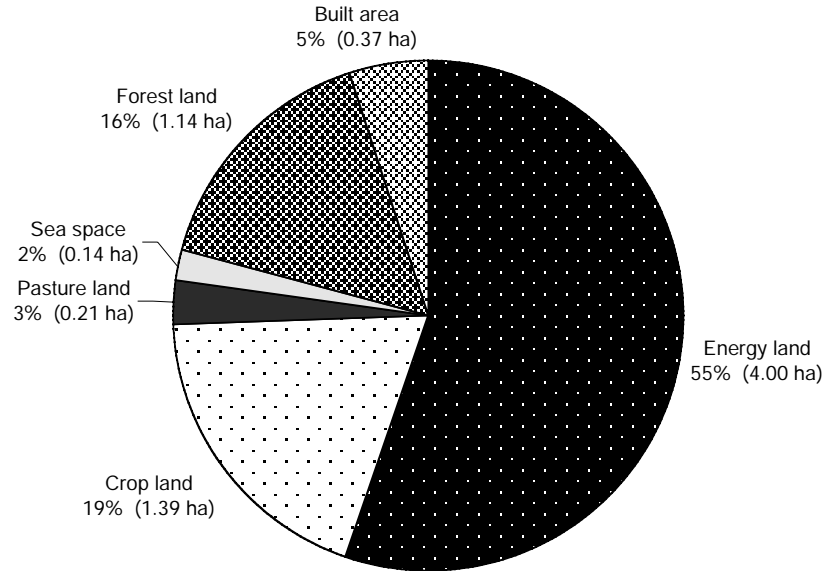
Table 5 shows that energy consumption places the highest demand on nature of any other component followed by crop land (for food production), forest land (for shelter and building products), built area (housing, buildings, infrastructure), pasture land (for livestock) and sea space (for seafood). Figure 4 highlights the contributions of the land/area categories to the total ecological footprint. Using the Canadian average as an example, energy land clearly makes up the largest component of the footprint (55%), followed by crop land (19%), forest land (16%), built area (5%), pasture land (3%), and sea space (2%).

Table 4: Ecological Footprint Results by Land/Area Category (Gha/person)

	Energy footprint	Crop land footprint	Pasture land footprint	Sea space footprint	Forest land footprint	Built area (non-hydro)	Total hydro reservoir footprint	Total Ecological Footprint
Canada	4.00	1.39	0.21	0.14	1.14	0.33	0.04	7.25
Calgary (CMA)	6.03	1.62	0.24	0.10	1.42	0.41	0.04	9.86
Edmonton (CMA)	5.85	1.48	0.22	0.10	1.35	0.41	0.04	9.45
Halton (RM)	5.03	1.70	0.25	0.18	1.43	0.28	0.04	8.91
Ottawa (CMA)	4.74	1.55	0.23	0.16	1.60	0.28	0.04	8.59
York (RM)	4.56	1.70	0.25	0.18	1.27	0.28	0.04	8.28
Peel (RM)	4.23	1.70	0.25	0.18	1.16	0.28	0.04	7.83
Halifax RM (CMA)	4.52	1.35	0.20	0.14	1.24	0.35	0.03	7.83
Vancouver (CMA)	4.21	1.53	0.23	0.21	1.18	0.31	0.05	7.71
Regina (CMA)	4.18	1.29	0.19	0.10	1.19	0.44	0.03	7.43
Waterloo (RM)	4.20	1.43	0.21	0.15	1.11	0.28	0.04	7.42
Hamilton (CMA)	4.03	1.50	0.23	0.22	1.09	0.28	0.04	7.38
Toronto (CMA)	4.05	1.48	0.22	0.15	1.14	0.28	0.04	7.36
Windsor (CMA)	4.09	1.45	0.21	0.15	1.12	0.28	0.04	7.34
Saskatoon (CMA)	4.11	1.22	0.18	0.10	1.14	0.44	0.03	7.23
Kingston (CMA)	4.06	1.38	0.20	0.14	1.07	0.28	0.04	7.18
Winnipeg (CMA)	3.73	1.45	0.21	0.10	1.27	0.34	0.05	7.15
London (CMA)	3.95	1.33	0.20	0.14	1.03	0.28	0.04	6.96
Quebec (CMA)	3.35	1.59	0.24	0.17	1.17	0.32	0.05	6.89
Niagara (RM)	3.92	1.31	0.19	0.14	1.01	0.28	0.04	6.88
Greater Sudbury (CMA)	3.91	1.30	0.19	0.13	1.01	0.28	0.04	6.87

Note: (1). Ranked highest to lowest by total ecological footprint. Blue font represents lowest total per category while red font represents the highest total per category. Municipalities in purple font are those CMAs for which personal consumption expenditure data was available; municipalities in green font are those for which personal consumption expenditure data was not available.

Figure 5: Average Canadian Ecological Footprint Breakdown by Land/Area Category (%)



Our analysis in Table 3 reveals that Calgary has the highest **energy footprint** (6.03 hectares) due to many factors including reliance on coal for electricity, while Quebec City (CMA) has the lowest (3.35 hectares). York RM, Halton RM, and Peel RM have the highest **cropland footprint** while Saskatoon had the lowest. Ottawa (CMA) had the highest **forest land footprint** while Niagara RM and Greater Sudbury had the lowest. Regina (CMA) and Saskatoon (CMA) had the highest **built area footprint** while a number of other municipalities had the lowest. Halton RM, York RM and Peel RM had the highest **pasture area footprint** while Saskatoon had the lowest. Hamilton (CMA) had the highest **sea space footprint** while several Prairie cities, including Edmonton, Calgary, Saskatoon, Regina, and Winnipeg, had the smallest footprint.

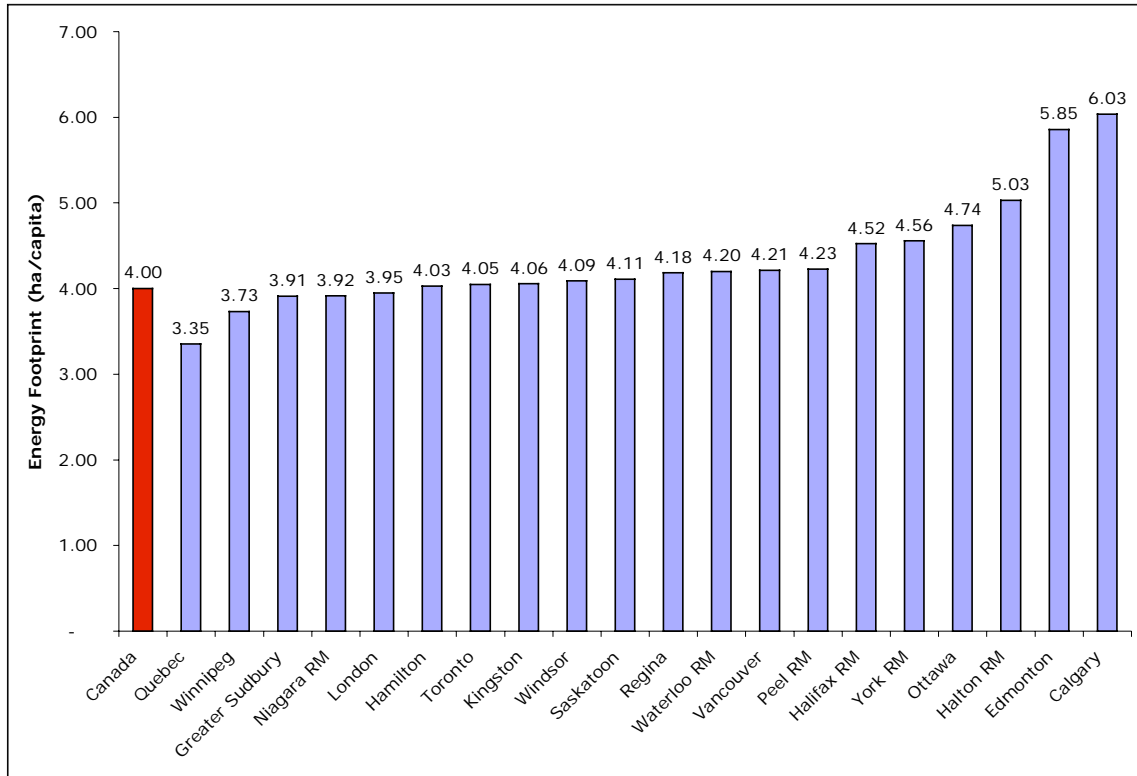
The following sections provide a more detailed explanation of each component of the footprint.

Energy land

The energy consumption portion of the ecological footprint is measured by what we call **energy land**, the land area necessary to sustain a region's energy consumption. This is calculated as the area of land (predominantly forest land) that has the capacity to sequester the CO₂ emissions from hydrocarbon fuel combustion. The energy footprint analysis answers the question: How much bigger would the biosphere have to be to absorb the CO₂ emitted by burning fossil fuels or, alternatively, how large an area of carbon-sequestering biosphere (land and sea) would be needed to supply the amount of energy using only biomass as a fuel source?

Energy consumption makes up the lion’s share of the ecological footprint, accounting for 55% or 4.00 hectares per capita of the average Canadian ecological footprint. The energy footprint ranks from a low of 3.35 hectares per capita for Quebec City to a high of 6.03 hectares per capita for Calgary. Figure 5 ranks the energy footprint of municipalities from lowest to highest. The relatively large size of Edmonton or Calgary’s energy footprint is due to the use of coal as the primary source for generating electricity while Quebec’s smaller energy footprint can be attributed to, in part, to reliance on hydroelectric power and possibly a higher urban population density.

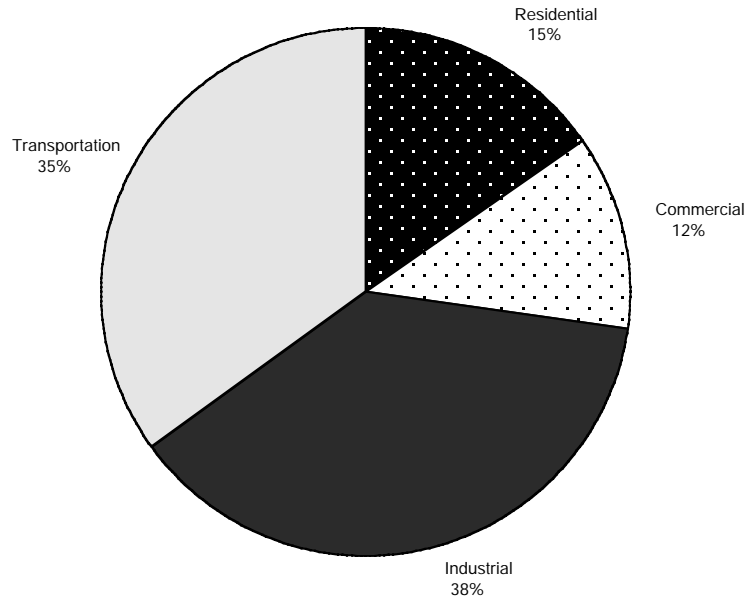
Figure 6: Energy Footprint (Gha/person)



The energy footprint for this report is calculated from end-use energy demand by sector, province and type, carbon intensity rates, source of electricity and electricity supply and use data, greenhouse gas emission data, and consumption expenditure data.²⁶ As the oceans absorb approximately 35% of the global CO₂ emissions, energy land is the forested area necessary to sequester the remaining 65% of CO₂ emissions. Nuclear power is also included in this category and is calculated at par with thermal fossil energy.²⁷

Figure 6 shows the energy footprint includes four major categories: residential energy footprint (15%), transportation energy footprint (35%), industrial energy footprint (38%), and commercial energy footprint (12%).²⁸

Figure 7: Energy Footprint Breakdown by Sector (% of Total Energy Footprint)



The residential and transportation energy footprints are calculated directly by using end-use energy demand data and green house gas emission data. The industrial and commercial energy footprints are based on the difference in per capita consumption between regional and Canadian averages. As the products and services we use do not necessarily come from our immediate area, it is assumed that overall consumption is a better proxy to determine regional industrial and commercial energy footprint size than directly using energy demand data.

While overall energy consumption influences energy footprint size, so does the energy source. For example, the carbon intensity (carbon output per energy unit) of coal and oil is higher than natural gas. In fact, energy derived from hydroelectric power** or renewable energy sources such as solar or wind power generate negligible to no CO₂ emissions. Municipalities, therefore, from provinces that derive the majority of their electricity from hydroelectric power, such as Manitoba, British Columbia, Quebec, and Newfoundland, tend to have smaller energy footprints. In contrast, municipalities within Alberta and Nova Scotia, which depend heavily on coal, have larger energy footprints.

The amount of forest area needed to sequester the CO₂ output resulting from total Canadian energy consumption totals 120 million hectares. There are over 400 million hectares of inventoried forestland and over 240 hectares of timber productive forestland in Canada (land that has standing timber and vegetation that can sequester carbon).²⁹ Note that these hectares do not

** A question that has not been adequately addressed in ecological footprint calculations is how much methane gas emissions result from hydro facilities (dams, reservoirs). This is an area for further study to advance ecological footprint calculations and theory.

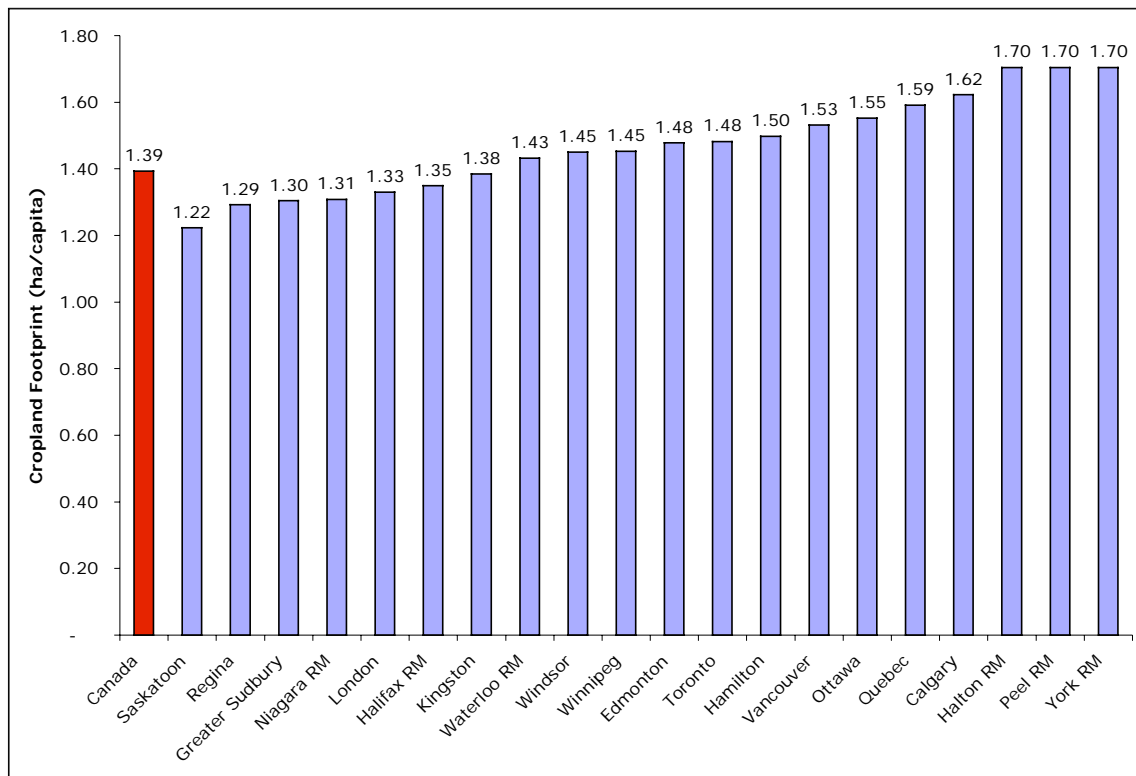
necessarily indicate the actual sequestration capacity of the forestland to sequester human-related carbon emissions but only what area of forest land exists to potentially sequester carbon from both natural and anthropogenic (human-related) sources. Moreover, these hectares have not been translated into global hectares. Despite this seeming surplus of forestland available in excess of demands on the land resulting from human-related emissions, Canada has the second highest rate of energy consumption per person in the world behind only the United States.³⁰

According to the *Living Planet Report 2002* (p. 14), of all the components of the ecological footprint, the energy footprint per person shows the greatest disparity between rich and poor, with a 16-fold difference between high and low income countries.³¹

Crop land

Crop land is the area used to grow food crops, fodder crops for animals, oil crops, fiber crops, cotton, jute, rubber, and tobacco. Crop land makes up 19% or 1.39 hectares per person of the average Canadian ecological footprint. The crop land footprint of studied municipalities ranges from a low of 1.22 hectares per person in Saskatoon to a high of 1.70 hectares per person in York RM, Peel RM and Halton RM. Figure 7 presents a breakdown of the crop land footprint from lowest to highest.

Figure 8: Crop Land Footprint (Gha/person)



The crop land calculation for this report is based on food expenditure data and consumption expenditure data. An income co-efficient was used for municipalities lacking food expenditure data. We capped the crop land adjustment coefficients at 15%. While there is a correlation between greater income and increased expenditure on food, it is not a linear correlation. Higher

income brackets purchase more meat and exotic food items, and eat out more frequently at restaurants, which have a correspondingly higher footprint, but higher income does not necessarily mean higher caloric intake. The 15% cap is based on the greatest difference in inflation adjusted food expenditure between select CMA municipalities where food expenditure data is available and the Canadian average. Halton RM, Peel RM, and York RM were capped at a 15% income to food adjustment coefficient. Quebec City and Calgary have inflation adjusted food expenditure 15% and 14% higher respectively than the Canadian average.

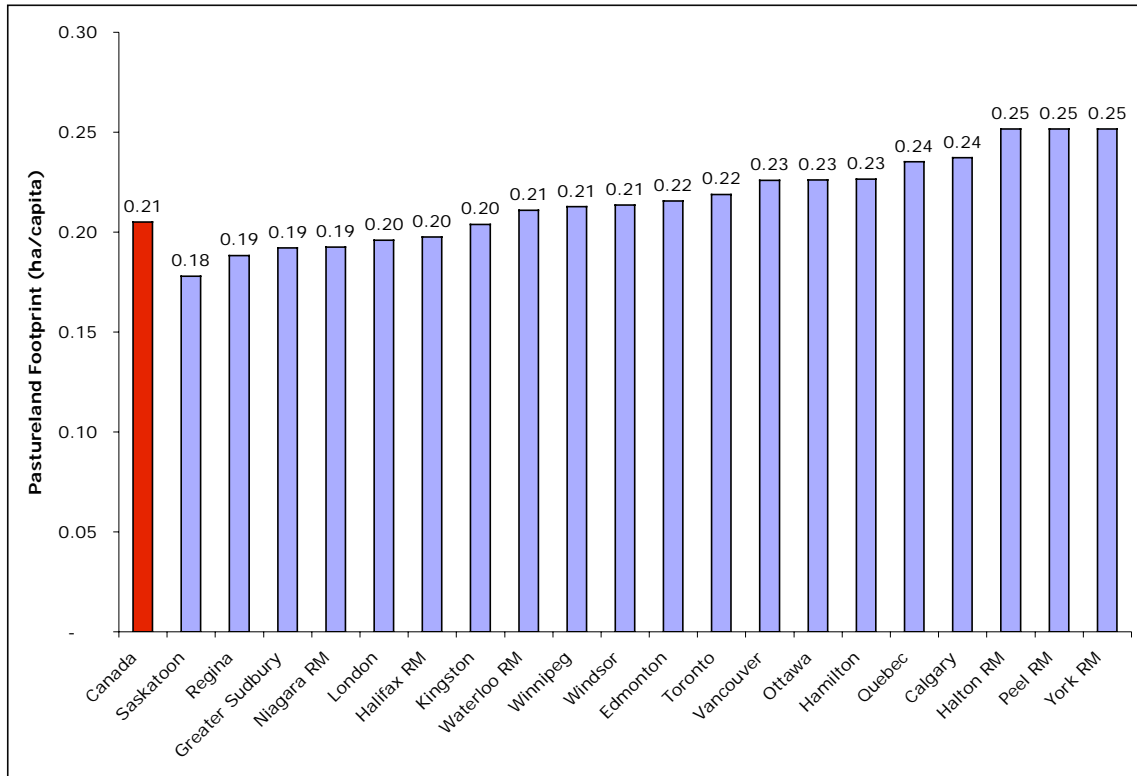
In Canada, there are over 67.3 million hectares of agricultural land.³² If we assume global productivity rates, Canada has a surplus of 25 million hectares of agricultural land above the amount needed to support Canadian household demand. Yet, Canadians have the second largest crop land footprint per person in the world, three times the global average.³³ Studies suggest, however, that with the grain trade removed, Canada is in fact a net importer of agricultural products.³⁴

This report does not include un-harvested crop land in the ecological footprint calculations. While this category was included in the *Living Planet Report 2002*, the authors chose not to include un-harvested cropland as this study takes a consumption based approach. In addition, due to the ambiguity of this land category we felt that it was better omitted. Authors of the Living Planet reports are currently debating if and how to include un-harvested cropland in future releases. Chad Monfreda of Redefining Progress remarks, “In short, the un-harvested crop land footprint is an ambiguous category, perhaps better labeled as miscellaneous agricultural land. It was included in the LPR (*Living Planet Report*) but may be excluded in future assessments to err on the conservative side.”³⁵ The un-harvested crop land footprint in the Redefining Progress Canadian ecological footprint estimate, but not included in this study, is 0.93 hectares per person. If you include un-harvested crop land as part of the ecological footprint, the total crop land footprint would add up to 2.42 hectares per capita (1.39 + .93) with the portion of the ecological footprint dedicated to cropland increasing to 28%.³⁶

Pasture land

Pasture land is the land area required to support the grazing animals that we use for food and other products. The pasture footprint makes up 3% or 0.21 hectares per capita of the average Canadian ecological footprint. The pastureland calculation for this report is based on food expenditure data and consumption expenditure data. An income co-efficient was used for municipalities lacking food expenditure data. As with the cropland footprint this was capped at 15% for the same reasons. There is an association between higher income levels and increased meat consumption which impacts food related footprint size. Regional differences in meat consumption data reveal higher meat consumption levels in Quebec with below average meat consumption levels in British Columbia, notably Vancouver.

Figure 9: Pasture Land Footprint (Gha/person)

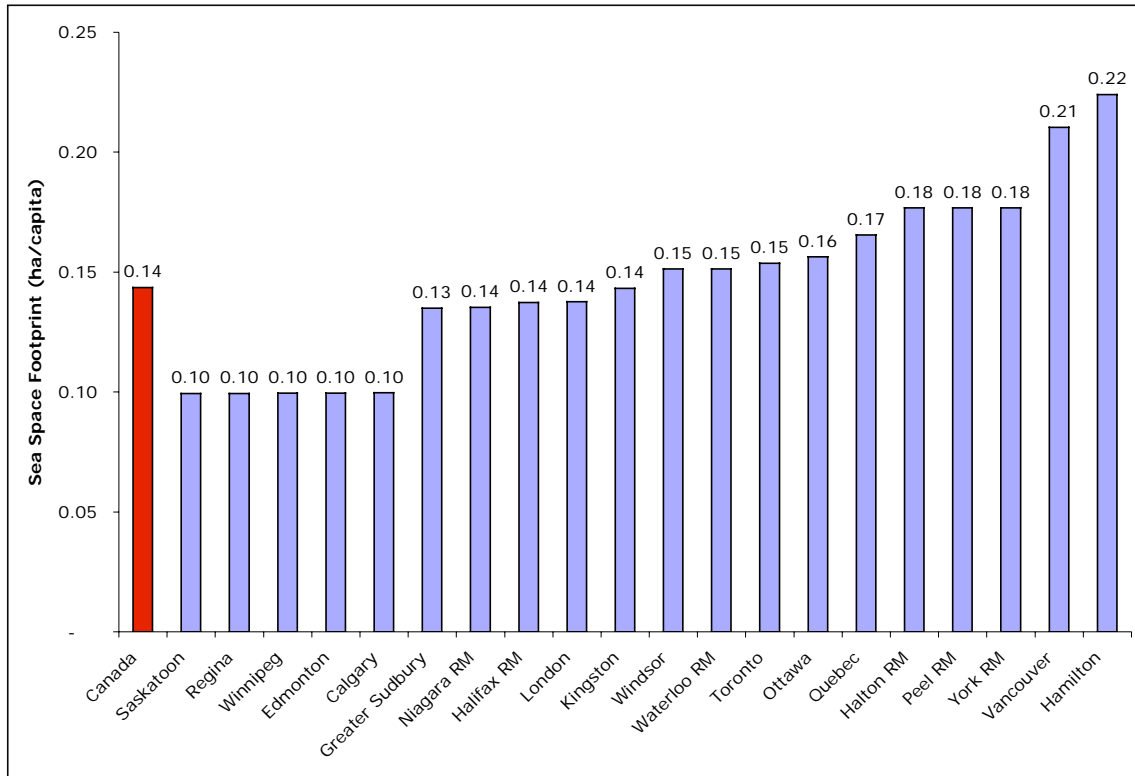


In Canada, there are 15,200,000 hectares of land classified as pasture. The total pasture footprint for all Canadians is 6,154,400 hectares; only 40% of the total land area is classified as pasture.³⁷ This pasture land is located almost entirely in the Prairies (93%) indicating that other regions in Canada depend on the Prairie provinces to support their pasture footprint. Along with Australia and the United States, Canada consumes the highest levels of meat in the world with an annual consumption of almost 100kg per person, more than twice the global average.³⁸ Despite high levels of meat consumption, Canada's large land area makes Canada a net exporter of pastureland.

Sea space

Sea space is the area required to catch fish and seafood for human consumption. This accounts for fish and other marine products, fishmeal, and oils. Sea space makes up 2% or 0.14 hectares per capita of the average Canadian ecological footprint and ranges widely across the country (See Figure 9). Based on available fishing ground biocapacity presented in the *Living Planet Report 2002*, in Canada there is 1.91 hectares of sea space available per person.³⁹ This is well above the available global biocapacity of 0.14 hectares per person and reflects Canada's large coastlines and abundance of fresh water.

Figure 10: Sea Space Footprint (Gha/capita)



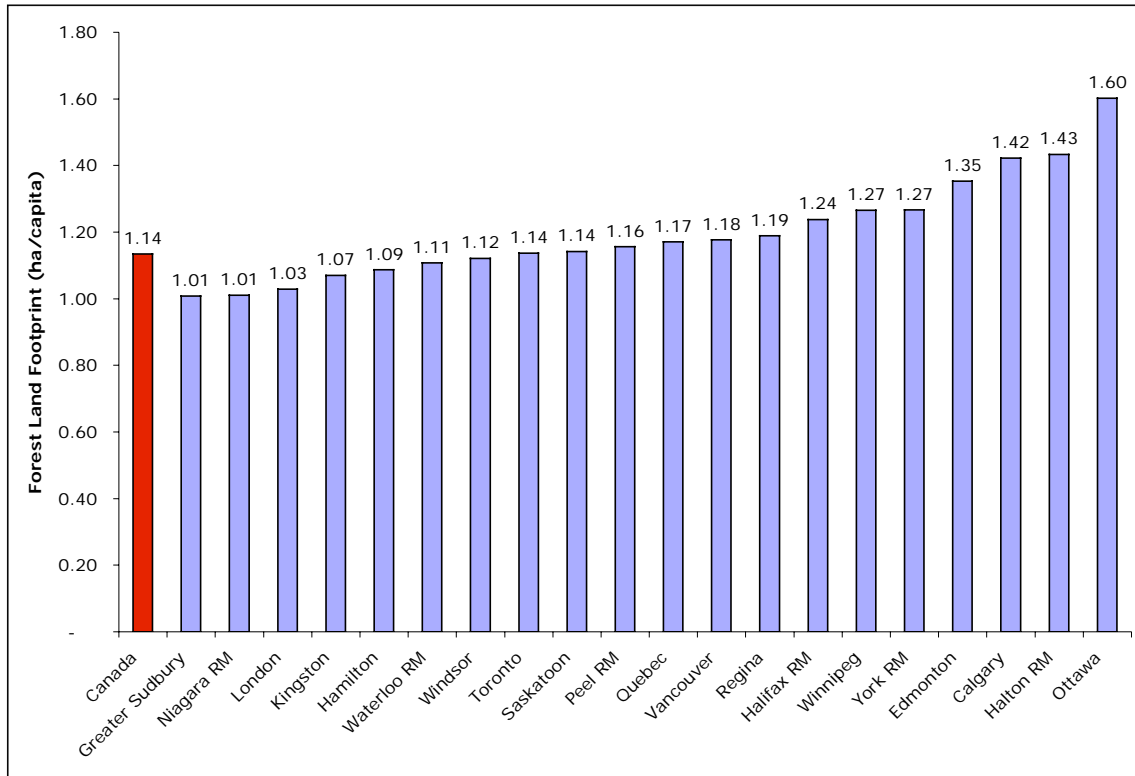
The sea space calculation for this report is based on provincial fish and other marine product expenditure data except for Toronto, and Vancouver where municipal expenditure data was available.⁴⁰ It is assumed that a complete municipal data set would show that areas located in coastal regions would have higher sea space footprints. Comparing Vancouver expenditure data on fish and marine products with Toronto supports this assumption. Per-person inflation-adjusted expenditure on fish and marine products in Vancouver is 13% higher than Toronto.

Forest land

Forest land is the area required for timber products (sawn boards, panels, fiber boards), fuel wood, pulp, paper, and paperboard. This includes both natural forests and plantation forests. Forest land represents 16% or 1.13 hectares per capita of the average Canadian ecological footprint and varies across municipalities (See Figure 10). This data does not indicate the age or species of trees, or productivity of the identified forest land. There are 240 million hectares of timber-productive forest land in Canada.⁴¹ To sustain Canadians use of wood fiber, fuel wood, pulp, and paper requires 34 million hectares. Therefore, Canadians enjoy a significant surplus (comparative advantage) of forest land to meet their forest product needs. *

* Note that these hectares have not been translated in global hectares and represent actual timber productive forest land in Canada.

Figure 11: Forest Land Ecological Footprint (Gha/capita)

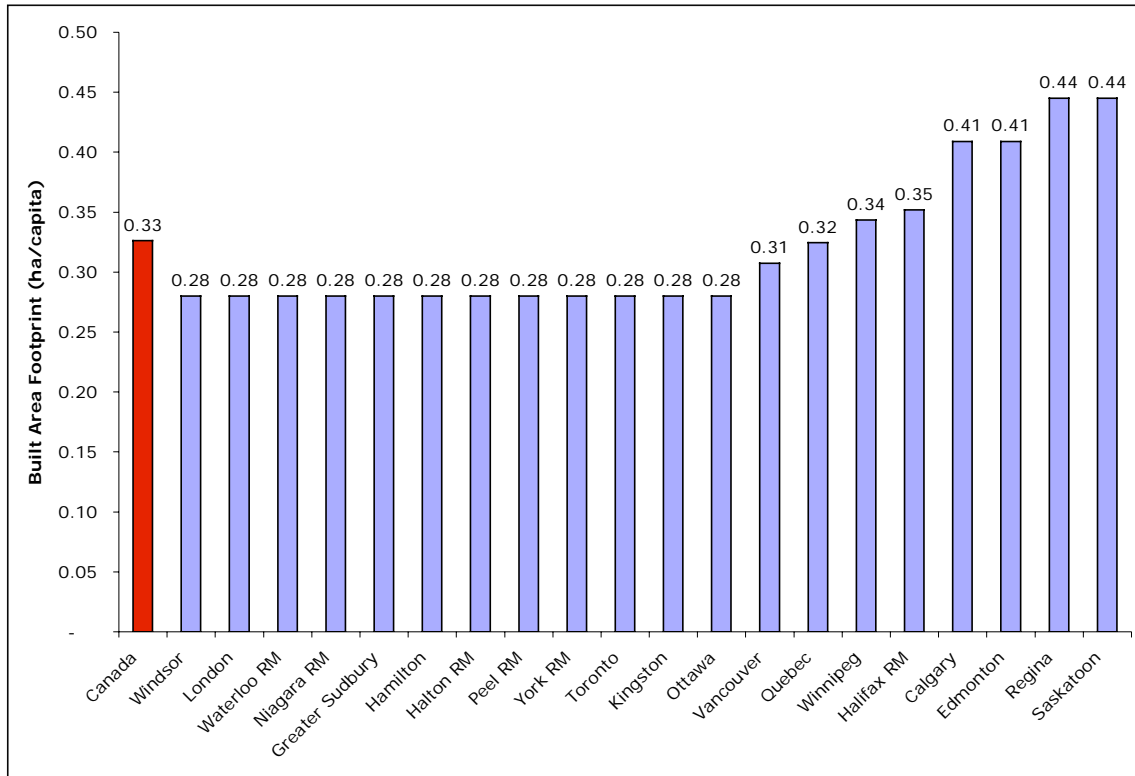


Timber products account for over 55% of the forest footprint while paper consumption accounts for 36% of the forest footprint. The forest land calculation for this report is based on paper and paper product expenditure data, residential energy use data, and overall consumption expenditure data. The forest footprint is strongly linked to cost of living adjusted disposable income as wealthier regions can afford larger homes, more wood based consumer goods, and tend to spend more on books, magazines and newspapers.

Built area

Built area is the land area used to accommodate human infrastructure. This includes our houses and buildings, roads and highways, factories and other centres of industrial production, and the area required to support hydro energy generation. Built area makes up 5% or 0.37 hectares per capita of the average Canadian ecological footprint and varies across the country (see Figure 11). The built area calculation for this report is based on provincial urban land use and infrastructure data.⁴² This includes urban land use, roads, railways, and utilities. The built area footprint (per capita) is higher for municipalities located in provinces with comparably smaller populations. In more populated regions, more people use the infrastructure and subsequently, due to economies of scale, reduce the per-person footprint size. Municipalities located in provinces that rely primarily on hydroelectric power have increased built area footprints. A larger built area footprint due to hydroelectric energy generation, however, is offset by a decrease in energy footprint size as hydroelectric power has a negligible carbon intensity rate.

Figure 12: Built Area Ecological Footprint (Gha/capita)



4. The ecological footprint from a global perspective

From a global perspective, the ecological footprints of the studied municipalities are among the highest in the world. According to the 2002 *Living Planet Report* Canada has the third largest ecological footprint per person in the world after the United Arab Emirates and the United States.

Table 4 is a summary of the 15 countries with the largest ecological footprints in the world as presented in the *Living Planet Report 2002*. The Canadian ecological footprint presented in tables 4, 5 and 6 comes directly from the *Living Planet Report 2002*. This estimate differs from the Canadian ecological footprint presented in this report as the footprint used in this report is the most recent updated estimate of that presented in the *Living Planet Report 2002* document. This is due to differences in the data sources used to calculate the ecological footprint. In addition, our estimates do not count unharvested cropland as part of the ecological footprint. See crop land in the “Ecological Footprint by Component” section for a detailed explanation. Unharvested crop land in the revised ecological footprint equals 0.93 hectares; adding this to our Canadian estimate of 7.25 ha/capita would result in a comparable 8.18 ha/capita footprint. The Canadian ecological footprint in the *Living Planet Report 2002* is 8.84 hectares per person.⁴³ We use the *Living Planet Report 2002* Canadian ecological footprint estimate in tables 5, 6 and 7 simply to provide a comparative analysis between Canada and other nations with large footprints.

Table 5: Largest 15 Ecological Footprints in the world, Gha per capita (as presented in Living Planet Report 2002)

Ranking	Country	Ecological Footprint
1	United Arab Emirates	10.13
2	United States of America	9.70
3	Canada	8.84
4	New Zealand	8.64
5	Finland	8.42
6	Norway	7.92
7	Kuwait	7.75
8	Australia	7.58
9	Sweden	6.73
10	Belgium/Luxembourg	6.72
11	Denmark	6.58
12	United Kingdom	5.35
13	Ireland	5.33
14	France	5.26
15	Greece	5.09

Canada clearly has one of the largest ecological footprints per person in the world. Table 6 reveals how the average Canadian ecological footprint compares by component to world averages.⁴⁴

Table 6: Ecological Footprint Size by Component, Canada and World Averages

	Canadian Footprint (Gha/person)	World Averages (Gha/person)	World Ranking
Total ecological footprint	8.84	2.28	3
Energy land footprint	4.74	0.30	4
Crop land footprint	2.18	0.53	2
Pasture land footprint	0.31	0.12	19
Sea space footprint	0.19	0.14	40
Forest land footprint	1.12	0.27	4
Built area footprint	0.31	0.10	2

Table 6 compares the average Canadian ecological footprint by component to other countries that enjoy high standards of living, including Sweden, Netherlands and Japan.⁴⁵

Table 7: How Canada compares to Sweden, Netherlands, and Japan

	Canada (Gha/person)	Sweden (Gha/person)	Netherlands (Gha/person)	Japan (Gha/person)
Total ecological footprint	8.84	6.73	4.81	4.77
Energy land footprint	4.74	3.21	2.89	3.04
Crop land footprint	2.18	1.21	0.77	0.47
Pasture land footprint	0.31	0.12	0.13	0.06
Sea space footprint	0.19	0.34	0.29	0.76
Forest land footprint	1.12	1.37	0.54	0.28
Built area footprint	0.31	0.48	0.19	0.16

Table 7 suggests that other countries have attained high standards of living with a lower impact on nature than Canada has.

The ecological footprint and global sustainability

Global sustainability requires that human activity remain within the carrying capacity of nature. Dividing all of the biologically productive land and sea on the planet by the number of people in habiting the Earth results in an average of 1.9 hectares per person⁴⁶. By contrast the average global footprint is 2.3 hectares per capita, so humanity’s footprint may exceed global carrying capacity by 21%.

The average available global biocapacity represents 26% of what is necessary to accommodate a typical Canadian footprint (7.25 ha/capita). The estimate of the biocapacity available assumes that the Earth’s bounty is for human use only. If we consider the need to protect specie habitat and biodiversity then even less biocapacity would be available to humans.⁴⁷ The lifestyle of the average Canadian, for example, with a footprint of 7.25 hectares per person, is clearly not sustainable since on a global scale using 382% of biocapacity available on a per capita basis worldwide. The Canadian lifestyle ultimately imposes an ecological deficit on other communities on the globe, even though Canada has itself a surplus of biologically productive land and sea space.

The ecological footprint highlights global inequities. A relatively large footprint may lead to unintentional and easily unaccounted-for impacts on our fellow global citizens, forcing some to go without the same access to natural capital or quality of life that we currently enjoy. Indeed, sustaining the whole world at the consumption levels of the average Canadian would require four planets the size of our Earth. How do our local consumption patterns impact the capacity of other humans to meet their basic needs? How does our high level of material wealth in Canada affect global sustainability?

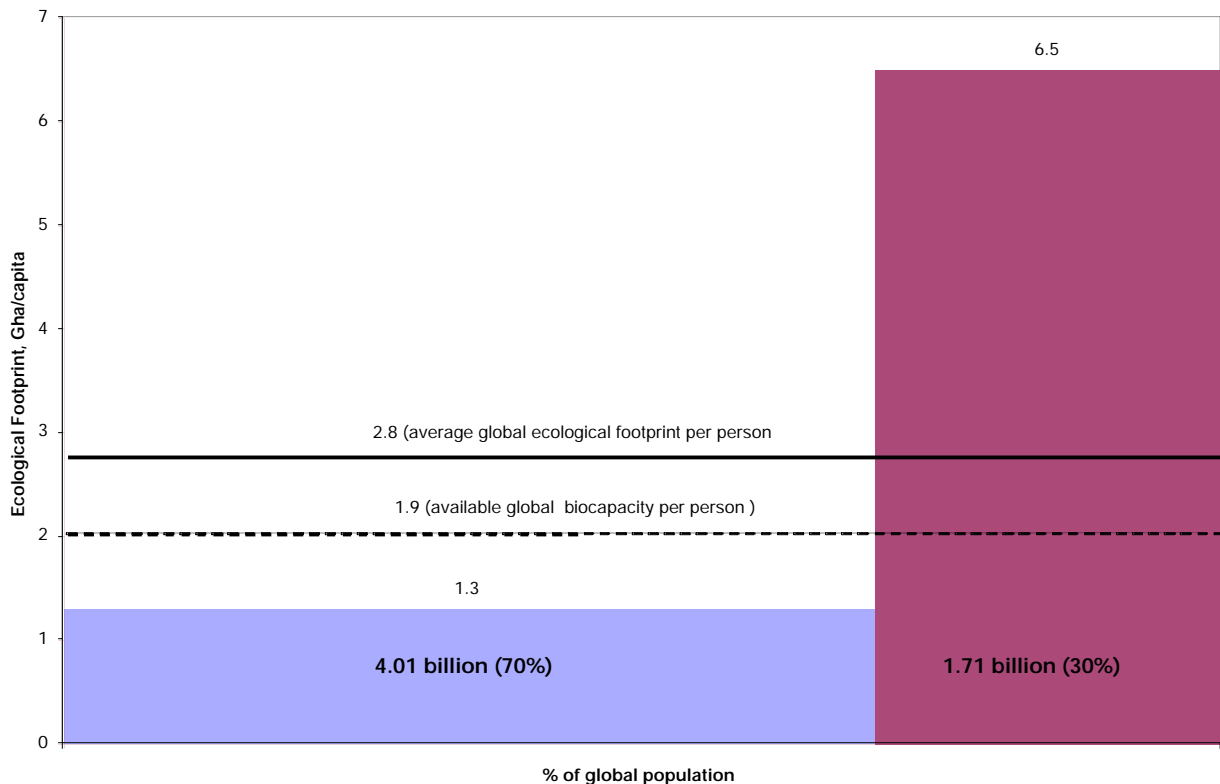
Even though the average footprint of humanity of 2.3 hectares per person is relatively small compared to the average Canadian ecological footprint of 7.2 ha per person, it still exceeds the capacity of the biosphere. Global consumption in excess of 1.9 hectares per person implies that the Earth’s resources and services are being used at an unsustainable rate. Humanity consumes more than what nature can regenerate by depleting the globe’s stock of natural capital and by reducing the biocapacity available for future generations.

Disparity in ecological footprint sizes

There are great disparities among countries' ecological footprint sizes. Industrialized countries far exceed their share of global bioproductive space, while the non-industrialized portions of the world tend to live well below the average global bioproductivity space per person. African and Asian-Pacific countries have ecological footprints of 1.3 hectares per person and 1.8 hectares per person respectively (1996 data).

Seventy percent of the world's population consumes less than the 1.9 ha per person of land and sea space available for human use.⁴⁸ Figure 12 highlights global ecological footprint distribution above and below 1.9 hectares. Arguably, global environmental decline can, therefore, be attributed to 30 percent of the world's richest population. In fact, this 30 percent uses 90 percent of the world's ecological capacity. Excessive consumption by one group in many cases directly undermines the capacity of others to secure their basic human needs.

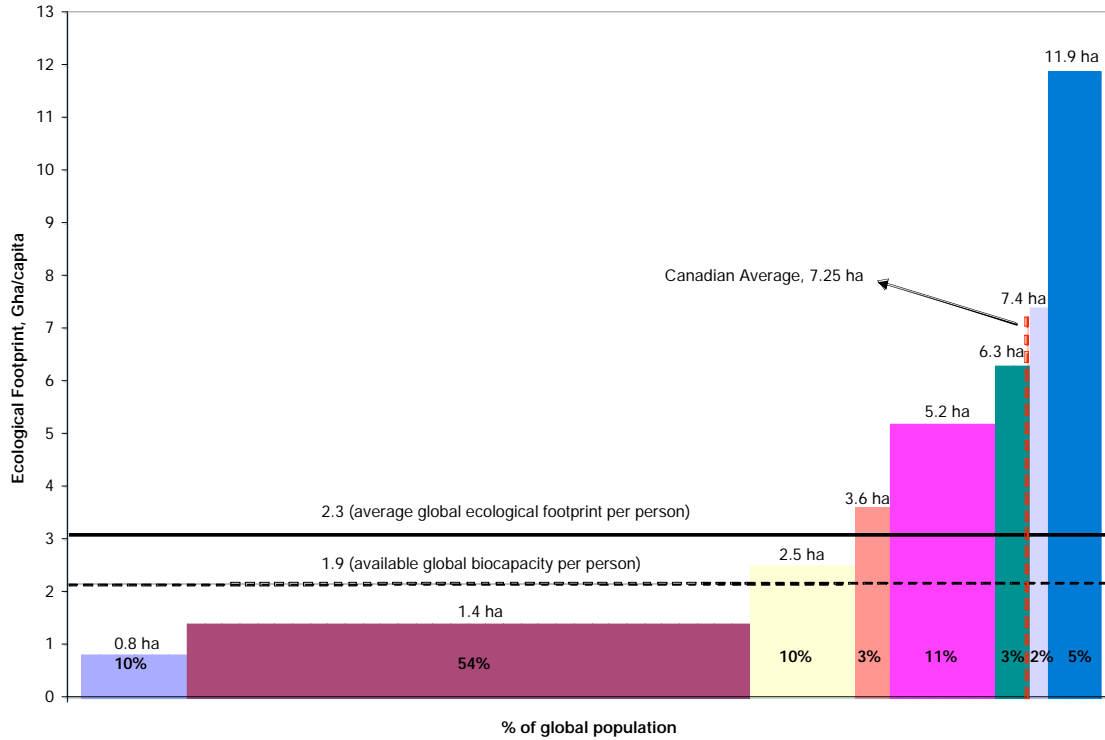
Figure 13: Global Ecological Footprint Distribution (above and below 1.9 ha)



Note: 1996 data from the 2000 *Living Planet Report*, based on similar chart created by Jeff Wilson and originally published in the *Nova Scotia Ecological Footprint Report, 2001*.

A mere 5% of the world's population (including Canada and the U.S.) has a total footprint larger than the total footprint of 50% of the world's population. Figure 13 shows the distribution of ecological footprints by the percentage of the world's population. Where does your municipality fit from a global perspective?

Figure 14: Global Ecological Footprint Distribution



Note: 1996 data from the 2000 *Living Planet Report*, based on similar chart originally published in the 2000 *Living Planet Report*.

5. Ecological footprint and bio-capacity of Canada's land

From a global perspective, the average ecological footprint of each municipality in this study is clearly not sustainable. The carrying capacity of the Earth would be vastly exceeded if an entire human population consumed at average Canadian levels.⁴⁹ Canada, however, is a resource-rich country that occupies a large land area with a relatively small population. Based on available land, Canada can, in fact, support the heavy Canadian footprint. According to the 2002 *Living Planet Report*, Canadians have enough biocapacity (biologically productive land) to support an ecological footprint of 14.24 hectares per person, a surplus of seven hectares per person.⁵⁰ Table 8 illustrates the Canadian carrying capacity both in estimated biocapacity in global hectares per person and actual land area in Canada versus ecological footprint size.

Table 8: Carrying Capacity versus Ecological Footprint

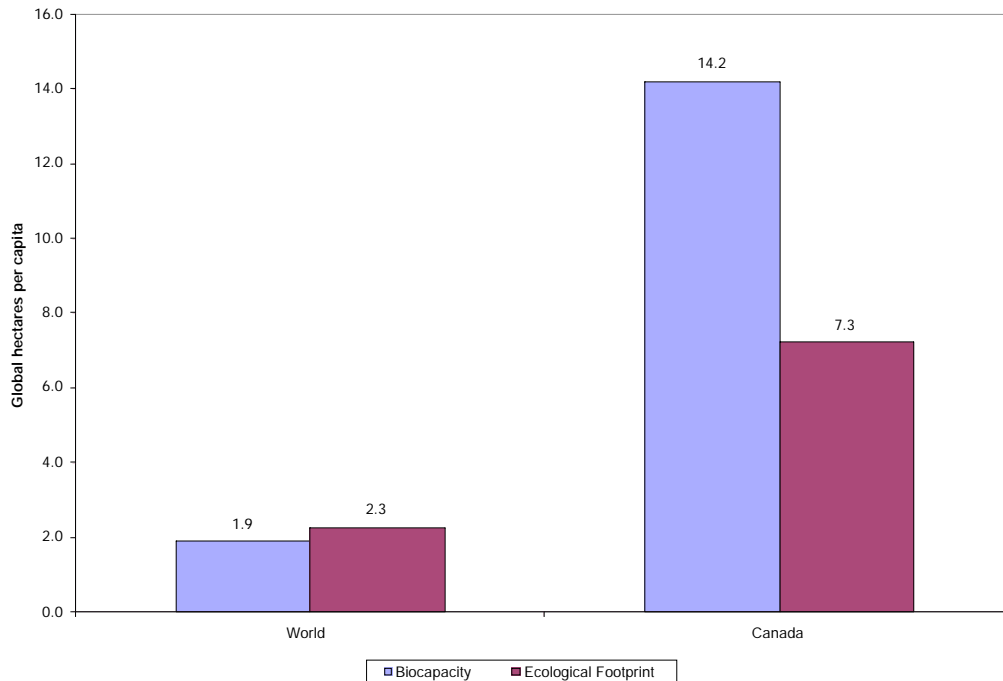
	Average Canadian ecological footprint (Gha/person)	Available biocapacity* (Gha/person)	Actual land area in Canada (actual hectares/person) ⁵¹
Energy land	4.00	7.24 (forest land)	21.3 (forest land, incl. timber productive land)
Crop land	1.39	3.46	2.24
Pasture land	0.21	1.25	0.51
Sea Space	0.14	1.91	?**
Forest land	1.14	7.24 (forest land)	8.00 (timber productive land)
Total footprint	7.25	14.24	31.78

*As estimated in 2002 *Living Planet Report*. Biocapacity refers to the amount of biologically productive land.

** No adequate data available.

Given that Canadians have surplus biocapacity, does this mean we don't have to reduce our footprint size? Figure 14 presents a comparison of available biocapacity and ecological footprint for Canada and the world. While Canada has a surplus of biocapacity, from a global perspective the ecological footprint exceeds what is available. What obligations do Canadians have to ensure global sustainability? What do large ecological footprints mean at the local level, at the national level, and at the global level?

Figure 15: Biocapacity and Ecological Footprint



6. The ecological footprint and regional sustainability

Despite Canada's biocapacity surplus, the ecological impacts of municipalities do not correspond to their geographic areas. William Rees, co-founder of the ecological footprint, refers to cities as "black holes" of resource and energy consumption.⁵² It is not surprising that urban demands on nature's goods and services far exceed the actual physical space occupied. These demands put pressure on other regions' land and sea areas, and other communities and other nations who may supply these goods and services to the respective municipality. A relevant question is how large, spatially, does a municipality's footprint extend beyond its own boundaries or land base? How many resources does it draw from the more immediate region (e.g., watershed or political region) on a sustainable basis? How many resources consumed by a municipality are imported from beyond the region?

All municipalities place demands on nature that far exceed the available land area (i.e., geographic land and water/sea area) they occupy. To illustrate this demand-supply relationship, we compared the total ecological footprint area of each municipality (i.e., demand on nature) with the municipal land base (Table 9), as a percentage relationship. These demand-supply ratios range from as low as 300% for Greater Sudbury, Ontario to a high of 6,646% for Peel RM, Ontario.

In terms of the largest ecological footprint in hectares, Torontonians have the lion's share of Canada's ecological footprint representing 16.0% of the total (with 15.6% of Canada's population) compared to 0.5% for Kingston and Greater Sudbury.

Table 9: Land Area Required to Support Ecological Footprint and Actual Land Area of Municipality

	Total ecological footprint, ha	Municipal Land Area, ha	Population Density, persons/ ha	Total ecological footprint versus land area available	Ecological footprint as a percentage of total Canadian ecological footprint
Canada	217,443,430	909,350,700	320	24%	100.0%
Vancouver (CMA)	15,321,259	287,900	69,000	5,299%	7.0%
Calgary (CMA)	9,381,611	508,300	18,700	1,848%	4.3%
Edmonton (CMA)	8,858,661	941,900	10,000	942%	4.1%
Regina (CMA)	1,432,432	340,800	5,700	419%	0.7%
Saskatoon (CMA)	1,631,779	519,200	4,400	312%	0.7%
Winnipeg (CMA)	4,802,184	415,200	16,200	1,164%	2.2%
Windsor (RM)	2,260,838	102,300	30,100	2,202%	1.0%
London (RM)	3,009,067	233,300	18,500	1,278%	1.4%
Waterloo (RM)	3,253,175	136,900	32,000	2,614%	1.6%
Niagara (RM)	2,825,299	186,300	22,000	1,503%	1.3%
Greater Sudbury (CMA)	1,068,739	353,600	4,400	300%	0.5%
Hamilton (CMA)	4,888,614	137,200	48,300	3,549%	2.2%
Halton (RM)	3,344,580	96,700	38,800	3,578%	1.6%
Peel (RM)	7,746,627	124,200	79,600	6,646%	3.8%
York (RM)	6,035,088	176,200	41,400	4,604%	3.7%
Toronto (CMA)	34,445,941	590,300	79,300	5,894%	16.0%
Kingston (CMA)	1,053,614	190,700	7,700	546%	0.5%
Ottawa (CMA)	9,137,629	531,800	20,000	1,710%	4.2%
Quebec (CMA)	4,703,825	315,400	21,600	1,490%	2.2%
Halifax RM (CMA)	2,811,040	549,600	6,500	508%	1.3%

Realistically, to maintain levels of consumption above what is locally available and sustainable, municipalities use imports from elsewhere through trade of goods and services derived from natural capital.⁵³ Trade is natural part of commerce amongst cities and nations. However, the ecological footprint raises our awareness that a constant supply of imported goods may have negative consequences for sustainability and quality of life in other regions of Canada or other countries. If local gains in natural, economic, or social well-being come at the expense of accelerating ecological damage and social disintegration elsewhere, then local prosperity represents a cost to global sustainability.⁵⁴ The ecological footprint addresses the impact of consumption —locally and globally — by providing a more complete picture of the consequences of consumption habitats and demands.

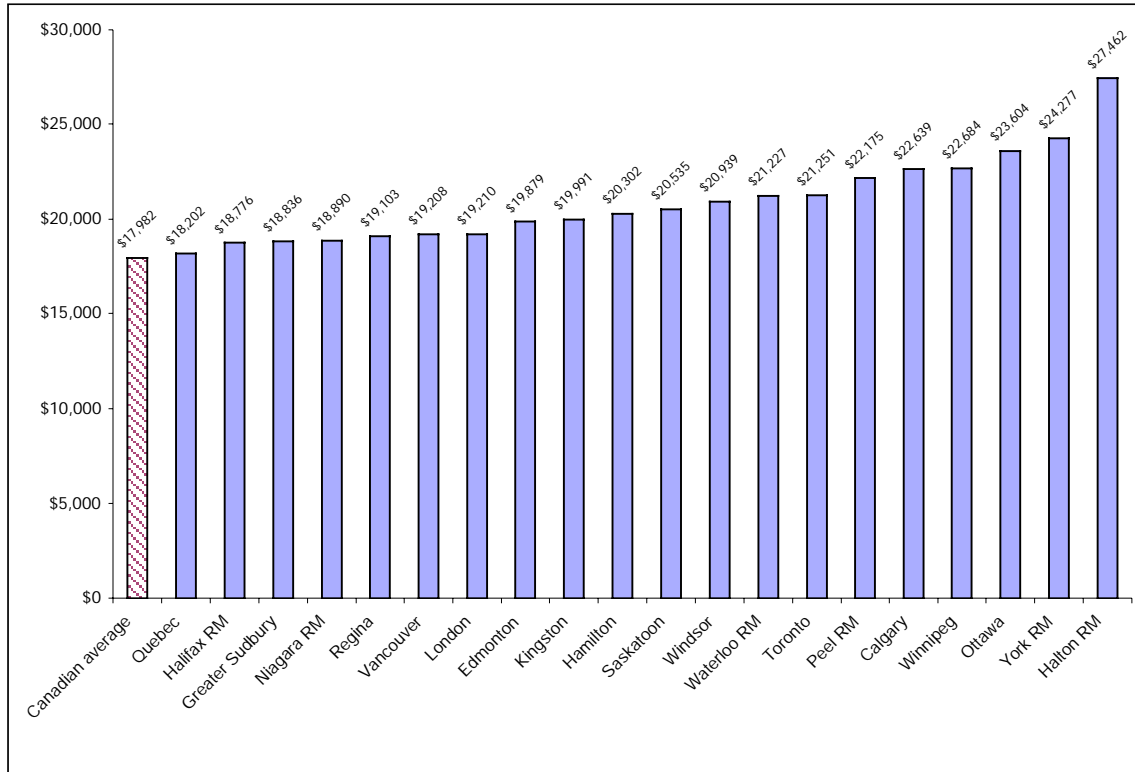
Canada is well endowed with a large amount of space and a relatively small population. The country spans an area of over 2.1 million sq km, with a population of 31 million people. What contributions should Canadians be making to ensure global sustainability? As occupants of a large land area, do Canadians have the right to live on a larger footprint? Do Canadians take for granted natural spaces? How would we need to change our lifestyles if we lived in conditions such as Hong Kong where there are 6,217 persons per square kilometer in contrast to Canada where we have a population density of 3.2 persons per square kilometer.*

* In 1999, Hong Kong's population was 6,826,500 people in a land area of 1,098 square kilometers, for a population density of 6,217 persons per km². Source: Wendell Cox Consultancy, 2000. Demographia web site www.demographia.com/db-hkdbd99.htm

Economies of scale and wealth

With their higher population densities, municipalities offer opportunities for lower ecological footprints due to economies of scale. The high population density of cities can support public transit and offer better access to amenities and services, thereby reducing automobile dependency. Cities also have higher density housing, and can support municipal recycling and composting programs. Urban centres ought to have a lower footprint than rural areas. The majority of the municipalities examined in this study, however, have ecological footprints above the Canadian average.⁵⁵

Figure 16: Median Household Income Per Capita (\$2001) CPI Adjusted



In contrast to advantages of economies of scale, there tends to be a greater concentration of wealth with a corresponding greater amount of consumption in urban centres. Figure 15 presents the median income for all municipalities. Given that the majority of the municipalities in this study have ecological footprints above the Canadian average, it suggests that any gains from economies of scale are outstripped by increased consumption.

7. Strengths and weaknesses of ecological footprint analysis

Ecological footprint analysis has both strengths and weaknesses, and room for methodological improvement. The main weakness is the lack of consumption expenditure data at the municipal level for all Canadian municipalities that would provide more accurate and comparable estimates (working from the Canadian average EF estimates). Despite these data challenges, Mathis Wackernagel (one of the architects of the footprint) notes that footprint estimates tend to be conservative because they do not account for all of the human demands on nature's goods and services (e.g., ecosystem services such as waste assimilation). The footprint does offer a new tool for communicating sustainability and helps households and decision makers. Table 10 provides a summary of the strengths and weaknesses of the ecological footprint for application at the local or municipal scale that were identified by European footprint practitioners.

Table 10: Strengths and Weaknesses of Ecological Footprint for Municipalities

Strengths	Weaknesses
<p>There are already many people involved in ecological footprint calculations. The methodological approach is becoming well known, and there is now also a search for a common methodology.</p> <p>The ecological footprint has the ability to communicate with the individual, as well as with politicians and environmental managers. It can be used at all levels and in all sectors.</p> <p>Ecological footprint is well known and advantages have been documented.</p> <p>Ecological footprint might also be characterized as a sustainable development indicator, which not only tells us what the demand is, but also in which direction we should be moving.</p> <p>There is a problem with access to data, and there are still methodological problems, but research is on going in these areas.</p> <p>WWF's adoption of the ecological footprint through the use of the Footprint of Nations calculations (Wackernagel et al.) is strengthening the approach.</p> <p>Regional authorities, e.g., Wales in the UK, have also adopted the concept by integrating the perspective in regional development strategies.</p> <p>Ecological footprint tells us what to do next. It illustrates strategies for change by presenting the key components of consumption, and thereby the potential for change by different efforts. The effectiveness of changes in energy sources, production systems, transportation, dematerialization, bio-production etc., becomes visible.</p>	<p>It is not yet clear what the broader application of the ecological footprint will be. The footprint answers questions that have in fact not yet been posed by the municipalities themselves. On what level should it be used and what is the purpose of having it?</p> <p>Energy is a problem: The consumption of energy is becoming a more and more important question for society, but the ecological footprint does not point towards specific energy decisions and changes of policy in this area of concern.</p> <p>The ecological footprint at the regional level: the concept does not focus very much on the possibilities at regional level. This is partly a result of the lack of access to local data.</p> <p>There is a lack of transparency: the calculations are complex and often not accessible for the potential users of the results.</p> <p>The production side of the process is only marginally brought in. Environmental quality or degradation is not treated in the approach. Neither does the ecological footprint give insight into these matters, nor is it a tool for change.</p> <p>To become an indicator for sustainability, the concept lacks several of the major dimensions of the Sustainable Development perspective. The ecological footprint does not include social/economical aspects, e.g., the question of poverty.</p> <p>As it is now calculated, rich countries may come out positively on "national ecological deficit" (comparing national ecological footprint with existing national biocapacity), while poor countries in the south might end up with a negative 'national ecological deficit'. This picture turns the focus of the discussion away from the over-consumption in the North, and represents a weakness of the approach.</p> <p>Further research should try to clarify the "why", "what" and "how" of the footprint approach, and what solutions may emerge from its use. At the same time, it is important to clarify what the ecological footprint does not tell us! The ecological footprint might then become a tool for scenario development, but never for realistic projections.</p>
<p>Source: Program for Research and Documentation for a Sustainable Society http://www.prosus.uio.no/english/sus_dev/tools/oslows/1.htm</p>	

Room for improvement

Other researchers are attempting to improve on the original EF model in many important ways; they include Deutsch et al. (2000)⁵⁶ who are building EF estimates from the bottom up by first using available ecological data and an understanding of local and regional ecosystem performance.⁵⁷ Deutsch et al. regard the EF as an “excellent tool for communication of human dependence on life-supporting ecosystems” that shows people how much they depend on ecosystems to generate resources and services — something they may have been unaware without such an account. They argue that EF is a way to engage citizens, making real how their lifestyles affect the resilience, adaptive capacity and renewal capability of complex ecosystems.

We believe EF accounting and analysis can and should play a key role in sustainability accounting and reporting, building on its current strengths and addressing its weaknesses with more research and development. It is possible to conduct ecological footprint accounting using Statistics Canada’s national income accounting system (to measure EF based on personal consumption expenditures) combined with the environment and natural resource accounting system.

8. How can the accuracy of municipal footprint analysis be improved?

The accuracy of Canadian Municipal Footprint estimates is dependent on the source data used to calculate them. There are many ways in which municipalities could improve their capacity to calculate the footprint including the following.

- Encourage **Statistics Canada** to begin accounting for material and energy flows at the provincial and municipal scale, as they do at the national level.
- Encourage **Statistics Canada** to begin collecting personal consumption expenditure data for all FCM’s municipalities and municipal regions, beyond only the CMA level.
- **Municipalities** begin to measure and track the following:
 - **Food** – the percentage of food consumed by municipal residents that is locally grown, organically grown, and unprocessed or unpackaged; consumption of meat and dairy products;
 - **Household** – residential electricity consumption (by source), natural gas consumption, and other fuel consumption; built up area occupied by housing and other structures;
 - **Transportation** – accounts of average car fuel efficiency, average car occupancy, passenger kilometers in private vehicles and public transportation, airplane kilometers and/or hours flown by residents, built up area occupied by transportation networks;
 - **Goods and Services** – consumption of physical quantities of various goods and services.
- Encourage households and business owners to calculate their own footprint using various footprint calculators available on the web.

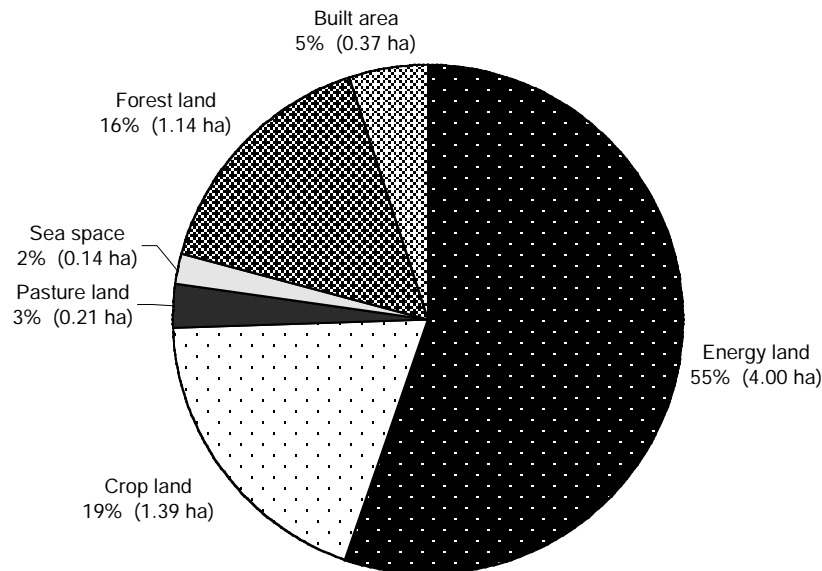
A more robust environmental indicator reporting system being developed by municipalities in cooperation with the Federation of Canadian Municipalities needs will facilitate some of these data needs.

9. How can Canadian municipalities reduce their ecological footprint?

What can Canadians and Canadian communities do to reduce their ecological footprint?

We have shown the key contributing factors to Canada's ecological footprint are energy, food and other material consumption (Figure 16).

Figure 17: Average Canadian Ecological Footprint Breakdown by Land/Area Category (%)



Reducing energy footprints

The single most important action to reduce Canada's ecological footprint is to cut energy consumption. It is the most important contributing factor to Canadian's large ecological footprint at 55% of total followed by food consumption (roughly 19%). Conserving and using energy more efficiently, as well as switching to renewable energy sources, would have the greatest impact on reducing a household's and community's ecological footprint.

The energy footprint alone accounts for more than 55% of the ecological footprint, which breaks down to transportation (35%), residential (15%), commercial (12%) and, industry (38%). On a hectare basis, transportation represents 1.4 hectares and residential energy use 0.6 hectares for a total ecological footprint of 2.0 hectares per person or 28% of the total ecological footprint. Given the significant contribution of energy consumption to the overall ecological footprint, these areas dramatically influence sustainable living.

Achieving greater sustainability requires a holistic perspective that is based on systems thinking. As individuals or municipal governments, we need to think more about whole systems (water, waste, buildings, transportation) and system parts. In a system everything is interrelated and interdependent.

For municipal governments to become more sustainable requires adopting certain tools like sustainable development decision frameworks that help assess the social, economic and environmental implications of local decisions. It will require using lifecycle assessment tools for all infrastructure and planning decisions and investing in environmental management systems to establish baselines of performance and to track progress.

All sectors of communities — municipal government, community groups, industry and institutions — must work together to develop and implement sustainable community plans.

The Green Municipal Funds, administered by FCM, and its Partners for Climate Protection Initiative, along with Infrastructure Canada programs, support projects aimed at reducing consumption and improving community sustainability.

Transportation: Transportation is biggest single component of the footprint that an individual can influence.

- **What drives it?** Excessive vehicle use.
- **What does it tell us?** We drive too much.
- **What can municipalities do?**
 - Adopt transit friendly land use plans that emphasize mixed-use development to facilitate active transportation (walking, cycling), and that make public transit accessible and convenient;
 - Adopt green procurement policies that include the purchase of energy efficient and alternative vehicle technologies and fuels in municipal fleets, including buses, trucks and cars;
 - Use fleet route optimization tools to maximize the efficiency of the fleet when it's on the road; and
 - Invest in Intelligent Transportation Systems that use Internet and telecommunication technologies to improve transit service.

Residential Energy Use: With respect to residential energy use (15% of the energy footprint), there are a number of changes that can be made at the individual household level.

- **What drives it?** Large homes, cold climate, lack of energy conservation mind set (lights on, TV on, computer on, etc.).
- **What does it tell us?** We need to be more energy conscious.
- **What can municipalities do?**
 - Develop planning approval processes that support energy efficient housing and use of renewable energy through site orientation (south facing, use of trees for shade/wind breaks), technology readiness standards (so solar can be installed after construction);
 - Consider differential permit pricing that better reflects the full cost of housing that makes use of existing infrastructure versus requiring new infrastructure;
 - Invest in community energy systems that heat and cool multiple buildings from a central source;

- Work with community groups and other orders of government to promote energy efficient audits and retrofits of homes;
- Enforce existing and R2000 building codes; and
- Educate citizens on options for cutting energy use and the effect of over consumption on the environment and their health.

Energy Source The carbon intensity (carbon output per energy unit) of energy sources has a significant influence on the overall energy footprint. For example the carbon intensity of coal and oil is higher than natural gas. In fact, energy derived from hydroelectric power** or renewable energy sources such as solar or wind power generate negligible to no CO₂ emissions.

- **What drives it?** Sources of energy
- **What does it tell us?** We need to shift toward renewable energy sources and sources of energy with lower carbon intensity rates.
- **What can municipalities do?**
 - Commit to purchasing up to 20 per cent of electricity for municipal operations from “green” power;
 - Invest in community energy systems utilizing renewable energy – biomass, solar thermal for example;
 - Develop a community energy plan that includes development of renewable energy industries as a community economic development strategy;
 - Commit to demonstrating renewable energy technologies on municipal buildings;
 - Facilitate through planning and permitting processes the use of renewable energy throughout the community; and
 - Commit to using alternative biofuels in municipal fleets.

Reduce household footprints

Food consumption makes up 19% of the ecological footprint. This includes the pasture footprint plus the portion of the crop footprint that goes to food production. Purchasing locally produced food is the most significant way to reduce the food footprint. Buying locally also helps support local businesses and maintains a diverse economic system. It also helps build stronger relationships between the suppliers of goods and services, which are local, and the households and businesses that consume them. A sustainable city strategy might explore urban agriculture options, promote and support local farmers and organic food production and educate community members about healthy eating and the environmental impacts of different food groups.

- **What drives it?** High food consumption, large amount of meat consumption, high amount of exotic food consumption, consumption of food imported from large distances.
- **What does it tell us?** We need to develop more conscientious eating habits and in many cases eat less.
- **What can municipalities do?**
 - Support the development of local farmers markets through municipal procurement policies; and
 - Encourage urban agriculture and organic farming through community initiatives.

** A question that has not been adequately addressed in ecological footprint calculations is how much methane gas emissions result from hydro facilities (dams, reservoirs). This is an area for further study to advance ecological footprint calculations and theory.

10. Using ecological footprint analysis in Canadian communities

Ecological footprint analysis is a powerful and appealing tool for communicating the sustainability of Canadian households and communities, by quantifying our demands on nature's capital in relationship with nature's capacity to supply a steady stream of goods and services, and in a way that makes sense to people. Because it allows for aggregated accounting of the real energy, food, clothing, real estate, infrastructure demands on nature's goods and services, it can engage both households and municipal governments in making lifestyle and public policy changes towards sustainability objectives. While it is by no means a perfect measurement tool, the ecological footprint provides an important starting point for accounting and communicating on the sustainability of Canadian lifestyles at the individual, municipal, regional, provincial/territorial or national scale.

Footprint analysis allows policy makers to examine the relative impact of different resource development and trade policy options regarding food, energy, and transportation at a local, provincial/territorial and national level. At the individual or national level, footprint analysis would give new meaning to the adage "think globally, act locally." Citizens would be equipped with powerful evidence of the size and potential distributional impact of their consumption patterns and footprint on their neighbours in Southeast Asia, Latin America, China, India or Germany. Acting locally would mean consciously reducing our footprint in Vancouver, Edmonton, Regina, Toronto, or Halifax by carefully examining our lifestyle choices and finding ways to reduce our consumption of ecological capital and thus provide more breathing room for other global citizens.

The Ecological Footprint has been used worldwide for a variety of purposes:

- The City of Petaluma and Carollo engineers used the ecological footprint as one of their main criteria in selecting a sewage treatment option for Petaluma's new facility.
- Several Swiss banks use the ecological footprint as part of their analysis of countries' credit worthiness.
- Researchers are working with some progressive businesses to develop an industrial ecological footprint accounting tool for measuring corporate sustainability.
- The National Assembly for Wales, a newly formed government, chose the ecological footprint as its headline indicator for measuring progress.
- The City of Santa Monica has chosen the ecological footprint as one of its key sustainability indicators.

Footprint analysis offers an exciting opportunity to engage citizens in a dialogue about what contributes to our large ecological footprint and how small lifestyle choices, like taking public transit, living walking distance from work, telecommuting (rather than using air travel), and buying locally can dramatically reduce our individual and collective footprint. It is this citizen engagement that is so important to gaining support for the policy changes municipal governments could make in support of sustainable community development. Footprint analysis begs the lifestyle question, "What can I do to live and act within the interests of nature?" and "How can I do my bit for sustainability?" What is exciting is that this empowers the individual or household with information about our lifestyle so that individuals are free to make daily choices that will lead to community sustainability

and improved quality of life. One can imagine either a regular audit or self-administered analysis of household ecological footprints of Canadians with a competition for reducing ecological footprints, with tax credit incentives tied to ecological dividends (e.g., carbon credits) based on ecological footprint reduction.

Ecological footprint analysis is by no means a simple solution or panacea to solving the world's ecological problems. There is room for continuous improvement in accounting for the actual physical demands on nature in terms of natural resources and ecological services. Evidence revealed in such analysis can only inform decision-making and stimulate debate among citizens. An individual or societal ecological footprint threshold is not something that can be imposed or regulated, per se. Ultimately, individuals should be free to make informed decisions about their consumption choices and be free to exercise the power of their disposable income. At the very least, ecological footprint analysis at the individual or societal level would provide all Canadians with an "ecological reality check" and leave us asking ourselves "What can I do today to reduce my footprint?" People who are free to choose how they exercise their spending power could then consciously select consumer goods with lower ecological footprints and items that support local sustainability. Making a more informed and conscious decision to act locally, conscious of the well-being of the global common good, will lead to the desired goal of a more sustainable future.

11. Recommendations

The ecological footprint not only offers a baseline index or measure of sustainability but also can be used as a tool to promote, track, motivate, and guide a municipality towards becoming a sustainable community. The following are recommendations as to how the ecological footprint can serve the Federation of Canadian Municipalities, individual communities. Included are suggestions for improvements to the ecological footprint methodology.

Recommendations to FCM

- Educate members on the ecological footprint results in this report.
- Encourage FCM members to use the ecological footprint analysis as a means to engage citizens in sustainable community development.
- Track the ecological footprint annually or bi-annually to measure a community's progress.
- Use the ecological footprint as a tool to evaluate community-funding proposals.
- Award sustainability grants based on progress in lowering ecological footprints.
- Explore the use of the EFA in conjunction with other environmental indicators in the Quality of Life Reporting System that can provide a comprehensive portrait of municipal/community sustainability.

Recommendation to municipalities and communities

- Consider using the EFA as one means of measuring and reporting the overall sustainability of your municipality or community. In combination with other tools like lifecycle assessment and environmental management systems, use the EFA to communicate progress towards a variety of sustainable community objectives that may include:
 - Sustainable and energy efficient transportation/transit systems;
 - Green/sustainable building design;
 - Greening of infrastructure (e.g., solid waste, waste water, and water systems).
- Consider using the EFA to communicate urban sprawl impacts.
- Develop a sustainability community development.
- Adopt green procurement policies, including green power, in support of sustainable community development objectives.

- Encourage full-cost pricing particularly for water and waste services to encourage conservation.
- Encourage or mandate renewable energy infrastructure investment by households and businesses through building codes and permitting, municipal showcasing and procurement.
- Support community gardens, and protect urban green-space.
- Encourage community members to calculate their ecological footprint on a regular basis. Household ecological footprint calculators can be found on the Internet. Redefining Progress www.rprogress.org and Mountain Equipment Co-op www.mec.ca have good calculators available at their websites.
- Promote programs that help community members reduce their ecological footprint. Examples include home energy audits, commute to work by public transit or bicycling initiatives, and programs that support local farmers, farmers markets, and organic food growers.
- Put ecological footprint estimates on household and business utility bills.

Recommendations on improving the ecological footprint as a tool for municipalities

- Encourage municipalities to track and report energy consumption data as well as material, goods and services “trade” or flows in and out of their municipal districts.
- Lobby Statistics Canada to report summary household expenditure data for all municipalities.
- Lobby Statistics Canada to develop an input-output material and energy flow tracking system at the provincial level.
- Lobby Environment Canada and Statistics Canada to use and support the ecological footprint as a benchmark measure of sustainability for all Canadian communities. A common calculation method to ensure compatibility is needed to make results meaningful.

12. Resources

The following resources are a good starting point for more information about the ecological footprint.

- The Ecological Footprint Network, <http://www.ecofoot.net/>
An excellent resource site. The Network was recently founded by Dr. Mathis Wackernagel, a network of organizations, government bodies, researchers, and practitioners, whose vision is to transform the ecological footprint into a vocal and rigorous measure of our demand on nature.
- Redefining Progress, www.rprogress.org
Click on “Ecological Footprint” under projects on the on-line menu bar. This is an excellent starting point for general information about the ecological footprint and access to other ecological footprint sources. *The Sonoma County Ecological Footprint Report* and *The Living Planet Report 2002* referenced in this report are accessible at this site.
- International Council of Local Environmental Initiatives (ICLEI), www.iclei.org
This website is a good source for sample ecological footprint calculations and access to ecological footprint publications.

- Wackernagel, Mathis and William E. Rees. 1996. *Our Ecological Footprint: Reducing Human Impact on the Earth*. New Society Publishers, Gabriola Island, BC.
Wackernagel and Rees developed the ecological footprint and first presented their pioneering results in this book. A great background read for anyone interested in the ecological footprint.
- Chambers, Nicky, Craig Simmons, and Mathis Wackernagel. 2000. *Sharing Nature's Interest: Ecological Footprints as an Indicator of Sustainability*. Earthscan Publishers.
Sharing Nature's Interest develops the ideas first presented in *Our Ecological Footprint: Reducing Human Impact on the Earth* and provides examples of where and how the ecological footprint has been successfully applied.
- Wackernagel, Mathis. 1998. "The Ecological Footprint of Santiago de Chile", *Local Environment*; 3 (2):16.
"The Ecological Footprint of Santiago de Chile" was the first published ecological footprint report using a top down calculation approach. *The Sonoma County Ecological Footprint Report* available at the Redefining Progress Web-Site (see first bullet) also uses this type of approach.
- David Suzuki Foundation. 2003. *The Green Guide to David Suzuki's Nature Challenge*, www.davidsuzuki.org/files/WOL/GreenGuide.pdf.
Suzuki's green guide is a well documented guide of strategies to reduce your impact on the environment and subsequently your ecological footprint.
- Household ecological footprint calculators are available at the Redefining Progress www.rprogress.org and Mountain Equipment Co-op www.mec.ca web sites.

Books and major reports⁵⁸

Sturm, Andreas, Mathis Wackernagel and Kaspar Müller. 2000. *The Winners and Losers in Global Competition: Why Eco-efficiency Reinforces Competitiveness: A Study of 44 Nations*, Rüegger, Chur/Zürich. (<http://www.rueggerverlag.ch>).

World-Wide Fund for Nature International (WWF), UNEP World Conservation Monitoring Centre, Redefining Progress, Center for Sustainability Studies, 2002, *Living Planet Report 2002*, WWF, Gland, Switzerland.
(http://www.panda.org/news_facts/publications/general/livingplanet/index.cfm, *Living Planet Report 2000* also contains footprints, but the 2002 report is built on the more comprehensive current methodology. Also available in French (<http://www.wwf.fr>). Translations of text available at <http://www.panda.org>.

Jim Merkel. 2003. *Radical Simplicity - Small Footprints on a Finite Earth*. New Society Publishers, Gabriola Island, BC. <http://www.globallivingproject.org/book.html>

Other reports and papers available over the web

Wackernagel, Mathis, Chad Monfreda, and Diana Deumling. 2002. "Ecological Footprint of Nations - November 2002 Update: How Much Nature Do They Use? How Much Nature Do They Have?" Redefining Progress, CA,

http://www.redefiningprogress.org/media/releases/021125_efnations.html

Wackernagel, Mathis, Niels B. Schulz, Diana Deumling, Alejandro Callejas Linares, Martin Jenkins, Valerie Kapos, Chad Monfreda, Jonathan Loh, Norman Myers, Richard Norgaard, and Jørgen Randers. 2002. "Tracking the ecological overshoot of the human economy," Proc. Natl. Acad. Sci. USA, 99(14): 9266-9271, July 9, 2002 <http://www.pnas.org> or for direct access to abstract <http://www.pnas.org/cgi/content/abstract/142033699v1> This web page has also a link to the calculation sheets backing up the paper.

Wackernagel, M. 2001. "Advancing Sustainable Resource Management: Using Ecological Footprint Analysis for Problem Formulation, Policy Development, and Communication," Prepared for DGXI, European Commission, Redefining Progress, Oakland.

<http://europa.eu.int/comm/environment/enveco/studies2.htm#26>

Directorate General for Research, Division Industry, Research, Energy, Environment, and Scientific and Technological Options Assessment (STOA). 2001. Ecological Footprinting, commissioned by the European Parliament, http://www.europarl.eu.int/stoa/publi/pdf/00-09-03_en.pdf

Sustainable Sonoma County with Redefining Progress. 2002. Time to Lighten Up? Report on the Sonoma County Footprint Project, Sustainable Sonoma County, Sebastopol, CA,

<http://www.sustainablesonoma.org/projects/scefootprint.html> or directly at

<http://www.sustainablesonoma.org/projects/footprintreport/scfpweb.pdf>

"Ecological Footprint Accounts: Moving Sustainability from Concept to Measurable Goal," 4-pager, Redefining Progress, CA. 2002. (<http://redefiningprogress.org/programs/sustainability/indicators/education/edParentMateria>)

"Your Ecological Footprint: Moving Sustainability from Abstract Concept to Concrete Goal." 2002. Handout for the World Summit on Sustainable Development (WSSD) Johannesburg, Redefining Progress, CA, World Wide Fund for Nature International, Switzerland, Earth Day Network, U.S. http://www.redefiningprogress.org/publications/wssd_brochure.pdf

Wackernagel, Mathis, Chad Monfreda, and Diana Deumling. 2002. "Ecological Footprint of Nations - November 2002 Update: How Much Nature Do They Use? How Much Nature Do They Have?" Redefining Progress, CA,

http://www.redefiningprogress.org/media/releases/021125_efnations.html

Redefining Progress and Earth Day Network. 2002. Sustainability Starts in Your Community A Community Indicators Guide, Redefining Progress and Earth Day Network

<http://www.redefiningprogress.org/publications/ciguide.pdf>

"State of Denial," building on the Ecological Footprint, shows how "California's environmental legacy of conserving resources at home is on a collision course with its habit of consuming them in record quantities from abroad. And often the losers are impoverished citizens and communities – and spectacular ecosystems – in remote parts of the globe." This remarkable report was written by Tom Knudson, a journalist adorned with two (!) Pulitzer prizes.

<http://www.sacbee.com/static/live/news/projects/denial>

Links to ecological footprint work

Calculate your own footprint from Earth Day Network and Redefining Progress:

<http://Myfootprint.org>

Earth Day Network's Ecological Footprint site:

<http://www.earthday.net/goals/footprint.stm>

WWF-The Conservation Organization (World-Wide Fund for Nature International):

http://www.panda.org/news_facts/publications/general/livingplanet/index.cfm

Redefining Progress provides information about the method, links to studies, calculation spreadsheets, frequently asked questions, and plenty more:

<http://www.rprogress.org/programs/sustainability/ef/>

Van Hall Institute in Holland has supported various footprint campaigns:

<http://www.voetenbank.nl>

The Global Living Project (GLP) has used the Ecological Footprint to find ways for living equitably and harmoniously within the means of nature:

<http://www.globallivingproject.org> Jim Merkel from the GLP recently published *Radical Simplicity - Small Footprints on a Finite Earth*, which applies footprinting to people's choices. New Society Publications, September, 2003.

Best Foot Forward (UK) is a leading UK consultancy on footprinting:

<http://www.bestfootforward.com> This site has a link to a footprint discussion group, where people may help you with questions.

For a survey of educational initiatives advancing sustainability and ecological footprints thinking:

<http://www.redefiningprogress.org/programs/sustainabilityindicators/education/edParentMaterials.html>

World-Wide Fund for Nature (France):

http://www.wwf.fr/empreinte_ecologique/index.htm or

http://www.wwf.fr/developpement_durable/missions.php?mission_id=34

The initiatives of World-Wide Fund for Nature (UK) are summarized in:

<http://www.wwf.org.uk/filelibrary/pdf/ecofootscotland.pdf>. WWF-UK has a number of reports out including <http://www.wwf.org.uk/filelibrary/pdf/thamesgateway.pdf>, or http://www.wwf.org.uk/News/n_0000000921.asp

World-Wide Fund for Nature (Switzerland):

<http://www.footprint.ch> /In French, German, and Italian.

WWF Italy has been a long-time supporter of ecological footprinting (contact – Gianfranco Bologna):

http://www.wwf.it/news/872002_3490.asp

Stockholm Environment Institute – York (UK):

<http://www.york.ac.uk/inst/sci/IS/sustain.html>

Sustainable Sonoma County (California):

<http://www.sustainablesonoma.org/projects/scefootprint.html>

Get inspired by the Blue Planet Footprint Campaign:

<http://www.globalchange.at> (In German and English)

EPA Victoria, Australia:

<http://www.epa.vic.gov.au/eco-footprint> EPA Victoria is the lead government agency responsible for enhancing the quality of Victoria's environment. EPA has established a series of pilots in partnership with a wide range of organizations and businesses to further investigate the practical applications of the ecological footprint as a communications tool to promote sustainability.

Urban Ecology Australia <http://www.urbanecology.org.au/articles> Sharon Ede looks at sustainability, food systems and the ecological footprint.

ICLEI International Council for Local Environmental Initiatives:

<http://www.iclei.org/ICLEI/ecofoot.htm>

City Limits London. A resource flow and ecological footprint analysis of Greater London:

<http://www.citylimitslondon.com>

Ambiente Italia. Impronta Ecologica della città di Torino (.zip -450Kb):

<http://www.provincia.torino.it/ambiente/file-storage/download/Agenda21/pdf/impronta.pdf>

The 2001 United Nations FPA report on the state of world population builds on Ecological Footprint concepts:

<http://www.unfpa.org/swp/2001/english/>

A Belgian social justice and international development organization, Broederlijk Delen, used the Ecological Footprint as the core theme of their 2002 campaign on sustainable development:

<http://www.broederlijkdelen.be/>

City of Toronto. The Ecological Footprint Questionnaire Pilot Study:

<http://www.city.toronto.on.ca/energy/footprint.htm>

University of Texas (Austin):

<http://www.sbs.utexas.edu/resource/WhatIs/ecofootprint.htm> by Prof. Dick Richardson

IFF Social Ecology Vienna – University of Vienna, Helmut Haberl, Karl-Heinz Erb, and Niels Schulz: http://www.iff.ac.at/socec/publs_en.php

Centro de Estudios para la Sustentabilidad / Centre for Sustainability Studies, Mexico:

<http://www.sustentabilidad.org>

Earth Council. Footprint of Nations study for Rio+5 Forum 1997:

<http://www.ecouncil.ac.cr/rio/focus/report/english/footprint>

De kleine Aarde has been running a number of footprint campaigns (contact – Jan Jufferman):

http://www.dekleineaarde.nl/text/3_1.htm

Carl Folke et al at the Beijer Institute and Systems Ecology of Stockholm University has been involved in a number of city footprint studies and applications to fisheries:

<http://www.beijer.kva.se/publications/pdf-archive/Disc150.pdf>

Carl Nordlund developed a footprint calculator based on Wackernagel's conversion factors:

<http://www.demesta.com/ecofoot/>

The Pembina Institute for Appropriate Development (Alberta) has estimated the ecological footprint of Alberta and the cities of Edmonton and Calgary – Mark Anielski and Jeff Wilson.

http://www.pembina.org/publications_display.asp?category=3

GPI Atlantic has analyzed the footprints of Canadian provinces – Ron Colman:

<http://www.gpiatlantic.org/publications/abstracts/ecofootprint-ab.shtml>

Rete Lilliput has promoted footprints and organized footprint weeks through their Social and Ecological Footprint group (contact: Roberto Brambilla):

<http://www.retelilliput.net/Gruppi/GLTIES/>

Instituto de Ecología Política has conducted a number of footprint studies (within ecological Economics: Dr. Bernardo Reyes):

<http://www.iepe.org/>

National Institute of Public Health and the Environment (RIVM) – Netherlands has been a leader in Footprint research (contact: Dr. Detlef van Vuuren), for instance:

<http://www.rivm.nl/bibliotheek/rapporten/807005004.html>

Appendix 1: About the Authors

Jeffrey Wilson is an Associate of Anielski Management Inc, a freelance researcher and expert in ecological footprint analysis. In 2001 he worked with a team of researchers in developing the prototype sustainability accounting system — the Alberta Genuine Progress Indicator (GPI) Sustainable Well-being Accounting System — with the Pembina Institute for Appropriate Development under the leadership of Mark Anielski, past-Director of Sustainability Measurement at the Pembina Institute. His work on the Alberta ecological footprint advanced the art and science of ecological footprint analysis. Before joining AMI, Jeff worked with the Nova Scotia Genuine Progress Index (GPI) Atlantic to develop measurements of well-being and community sustainability. While at GPI Atlantic he authored the Nova Scotia Ecological Footprint report and collaborated on two Nova Scotia community-based GPI projects. In addition, Jeff has spent time in the United States doing alternative energy research and advocacy. Jeff holds an Honours Bachelor of Environmental Studies degree from the University of Waterloo.

Mark Anielski is a genuine wealth economist, President and CEO of AMI , Anielski Management Inc., a consulting practice that provides strategic counsel on sustainability performance measurement to communities, business and governments. Mark is also an Adjunct Professor of Ecological Economics at the newly established Bainbridge Graduate Institute (Washington) — the first sustainability MBA program in U.S. whose goal is to "integrate the wisdom of sustainability, ethics, and social responsibility into business practice via management education and research, business sustainability, ethics and corporate social responsibility". Mark is also an Adjunct Professor in Corporate Social Responsibility and Social Entrepreneurship at the University of Alberta, School of Business. He holds a Masters degree in forest economics and two bachelor degrees — one in economics and a second in forestry, from the University of Alberta. Mr. Anielski serves as a Senior Fellow with the Oakland-based economic policy think-tank, Redefining Progress. He is the current President of the Canadian Society for Ecological Economics (CANSEE) and a founding Board member of the International Sustainability Indicators Network (ISIN).

¹ Source of quote: Ecological Footprint Network <http://www.ecofoot.net/>

² Holmberg, J., Lundqvist, U., Robert, K-H, and Wackernagel, M. 1999. "The Ecological Footprint from a Systems Perspective of Sustainability." *International Journal of Sustainable Development and World Ecology* 6:17-33.

³ Source: Ecological Footprint Network <http://www.ecofoot.net/>

⁴ Holmberg, J., Lindqvist, U., Robert, K-H, and Wackernagel, M. 1999. "The Ecological Footprint from a Systems Perspective of Sustainability." *International Journal of Sustainable Development and World Ecology* 6:17-33.

⁵ Lester R. Brown, former Chairman of the Board of World Watch Institute (Washington, D.C.) whose commentary appeared on the jacket of *Sharing Nature's Interest: Ecological Footprints as an Indicator of Sustainability* (2000) by Nicky Chambers, Craig Simmons, and Mathis Wackernagel.

⁶ Redefining Progress, 2003. *Accelerating Sustainability with Local Footprints*, Sustainability Program Ecological Footprint Accounts.

⁷ Chambers, Nicky, Craig Simmons, and Mathis Wackernagel. 2000. *Sharing Nature's Interest: Ecological Footprints as an Indicator of Sustainability*. Earthscan Publishers, p. 31.

⁸ WWF International (www.panda.org), Redefining Progress (www.rprogress.org), UNEP-WCMC (www.unep-wcmc.org), Center for Sustainability Studies (www.sustentabilidad.org). 2000. *The Living Planet Report 2000*, available at (www.panda.org) or (www.rprogress.org).

⁹ Mathis Wackernagel, Larry Onisto, Alejandro Callejas Linares, Ina Susana López Falfán, Jesus Méndez García, Ana Isabel Suárez Guerrero, Ma. Guadalupe Suárez Guerrero. 1997. *Ecological Footprints of Nations: How Much Nature Do They Use? How Much Nature Do They Have?* Commissioned by the Earth Council for the Rio+5 Forum. International Council for Local Environmental Initiatives, Toronto.

¹⁰ Mathis Wackernagel and William E. Rees. 1996. *Our Ecological Footprint: Reducing Human Impact on the Earth*. New Society Publishers, Gabriola Island, BC.

¹¹ Adapted from *Sonoma County Ecological Footprint Report*, p.2. Sustainable Sonoma County and Redefining Progress, May 2002. The *Sonoma County Ecological Footprint Report* is available at the Redefining Progress website www.rprogress.org.

¹² World Wide Fund for Nature. 2000. *Living Planet Report 2000*. October 2000. www.panda.org/livingplanet/lpr00/ecofoot.cfm accessed October 24, 2000.

¹³ World Wide Fund for Nature. 2000. *Living Planet Report 2000*. October 2000. www.redefiningprogress.org/ef/LPR2000/index.html

¹⁴ Rees, W. E. and M. Wackernagel. 1994. "Ecological Footprints and Appropriated Carrying Capacity: Measuring the Natural Capital Requirements of the Human Economy" in A-M Jansson, M. Hammer, C. Folke, and R. Costanza (eds.) *Investing in Natural Capital: The Ecological Economics Approach to Sustainability*, Washington, DC: Island Press, 1994: 362-390.

¹⁵ Sustainable Calgary. Ecological Footprint. <http://www.sustainablecalgary.ca/projects/ecofootprint/>

¹⁶ Living Planet Report. See <http://www.rprogress.org/programs/sustainability/ef/projects/lpr2000/>

¹⁷ This report is available at <http://panda.org/livingplanet/> or www.rprogress.org/ef/ The current ecological footprint methodology is based on the pioneering work of William Rees and Mathis Wackernagel of the University of British Columbia. Their ideas were widely introduced in their book *Our Ecological Footprint: Reducing Human Impact on The Environment*.

¹⁸ Sustainable Sonoma County and Redefining Progress, May 2002. *Sonoma County Ecological Footprint Report*. The report is available at the Redefining Progress website www.rprogress.org.

¹⁹ Sustainable Sonoma County and Redefining Progress, May 2002. *Sonoma County Ecological Footprint Report*. P. 5. The report is available at the Redefining Progress website www.rprogress.org

²⁰ The Canadian spreadsheets used in this report are available from Redefining Progress, www.rprogress.org.

²¹ This methodological explanation is based on similar explanations presented by Mathis Wackernagel. For a more in-depth methodological explanation see Mathis Wackernagel and William E. Rees, 1996. *Our Ecological Footprint: Reducing Human Impact on the Earth*. New Society Publishers, Gabriola Island, BC.

²² The Canadian ecological footprint used in this report is the most recent estimate available. This was provided to us by Redefining Progress. For detailed ecological footprint spreadsheets go to the Redefining Progress website at www.rprogress.org

²³ Based on a table presented in the *Sonoma County Ecological Footprint Report* entitled "Data Used to Adjust Footprint- 1999", p. 5. Sustainable Sonoma County and Redefining Progress, May 2002. Sonoma County Ecological Footprint Report. The report is available at the Redefining Progress website www.rprogress.org. See Appendix 1, for municipality summary sheets. The energy footprint for this report is largely derived from provincial energy use and consumption data.

²⁴ Sustainable Sonoma County and Redefining Progress, May 2002. *Sonoma County Ecological Footprint Report*. The report is available at the Redefining Progress website www.rprogress.org

²⁵ World Wide Fund for Nature. 2000. *Living Planet Report 2000*. October 2000
www.panda.org/livingplanet/lpr00/ecofoot.cfm accessed October 24, 2000.

²⁶ NRCAN, Office of Energy Efficiency, Energy Use Databases. Accessed Spring 2003. Available at www.oe.nrcan.gc.ca/neud/dpa/data_e/databases.cfm; Natural Resources Canada. Canada's Emissions Outlook: 1997-2020. "Electricity Demand and Supply", www.nrcan.gc.ca, December 1999.; Redefining Progress, ecological footprint by country reports 2002. Uses of carbon intensity rates include 2002 Living Planet report and 1999 Canada ecological footprint.; Statistics Canada, CANSIM II, table 203-0001. Canadian statistics, average household expenditures, provinces and territories.

²⁷ Based on definition by Redefining Progress, 2003. *Accelerating Sustainability with Local Footprints, Sustainability Program Ecological Footprint Accounts*.

²⁸ The energy footprint is broken down by sector based on total carbon intensity of energy sources using end use energy demand by sector and not by total GJ of energy sources using energy demand by sector. A breakdown of the energy footprint by total GJ demand would be residential energy footprint (18%), transportation energy footprint (25%), industrial footprint (44%), and commercial (13%).

²⁹ Inventory forest land includes land primarily intended for growing, or currently supporting forest. This includes productive forest land and reserved forest land not available by law for production. Timber productive forest land includes productive forest land available for growing and harvesting forest crops. The inventoried forest land presents only actual land area and not how much of the inventoried forest land is sequestering carbon from human-activities.

Natural Resources Canada, Compendium of Canadian Forestry Statistics. Available at the Statistics Canada website (www.statscan.ca) under Canadian Statistics.

³⁰ United Nations Environmental Program, 2002. *Global Environmental Outlook 3*. Data compiled from IEA sources, 1999.

³¹ WWF International (www.panda.org), Redefining Progress (www.rprogress.org), UNEP-WCMC (www.unep-wcmc.org), Center for Sustainability Studies (www.edg.net.mx/~mathisw), 2002. *The Living Planet Report 2002*, Available at <http://panda.org>

³² This does not specify the land productivity or the soil capability classification. Statistics Canada, 1991. *Dominant Economic Land Use Classes by Province and Territory, 1991*, Environment Accounts and Statistics Division. Moreover, these hectares have not been translated into global hectares and represent the actual area dedicated to agriculture land in Canada.

³³ New Zealand has the largest cropland footprint in the world. WWF International (www.panda.org), Redefining Progress (www.rprogress.org), UNEP-WCMC (www.unep-wcmc.org), Center for Sustainability Studies (www.sustentabilidad.org), 2002. *The Living Planet Report 2002*, Available at <http://panda.org>

³⁴ Toronto Food Policy Council. 1994. Health, Wealth and the Environment: the impact of the CUSTA, NAFTA, and GATT on Canadian food security, pp. 20-24.

³⁵ Chad Monfreda, June 2003. *Personal communication* (e-mail correspondence). For a more in-depth discussion of the un-harvested cropland footprint, please contact the authors of this report or Chad Monfreda of Redefining Progress.

³⁶ (0.93 hectares (un-harvested crop land) + 1.393 hectares (harvested crop land)) / 8.18 hectares.

³⁷ The land classification data does not specify the productivity of the pasture land. Statistics Canada, 1992. *Land Cover by Province and Territory, 1992*, Environment Accounts and Statistics Division.

³⁸ David Suzuki Foundation, 2003. The Green Guide to David Suzuki's Nature Challenge. Available at www.davidsuzuki.org/files/WOL/GreenGuide.pdf. According to the Green Guide, in 1999, the average Canadian consumed 275 grams of meat per day, 101 kg of meat per year.

³⁹ The 2002 *Living Planet Report* uses 1999 data. WWF International (www.panda.org), Redefining Progress (www.rprogress.org), UNEP-WCMC (www.unep-wcmc.org), Center for Sustainability Studies (www.edg.net.mx/~mathiswa), 2002. *The Living Planet Report 2002*, Available at <http://panda.org>.

⁴⁰ Direct fish and other marine products consumption data would be a better indicator but this is only available at the national level.

⁴¹ Inventory forestland includes land primarily intended for growing, or currently supporting forest and includes productive forestland and reserved forestland not available by law for production. Timber productive forestland includes productive forestland available for growing and harvesting forest crops. Natural Resources Canada, Compendium of Canadian Forestry Statistics. Available at the Statistics Canada website (www.statscan.ca) under Canadian Statistics.

⁴² Statistics Canada, 1996. *Urban Land Use by Province*, Environment Accounts and Statistics Division.

⁴³ WWF International (www.panda.org), Redefining Progress (www.rprogress.org), UNEP-WCMC (www.unep-wcmc.org), Center for Sustainability Studies (www.sustentabilidad.org), 2002. *The Living Planet Report 2002*, Available at <http://panda.org>.

⁴⁴ World averages and ranking are from the 2002 *Living Planet Report*. WWF International (www.panda.org), Redefining Progress (www.rprogress.org), UNEP-WCMC (www.unep-wcmc.org), Center for Sustainability Studies (www.sustentabilidad.org), 2002. *The Living Planet Report 2002*, Available at <http://panda.org>.

⁴⁵ The 2002 *Living Planet Report* provides the ecological footprint by component for all countries in the world with populations over 1 million.

⁴⁶ The 2002 *Living Planet Report* uses 1999 data. WWF International (www.panda.org), Redefining Progress (www.rprogress.org), UNEP-WCMC (www.unep-wcmc.org), Center for Sustainability Studies (www.sustentabilidad.org), 2002. *The Living Planet Report 2002*, Available at <http://panda.org>.

⁴⁷ The Brundtland Commission recommended that we set aside 12% of the bioproductive area in the world for biodiversity preservation. The exact amount of land needed to preserve biodiversity is an issue of contention but the general consensus in the literature is that 12% would be a bare minimum and a more realistic figure would be 30%.

⁴⁸ Total population (1996) for countries with an ecological footprint of 1.9 ha or less = 4.0 billion. Total population (1996) for countries with an ecological footprint greater than 1.9 h = 1.8 billion. Estimates derived from Living Planet Report 2000 data tables. See endnote 1.

⁴⁹ WWF International (www.panda.org), Redefining Progress (www.rprogress.org), UNEP-WCMC (www.unep-wcmc.org), Center for Sustainability Studies (www.sustentabilidad.org), 2002. *The Living Planet Report 2002*, Available at <http://panda.org>.

⁵⁰ Globally, approximately 11.4 billion hectares (25% of the earth's surface) are biologically productive. The remaining three-quarters include deserts, ice caps, and deep-oceans that support minimal (if any) bio-productivity. Canadian biocapacity therefore includes only those areas that can support bio-productivity. Idem.

⁵¹ See section, Ecological Footprint Components for land areas in total amounts and sources.

⁵² Rees, William, 1997. "Is Sustainable City an Oxymoron?" *Local Environment*, volume 2: 303-310, 1997.

⁵³ Mathis Wackernagel, Larry Onisto, Patricia Bello, Alejandro Callejas Linares, Ina Susana López Falfán, Jesus Méndez García, Ana Isabel Suárez Guerrero and Ma. Guadalupe Suárez Guerrero, "National Natural Capital Accounting with the Ecological Footprint Concept." *Ecological Economics*, Vol. 29 No. 3, June 1999.

⁵⁴ Rees, William. 2000. Personal Communication concerning recommendations on the Alberta GPI methodology. The *Alberta Ecological Footprint* was part of the Alberta GPI report (2001) published by The Pembina Institute.

⁵⁵ Greater Sudbury, Niagara RM, Quebec, London, Kingston, Winnipeg, have lower footprints but all fall within 6% of the Canadian average.

⁵⁶ Deutsch, L., A. Jansson, M. Troell, P. Rönnbäck, C. Folke, and N. Kautsky. "The 'ecological footprint': communicating human dependence on nature's work. Commentary Forum: the Ecological Footprint in *Ecological Economics* 32 (2000): 351-355.

⁵⁷ Deutsch et al. note that EF methodology provides only a snapshot of the demand for nature's services by people. Deutsch et al. take an intuitively attractive approach to accounting for the biophysical services appropriated annually from ecosystems by an average person for their social and economic well being. The services they track are for timber and terrestrial food production, which includes the storage of carbon, phosphorous and nitrogen as well as the freshwater requirements needed to generate these services.

⁵⁸ These resources (books, major papers and other links) are from The Ecological Footprint Network website <http://www.ecofoot.net/>