



The Alberta GPI Accounts: Ecological Footprint

Report # 28

by

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About this Report

This is one of 28 reports that provide the background for the Genuine Progress Indicators (GPI) System of Sustainable Well-being Accounts. It provides more detail on the Alberta ecological footprint analysis that was earlier published in "*Sustainability Trends 2000: The Genuine Progress Statement for Alberta, 1961 to 1999.*" The research for this report was completed near the end of 2000. The appendices provide further background and explanation of our methodology; additional details can be obtained by contacting the authors. Appendix A includes a list of all GPI background reports. This report answers the following questions:

- 1) What is the ecological footprint of Albertans?
- 2) How has the ecological footprint changed since 1961 in Alberta?
- 3) How does Alberta's per person ecological footprint compare with Canada's and those of other regions of the world?
- 4) What are the major contributors to Alberta's ecological footprint?
- 5) How do the ecological footprints of those in different income brackets compare?
- 6) How do the per-person ecological footprints for Edmonton and Calgary differ from each other and from the provincial average?
- 7) What is the forecasted ecological footprint change in Alberta and Canada during the next 20 years?
- 8) What is the correlation between Alberta's ecological footprint and consumption?
- 9) How can the ecological footprint be applied to create a more sustainable Alberta?

About the Author

Jeffrey Wilson joined the Alberta GPI as a guest contributor and researcher. His work on the Alberta ecological footprint is part of his overall goal to establish a regional ecological footprint framework to promote healthy sustainable Canadian communities. Jeff is currently working with the Nova Scotia Genuine Progress Index Atlantic to develop measurements of well-being and community sustainability. He has recently released the Nova Scotia Ecological Footprint and is collaborating on two Nova Scotia community-based ecological footprint 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.

Acknowledgements and Disclaimer

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In addition, we thank Kim Sanderson for her editing assistance. Finally, the Pembina Institute appreciates the vision of Western Economic Diversification in supporting this project—the first of its kind for Alberta, if not internationally.

The contents of this report are the responsibility of the Pembina Institute and do not necessarily reflect the views and opinions of those who are acknowledged above or the opinions or positions of Western Economic Diversification.

We have made every effort to ensure the accuracy of the information contained in this document at the time of writing. However, the author advises he cannot guarantee that the information provided is complete or accurate and that any person relying on this publication does so at their own risk. Given the broad scope of the project and time constraints, it has not been possible to submit the entire report for peer review. The material should thus be viewed as preliminary and we welcome suggestions for improvements that can be incorporated in any later edition of the work.

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1. Executive Summary

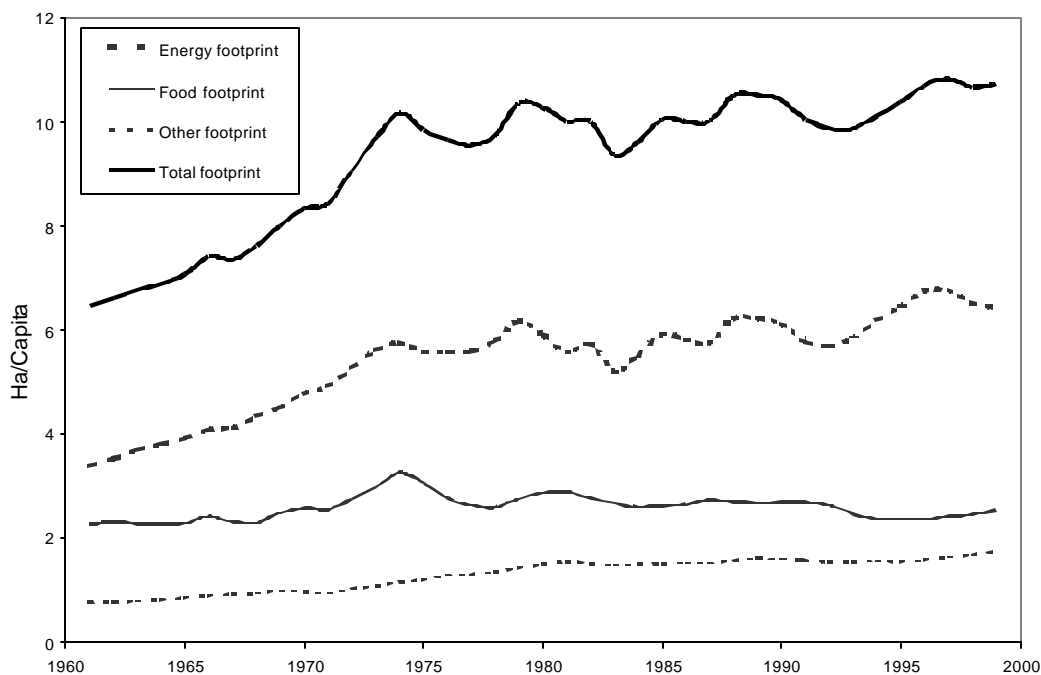
Alberta's Ecological Footprint: How Big?

Keeping humanity's footprint within the planet's biocapacity is a minimum requirement for sustainability. The ecological footprint measures the extent to which the biosphere is overburdened by human activities. Between 1961 and 1999, Alberta's ecological footprint grew by 66 percent—increasing from 6.5 hectares per person to 10.7 hectares per person, over five times the global ecological carrying capacity of 1.8 hectares per person. The Alberta ecological footprint peaked in 1997 at 10.8 hectares per person, of which the energy footprint made up over 60 percent. During the late 1970s and early 1980s Alberta's ecological footprint decreased marginally due to improved energy efficiency. Increased consumption of energy and consumer goods in the 1990s, however, has outstripped energy efficiency gains. Alberta's ecological footprint is forecast to reach 15 hectares per person by 2020, over eight times the global ecological capacity. If the entire world had an ecological footprint as large as the average Albertan, five planets would be needed to meet consumption demands.

Noteworthy

- The Alberta ecological footprint increased 66% between 1961 and 1999.
- Albertans are consuming at a rate over four times greater than what is sustainable from a global perspective.
- If the entire world had an ecological footprint as large as the average Albertan, five planets would be needed to meet consumption demands.
- Albertans' present footprint of 10.7 ha/person ranks fourth highest among average per person footprints of countries in the world.
- The Alberta ecological footprint is 37% larger than the Canadian ecological footprint.
- Albertans in the top income quintile have an ecological footprint almost 50% larger than the provincial average and 200% larger than Albertans in the lowest income quintile.

The Alberta Ecological Footprint, 1961 to 1999



Changes in Alberta's ecological footprint size from 1961 to 1999

- Energy Footprint + 89%
- Food Footprint + 12%
- Other Footprint + 126%
- Ecological Footprint + 66%

So What?

Ecological footprint analysis (EFA) gives policy makers and citizens information about the impacts of their consumption behaviour on ecological integrity and sustainability. EFA complements the other indicators of the GPI accounts by providing a benchmark of sustainability to guide policy decisions and personal lifestyle choices that address Alberta's sustainable well-being from a global perspective. If local gains in natural, economic, or social capital come at the expense of accelerating ecological damage and social disintegration elsewhere, then local prosperity comes with a cost to global sustainability. The ecological footprint addresses the impact of our consumption locally in Alberta and provides a more complete global picture of the consequences of our consumption habits and demands.

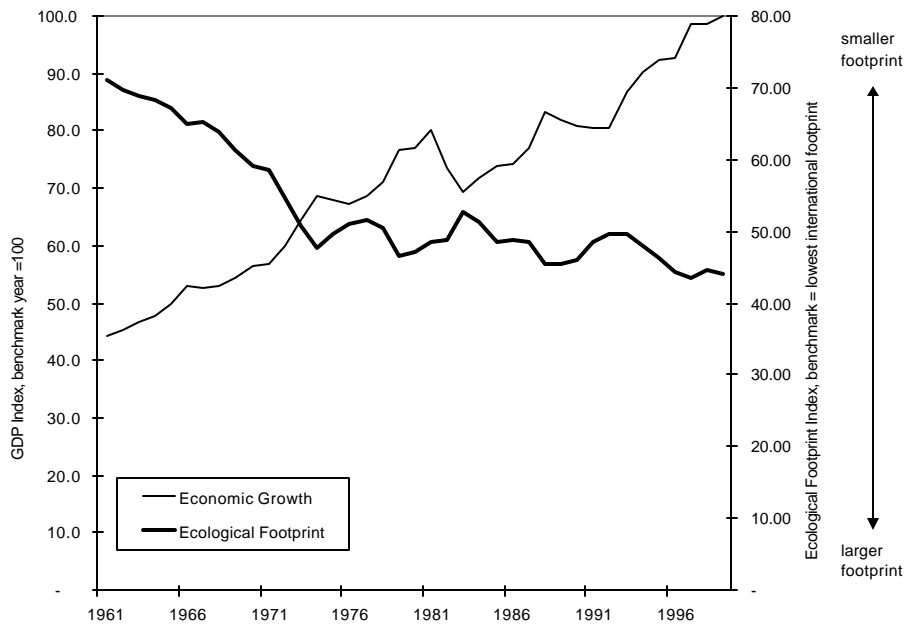
If EF analysis and audits were incorporated into the public policy and budgeting processes, they could have profound implications for households, businesses and governments. For example, trade and foreign policy could consider both interregional and transnational impacts of import and export policies that impose ecological deficits on other citizens and ecosystems, depleting natural and human capital in one region to feed consumption demands in Alberta or Canada. This would give a whole new perspective on the full impacts of globalization and free trade.

Footprint analysis also empowers individual citizens to engage in a dialogue, based on EF evidence, about changing personal lifestyle choices to ensure a sustainable future for Albertans and for citizens of the global community. For example, Albertans' relatively large ecological footprint could be reduced if people chose to travel less, take public transit, walk or cycle to work, or buy local produce, goods and services. EFA provides an "ecological reality check" that leads to a fundamental personal examination of "what can I do today to reduce my footprint?"

The figure below shows the ecological footprint and GDP in Alberta as indices. In the index, an ecological footprint of 1.8 hectares per person* is set equal to 100, and deviations from that benchmark are measured as movement towards zero. Thus, as the ecological footprint increases relative to the benchmark of 1.8 ha per person, the index moves toward zero. While Alberta has boasted a steady increase in provincial GDP over the study period, the ecological footprint index has decreased, indicating a larger Alberta ecological footprint.

* 1.8 ha per person is the amount of biocapacity or footprint space available per person if we take all the global biocapacity and divide by the global population. One hectare equals 2.47 acres.

GDP and Ecological Footprint for Alberta as Indices, 1961 to 1999



2. What is ecological footprint analysis?

Ecological footprint analysis measures the pressure or human load on the earth resulting from humanity's natural resource consumption and waste generation. It does this by measuring how much of nature people use today to sustain themselves. Ecological footprint calculations are based on two simple facts: first, most of the resources we consume and much of the waste we generate can be accounted for; secondly, we can convert resource consumption and waste generation into the biologically productive area necessary to meet our consumption needs.

"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 any defined population (a single person, household, province, country) is the biologically productive area required to produce the food, wood 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.* 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.^{1,2,3}

* This means that land with higher than average productivities would appear larger in footprint accounts. The same is done on the capacity side when a region or nation's ecological capacity to accommodate footprints is analyzed.

Current ecological footprint estimates err on the conservative side. Cautious figures have been consistently used; areas for the protection and treatment of water have not been included; and areas for the absorption of wastes, pollutants and toxic materials, with the exception of carbon dioxide, have been omitted. In addition, the probability that chemical pesticide and fertilizer use, soil compaction, clearcutting and other non-sustainable harvesting practices will reduce future soil productivity have not been considered. The current biological productivity of a given piece of land is assumed to continue into the future.

3. Methodology

The Alberta ecological footprint is based on the methodology developed by William Rees and Mathis Wackernagel of the University of British Columbia in their book *Our Ecological Footprint: Reducing Human Impact on The Environment*⁴ and, more specifically, on the results presented in Wackernagel's 1996 Canadian Ecological Footprint estimate. His 1996 ecological footprint update was part of the *Living Planet Report* published by the World Wide Fund For Nature.⁵ Calculations for the Alberta footprint were undertaken using the same categories of material flows as used in the Ecological Footprints calculated for the "Living Planet Index" report.

As the data to directly calculate the ecological footprint at the provincial level were not available, the Alberta footprint was calculated by adjusting the footprint area for differences in consumption patterns between Alberta and Canada.⁶ These adjustments rely on Statistics Canada data, including data from "Food Expenditure Surveys", "Family Expenditure Surveys", "Spending Patterns In Canada", "Food Consumption in Canada", "Canadian Economic Observer" and the "Report on Energy Supply-Demand In Canada." National Energy Board figures were used to help calculate the energy footprint. This approach is similar to the methodology used in the Nova Scotia ecological footprint conducted by Jeff Wilson and The Genuine Progress Index Atlantic.⁷ An ideal ecological footprint would be measured by tracking the actual material and energy flows used to support our consumption demands: a full ecological footprint life-cycle analysis.

4. Alberta's Ecological Footprint

In 1999, Alberta had a population of 2,964,689 people and a land area of 66,200,000 hectares.⁸ An Alberta ecological footprint analysis, based on Mathis Wackernagel's Canadian footprint analysis, reveals that the area required to sustain Alberta's resource use and waste by-products is 10.7 hectares (26.4 acres) per person or 12.2 hectares (30.1 acres) per person if the suggested 12 percent of ecological space for biodiversity is included.

With a per capita footprint of 10.7 hectares, Albertans require 31,722,172 hectares of land to support their current consumption levels. This means that the citizens of Alberta use the productive output of a land area almost five times larger than all the Maritime provinces combined to sustain themselves or over 48 percent of the Alberta land area.⁹ To calculate your personal ecological footprint visit Redefining Progress's web site at www.rprogress.org/resources/nip/ef/ef_household_calculator.html.¹⁰

To maintain current levels of consumption, Albertans use the ecological capacity of their own province but also depend on additional ecological capacity from elsewhere through trade of goods and services derived from natural capital.¹¹ By maintaining a constant supply of goods, trade disguises the negative consequences of over-consumption and unsustainable resource use by transferring the impacts to other regions. The ecological footprint exposes this discrepancy by attributing the consequences of a given population's consumption no matter where it occurs on the planet. One can imagine a society that enjoys high material standards based on the knowledge industries and high-end service sector jobs, for example, and that boasts excellent population health, high levels of education, and growth in its manufactured capital and even natural capital stocks. By most standard measures and criteria, this society would represent the essence of sustainability. However, if local gains in natural, economic, or social capital come at the expense of accelerating ecological damage and social disintegration elsewhere, then local prosperity represents a cost to global sustainability.¹² The ecological footprint addresses the impact of consumption—locally in Alberta and globally—by providing a more complete picture of the consequences of Albertans' consumption habits and demands.

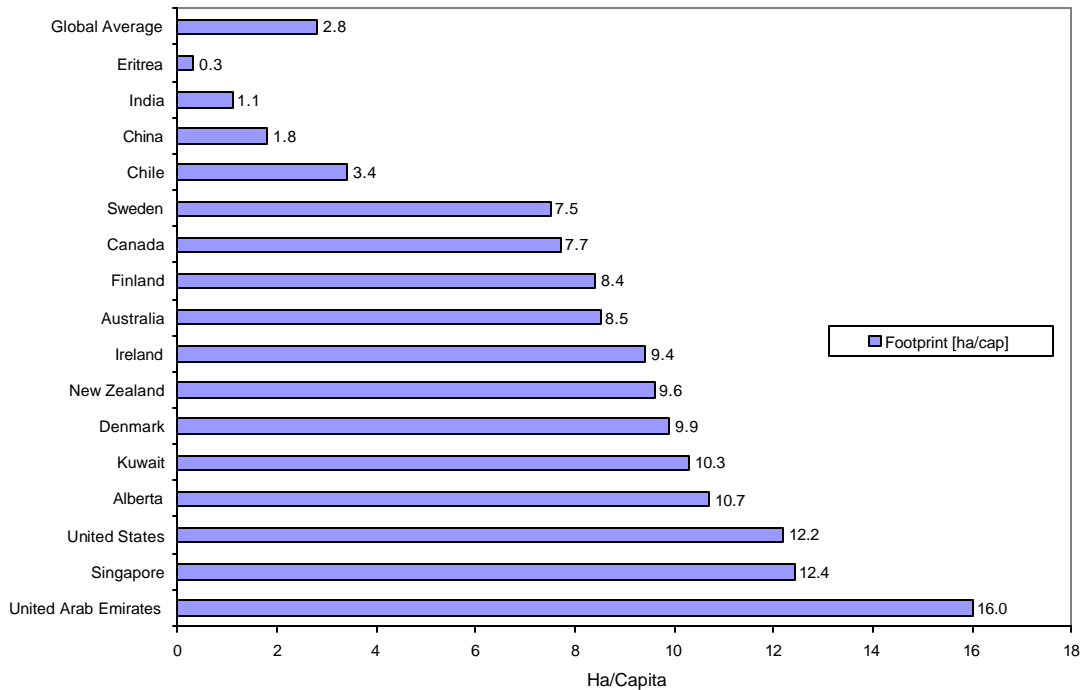
Alberta is well endowed with a large amount of space and a relatively small population. The province spans an area of over 660,000 sq km, with a population of less than three million people. What contributions should Albertans be making to ensure global sustainability? As occupants of a large land area, do Albertans have the right to live on a larger footprint? Do Albertans 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 kilometre in contrast to Alberta where we have a population density of 4.5 persons per square kilometre.*

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

When Alberta's ecological footprint is compared with those shown in the World Wildlife Fund's "Living Planet Report," Alberta has the world's fourth largest ecological footprint per capita. Compared with other countries, Canada has the tenth largest ecological footprint per capita (see Figure 1).¹³

Figure 1: Top 10 Country Ecological Footprints and Comparisons

Ecological footprints in chart do not include space set aside to preserve biodiversity.



Sustainability requires that human activity remain within the carrying capacity of nature. If we divide the Earth’s biologically productive land and sea by the human population, we get an average of 2.1 hectares per person in the year 2000. If we set aside 12 percent of the ecologically productive land for biodiversity preservation¹⁴ as recommended by the Brundtland report,¹⁵ the available bioproductive space per person shrinks from 2.1 hectares to just under 1.8 hectares. The ecological footprint model acts as a benchmark of sustainability by comparing the per capita consumption of a defined population with the global per capita share of 1.8 ha. Consumption in excess of 1.8 ha per capita implies that these resources and services are being used at an unsustainable rate. The excess consumption in relation to the per capita global area available is called the global sustainability deficit¹⁶ (see Tables 1 and 2).

The lifestyle of the average Albertan, for example, with a footprint of 10.7 ha per capita, is clearly not sustainable on a global scale. Our lifestyle can only be maintained by continually imposing an ecological footprint—and possibly ecological deficits—on other communities. Thus the ecological footprint has significant global equity and distributional issues. 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 Albertan would require five planets the size of our Earth.

Even though the average footprint of humanity of 2.8 ha per person is relatively small compared with the Alberta ecological footprint of 10.7 ha per person, it still exceeds the capacity of the biosphere. Assuming we set aside 12 percent for biodiversity protection, then we already exceed the Earth’s capacity by 50 percent. 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. Table 1 and Figure 2 illustrate the differences among selected countries; countries in Table 1 are ranked by 1996 footprint.

Table 1: Global Sustainability Deficit by Region (I)

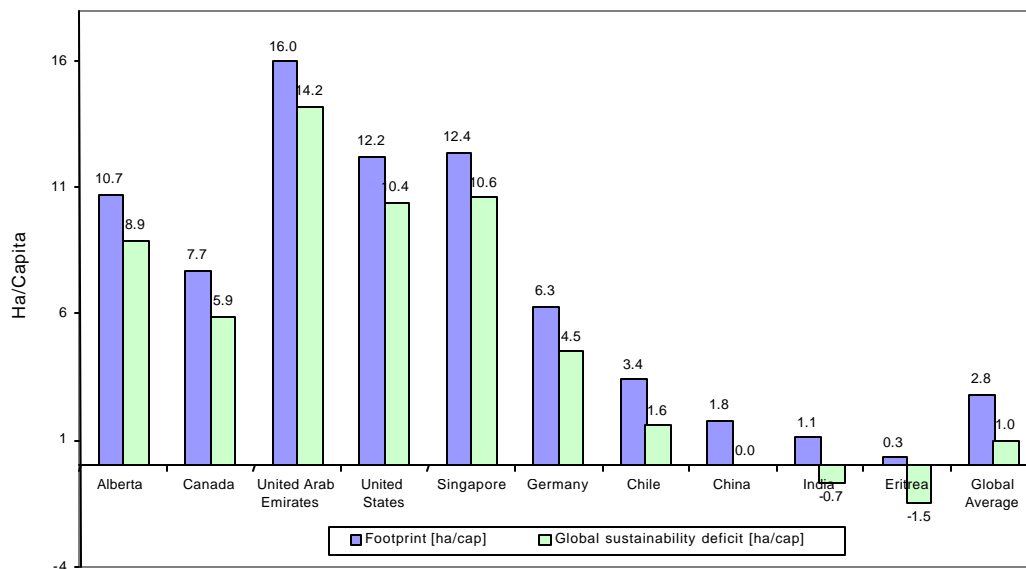
Region	1996 footprint (ha/capita)*	Global sustainability deficit (ha/capita)	1996 GDP/Capita (\$US)
United Arab Emirates	16.0	14.2	18,941
Singapore	12.4	10.6	23,654
United States	12.2	10.4	26,351
Alberta	10.7	8.9	25,882
Canada	7.7	5.9	19,157
Germany	6.3	4.5	27,498
Chile	3.4	1.6	4,102
China	1.8	0	604
India	1.1	- 0.7	336
Eritrea	0.3	- 1.5	-
Global Average	2.8	1.0	-
Global Availability**	1.8	-	-

(The Living Planet Report is available at the WWF web site www.panda.org or the Redefining Progress web site www.rprogress.org)

* does not include space set aside to preserve biodiversity

** The global footprint target assumes current population figures and that 12 percent of ecologically productive space is set aside to preserve biodiversity.

Figure 2: Global Sustainability Deficit by Region (I)



Alberta and Canada have footprints significantly larger than the 1.8 ha available per citizen that would ensure global sustainability. Alberta's EF is 6 times larger than China's and almost 10 times larger than India's, the new developing economies of the world. If China, with 1.26 billion people, had the same per capita footprint as Albertans, the Chinese would require more than an entire planet the size of Earth to meet consumption demands.¹⁷ Clearly this is not possible.

Alberta’s global sustainability deficit now stands at 8.9 ha. In other words, Albertans are consuming at a rate over four times what is sustainable from a global perspective.

As Table 2 and Figure 3 demonstrate, 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. Africa and Asia/Pacific countries have ecological footprints of 1.3 ha per capita and 1.8 ha per capita respectively. This suggests that the average Albertan places the same demand on the planet’s resources and waste assimilation capacities as eight individuals from Africa or six individuals from the Asia/Pacific region.

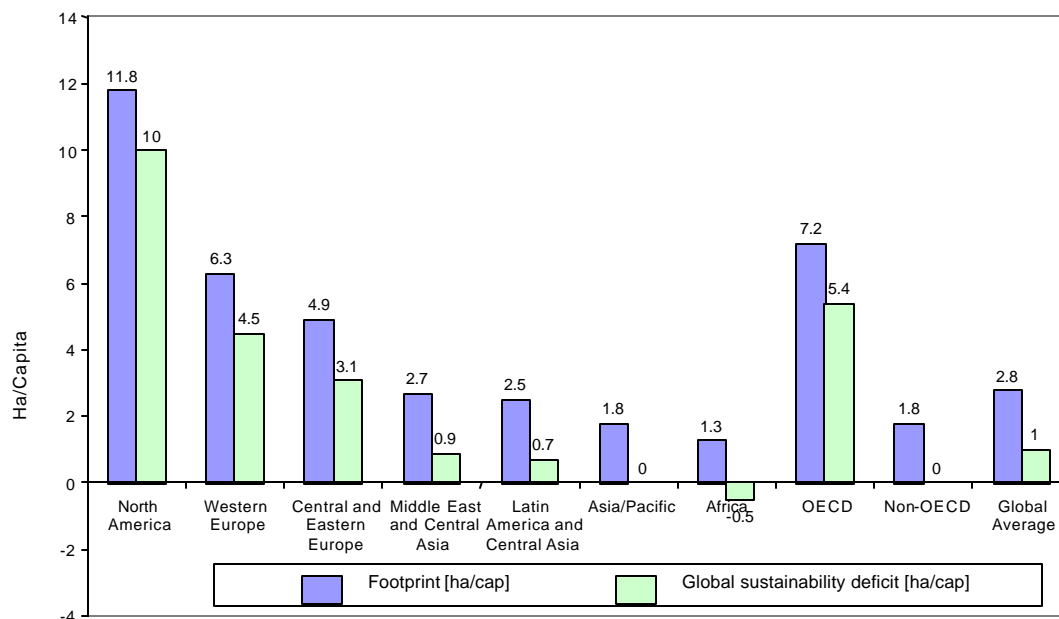
Table 2: Global Sustainability Deficit by Region (II)

Region	Footprint (ha/capita)*	Global sustainability deficit (ha/capita)
North America	11.8	10.0
Western Europe	6.3	4.5
Central and Eastern Europe	4.9	3.1
Middle East and Central Asia	2.7	0.9
Latin America and Central Asia	2.5	0.7
Asia/Pacific	1.8	0
Africa	1.3	- 0.5
OECD	7.2	5.4
Non-OECD	1.8	0
Global Average	2.8	1
Global Availability	1.8**	

* does not include space set aside for biologically productive space

** The global footprint target is based on current population figures and assumes that 12 percent of ecologically productive space is set aside to preserve biodiversity.

Figure 3: Global Sustainability Deficit by Region (II)



Seventy percent of the world's population consumes less than the 1.8 ha per capita of land and sea space available for human use (Figure 4).¹⁸ Arguably, global environmental decline can, therefore, be attributed to 30 percent of the world's population. In fact, this 30 percent uses 90 percent of the world's ecological capacity. This group is largely concentrated in OECD nations whose per capita ecological footprint is 7.2 ha. In contrast, non-OECD countries have an ecological footprint of 1.8 ha/per capita.¹⁹ Excessive consumption by one group in many cases directly undermines the ability of others to secure their basic human needs.

Figure 4: Global Ecological Footprint Distribution (above and below 1.8 ha)

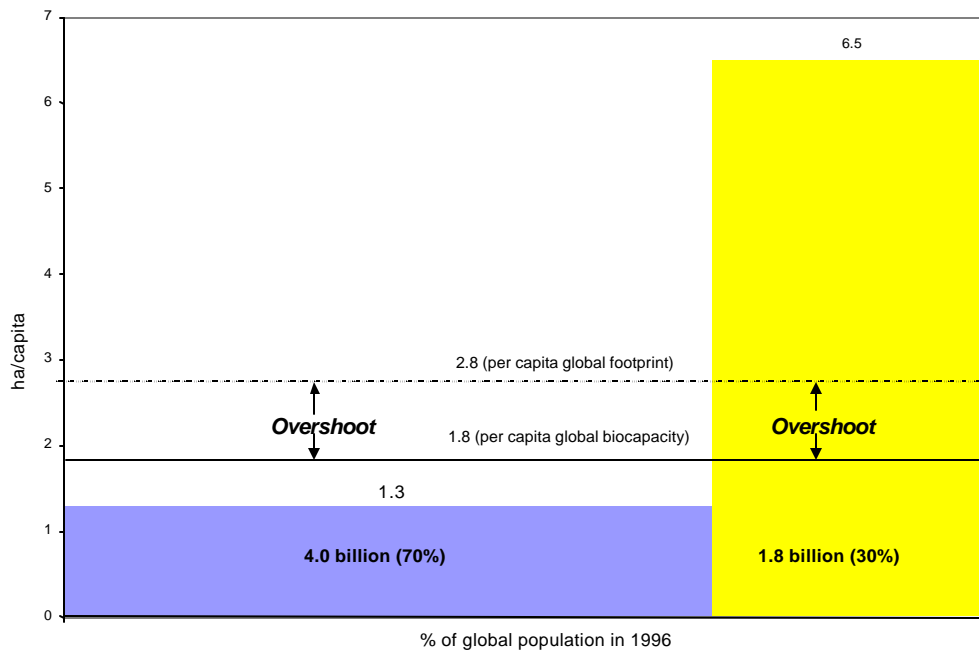
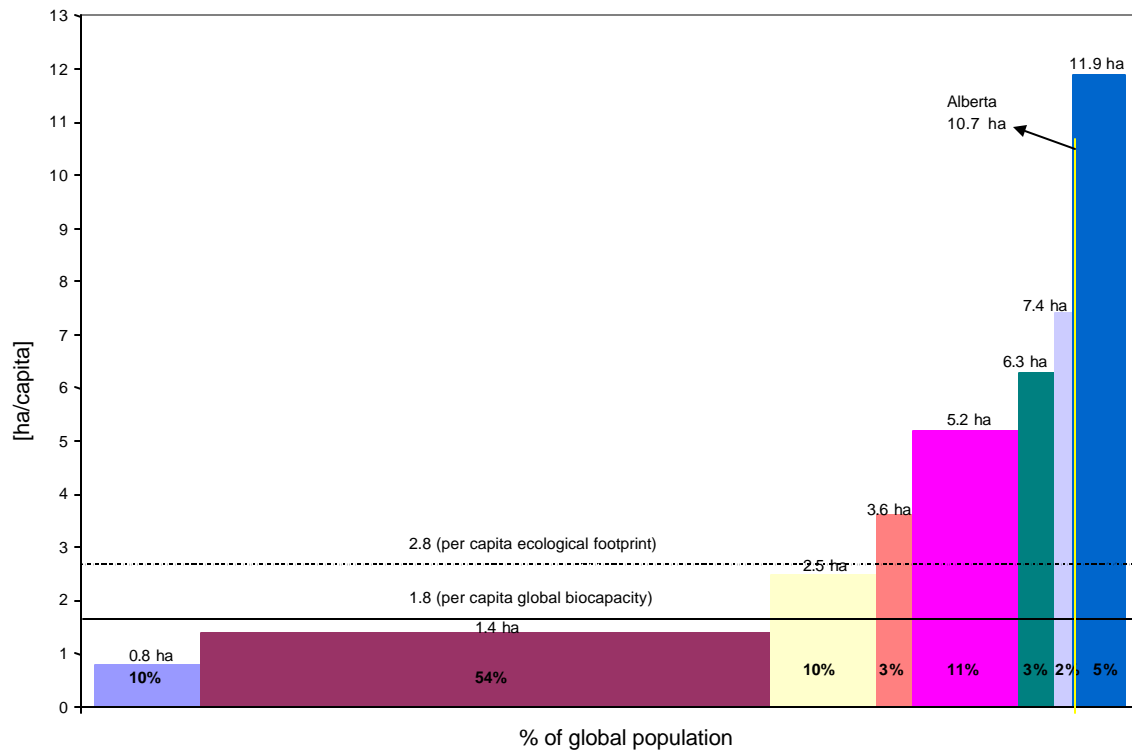


Figure 5 shows the remarkable distribution of ecological footprints by the percentage of the world's population. A mere five percent of the world's population (which includes Alberta, other Canadian provinces, and the U.S.) has an average footprint of 11.9 ha/capita or 8.5 times that of the 54 percent of the world's population with a footprint of 1.4 ha/capita. Alberta's footprint amounts to 10.7 ha/capita.

Figure 5: Global Ecological Footprint Breakdown



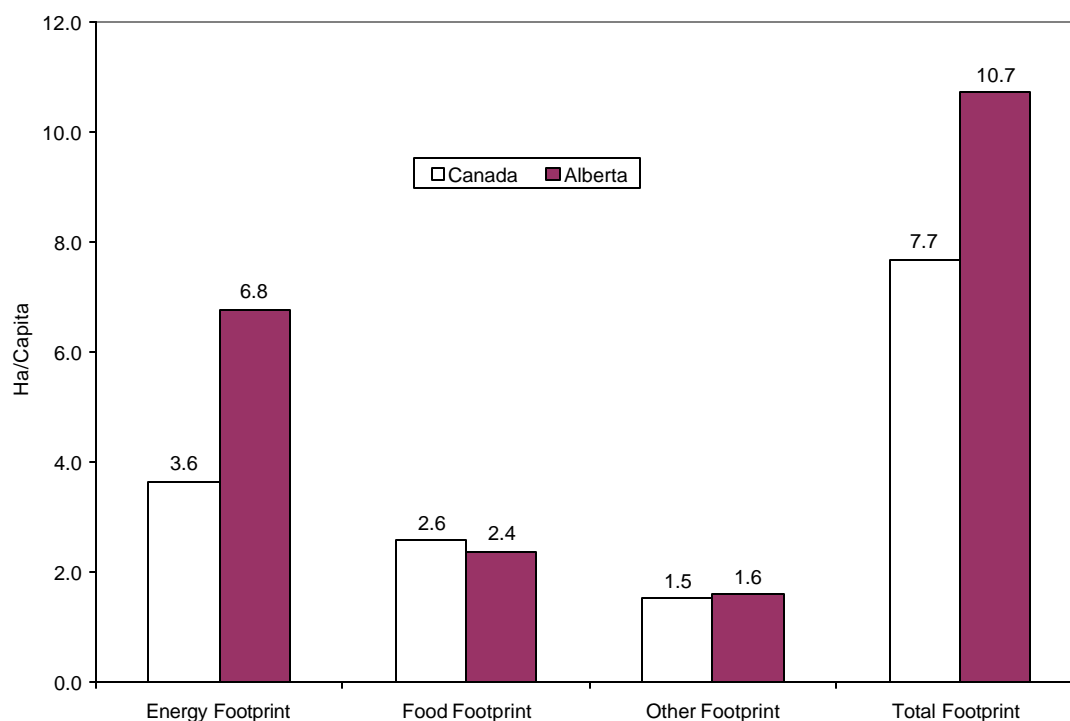
5. How does Alberta compare with Canada?

Alberta's ecological footprint of 10.7 ha per person is almost 40 percent larger than the Canadian average of 7.7 ha per capita.²⁰ Table 3 and Figure 6 show that with the exception of the food footprint, Alberta is above average in all other footprint categories. The "other crop" footprint, "timber" footprint and "built-up area" footprint are marginally above their Canadian counterparts. The significant difference in ecological footprint size can be attributed almost entirely to Alberta's larger energy footprint (6.8 ha per capita), compared with the Canadian energy footprint (3.6 ha per capita).

Table 3: Alberta/Canada Summary

Canada				Alberta			
Food Footprint							
Footprint Area	total (ha/cap)	equivalence factor	equivalent total (ha/cap)	Footprint Area	total (ha/cap)	equivalence factor	equivalent total (ha/cap)
total arable land	0.54	3.16	1.70	total arable land	0.49	3.16	1.54
total pasture land	2.07	0.39	0.80	total pasture land	2.03	0.39	0.78
total sea	0.97	0.06	0.06	total sea	0.69	0.06	0.04
total food footprint	3.58		2.56	total food footprint	3.20		2.37
"Other Crop" Footprint							
Footprint Area	total (ha/cap)	equivalence factor	equivalent total (ha/cap)	Footprint Area	total (ha/cap)	equivalence factor	equivalent total (ha/cap)
total arable land	0.01	3.16	0.03	total arable land	0.01	3.16	0.03
total pasture land	0.09	0.39	0.04	total pasture land	0.11	0.39	0.04
total other crop footprint	0.10		0.06	total other crop footprint	0.12		0.07
Energy Footprint							
Footprint Area	total (ha/cap)	equivalence factor	equivalent total (ha/cap)	Footprint Area	total (ha/cap)	equivalence factor	equivalent total (ha/cap)
CO ₂ absorption land	2.04	1.78	3.62	CO ₂ absorption land	3.80	1.78	6.76
"Built-Up" Footprint							
Footprint Area	total (ha/cap)	equivalence factor	equivalent total (ha/cap)	Footprint Area	total (ha/cap)	equivalence factor	equivalent total (ha/cap)
Built area land	0.13	3.16	0.40	Built area land	0.13	3.16	0.42
Timber Footprint							
Footprint Area	total (ha/cap)	equivalence factor	equivalent total (ha/cap)	Footprint Area	total (ha/cap)	equivalence factor	equivalent total (ha/cap)
Forest land	0.59	1.78	1.05	Forest land	0.62	1.78	1.09
Total Footprint		7.68				10.71	

Figure 6: Footprint Comparison Chart



6. Energy Footprint

Alberta's per capita energy footprint of 6.8 ha makes up 64 percent of its total ecological footprint. Alberta's per capita energy footprint is more than 50 percent greater than the Canadian average because of higher per capita energy demand coming from coal, oil and natural gas.²¹ Alberta has almost 20 percent more vehicles registered per capita,²² 47 percent more SUVs and light trucks per capita than the Canadian average,²³ and Albertans live in larger houses²⁴ (see Table 4).

Table 4: Energy Consumption Facts

	Alberta	Canada
Secondary Energy Demand (Gj/capita/yr)	234	155
Registered Motor Vehicles (vehicles/capita)	.69	.58
SUV-Light Truck (stock/capita)	.24	.17
Average Dwelling Size (rooms/dwelling)	6.5	6.1

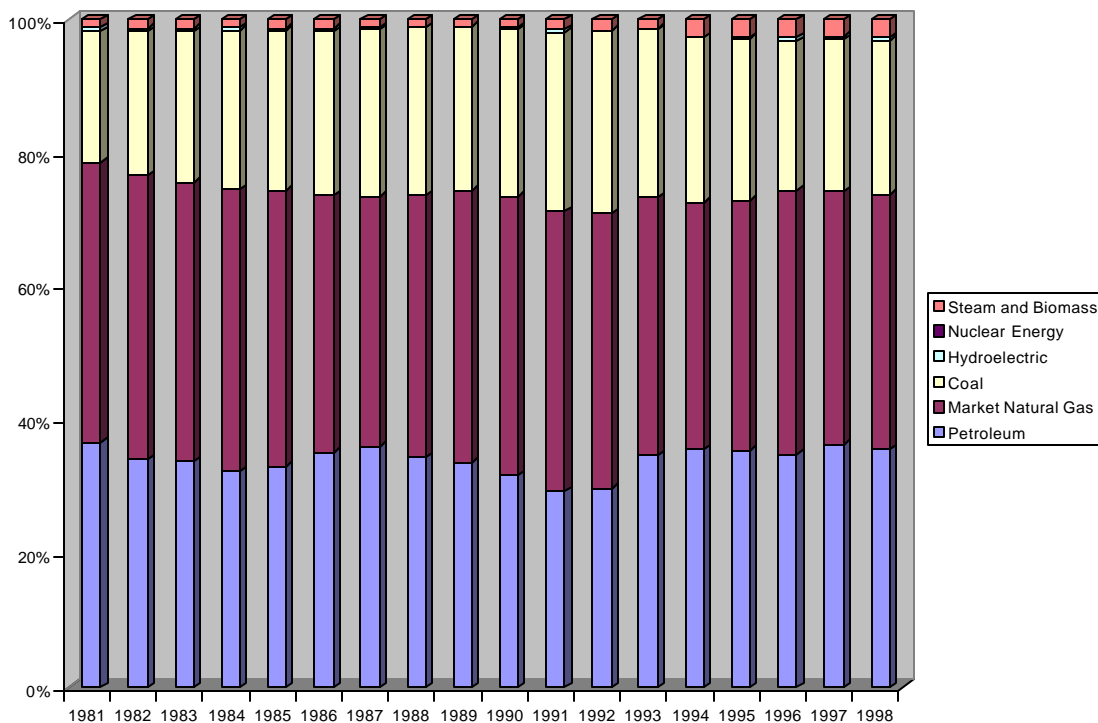
Sources of Alberta's energy also play a critical role in the larger energy footprint. Alberta relies heavily on fossil fuels. Coal and oil supply 98.4 percent of Alberta's electricity while only 32.2 percent of the electricity in Canada is derived from coal or oil.²⁵ In contrast, where hydroelectricity is the dominant source of energy in the rest of Canada, it is virtually unused in Alberta.²⁶ The footprint for 100 Gigajoules per year for petroleum-based fossil fuel is 1.0 hectare compared with 0.1 hectare for hydroelectricity²⁷ (see Table 5).

Table 5: Footprint Conversion Ratios for Fuel Source

Energy Type	Gj (ha/cap) ratio
coal consumption	0.018
liquid fossil fuel consumption	0.014
fossil gas consumption	0.010
nuclear energy consumption (thermal)	0.014
energy embodied in net imported goods	0.014
hydroelectricity consumption	0.001

The use of renewable energy sources would dramatically reduce Alberta’s ecological footprint. Since the 1960s, however, the use of renewable energy has increased only marginally. Figure 8 indicates that as a percentage of overall consumption, steam and biomass rose from 1.3 percent of total energy consumption in 1980 to 2.7 percent in 1998.²⁸ The use of solar energy does not even register, at less than 0.00005 percent.²⁹

Figure 7: Consumption as a Percentage of Total Provincial Consumption



Alberta has great potential to harness wind and solar energy and increase its use of biomass. The Pembina Institute’s Andrew Pape-Salmon, a renewable energy expert, estimates that Alberta’s renewable energy production capacity from wind, solar and micro-hydro facilities could be as much as 30 percent of Alberta’s current energy production.³⁰ Alberta would require diversity of wind power (30 percent intermittents, wind, photovoltaic power) combined with natural gas. It is technically feasible to have 30 percent wind, 20 percent storage hydro and 50 percent natural gas (combined cycle). Alberta is constrained in terms of biomass capacity since this would require conversion of agriculture land to biomass energy farms. Also, Alberta does not have the same large hydro storage (battery) facilities as B.C. does.

Despite this potential, future projections indicate that the use of renewable energy as a percentage of overall end use energy consumption will decrease from 3.69 percent in 1996 to 2.74 percent in 2025³¹ (see Table 6).

Table 6: Projected Renewable Energy Use

	1996	2000	2005	2010	2015	2020	2025
Steam	7.7 PJ [†]	4.1 PJ	4.2 PJ	4.1 PJ	4.2 PJ	4.2 PJ	4.1 PJ
Biomass	55.3 PJ	58.1 PJ	61.2 PJ	60.3 PJ	63.4 PJ	66.0 PJ	67.0 PJ
Solar	0.1 PJ	0.1 PJ	0.1 PJ	0.1 PJ	0.1 PJ	0.1 PJ	0.1 PJ
percentage of total end use energy consumption	3.69%	3.30%	3.01%	2.81%	2.76%	2.80%	2.74%

To decrease its energy footprint significantly, Alberta needs to substantially increase its renewable energy sources and decrease dependency on coal and petroleum. In 1996, if half of the coal, petroleum, and natural gas had been replaced by renewable energy sources, Alberta's energy footprint would have declined by 3.1 ha/capita.³² This would have decreased the overall Alberta ecological footprint by almost 30 percent.

[†] A PJ (petajoule) is 10¹⁵ joules.

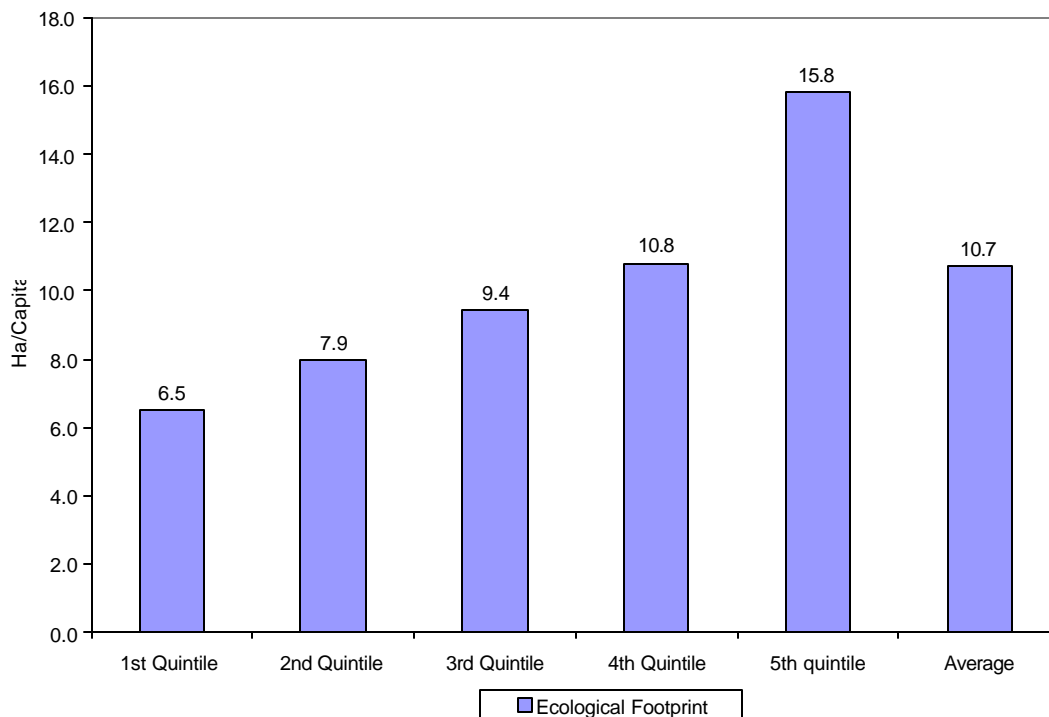
7. Not All Albertans Have Equal Footprints

Not everybody in Alberta has the same sized ecological footprint. Although the average footprint is large, there is considerable disparity depending on spending power, which is reflected in different consumption or spending patterns. As indicated in Table 7 and Figure 9, the poorest 20 percent of Albertans have a footprint of 6.5 hectares per person while the wealthiest 20 percent have a footprint of 15.8 hectares per person. This means that the average wealthy Albertan has almost 2 1/4 times the impact on the environment that the average low income Albertan does. This comes as no surprise, as money flows are closely linked to resource flows.³³

Table 7: Ecological Footprint by Quintile³⁴

1999	1st Quintile	2nd Quintile	3rd Quintile	4th Quintile	5th quintile	Average
Expenditure (\$/capita)	13,295	16,232	19,266	22,063	32,334	21,930
Ecological Footprint (ha/capita)	6.5	7.9	9.4	10.8	15.8	10.7

Figure 8: Ecological Footprint by Quintile



Wealthy Albertans, by having more discretionary spending power, have a potentially larger ecological footprint and associated global impact. Most people do have some flexibility in their consumption choices and thus the ability to reduce their ecological footprints. For example, purchasing locally-grown food and organic produce, improving insulation, using energy efficient appliances, and using bicycles and public transit all produce smaller ecological footprints per dollar spent than the usual alternatives.^{35,36}

8. The Tale of Two Cities

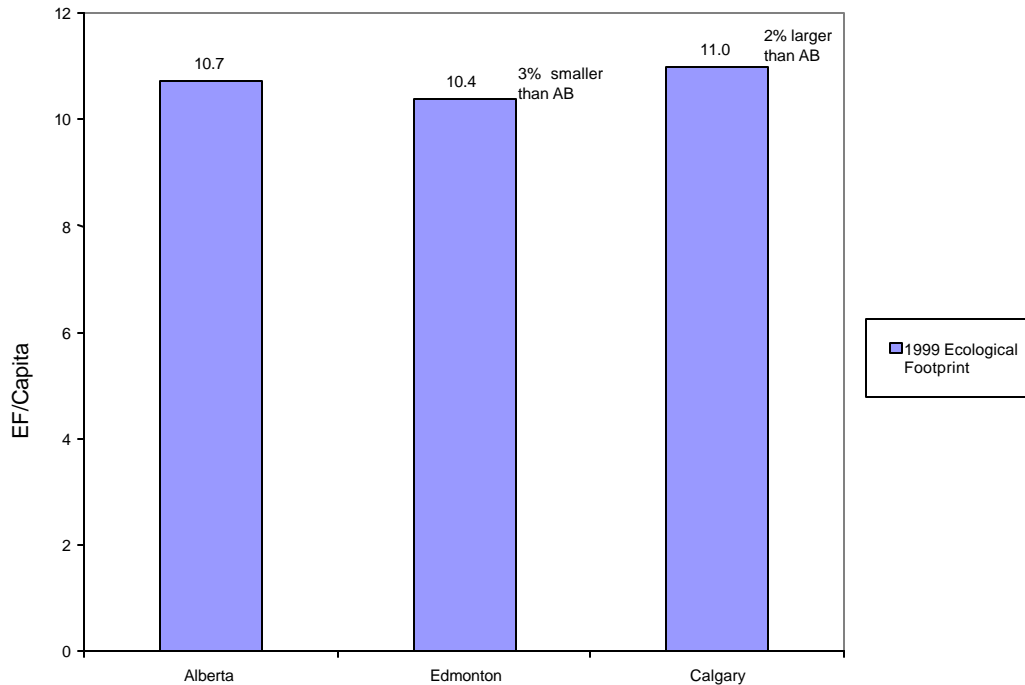
With their higher population densities, cities offer potential footprint savings due to economies of scale. Cities' denser populations can support public transit and offer better access to amenities and services, thereby reducing automobile dependency. Cities also have higher density housing, and can support municipal recycling and composting programs. One would expect therefore that, per person, cities ought to have a lower footprint than rural areas. Edmonton, for example, in 1999 had an ecological footprint of 10.4 ha per person, three percent lower than the Alberta ecological footprint of 10.7 per person.

In contrast to the potential footprint savings that cities offer, there tends to be a greater concentration of wealth with a corresponding greater amount of consumption in urban centres, which may offset ecological footprint gains. Calgary, for example, in 1999 had an ecological footprint of 11.0 hectares per person, two percent larger than the Alberta ecological footprint per person. Calgary's per capita consumption, however, exceeded the provincial average by six percent (see Table 8 and Figure 9).

Table 8: Edmonton and Calgary: Consumption and Ecological Footprints

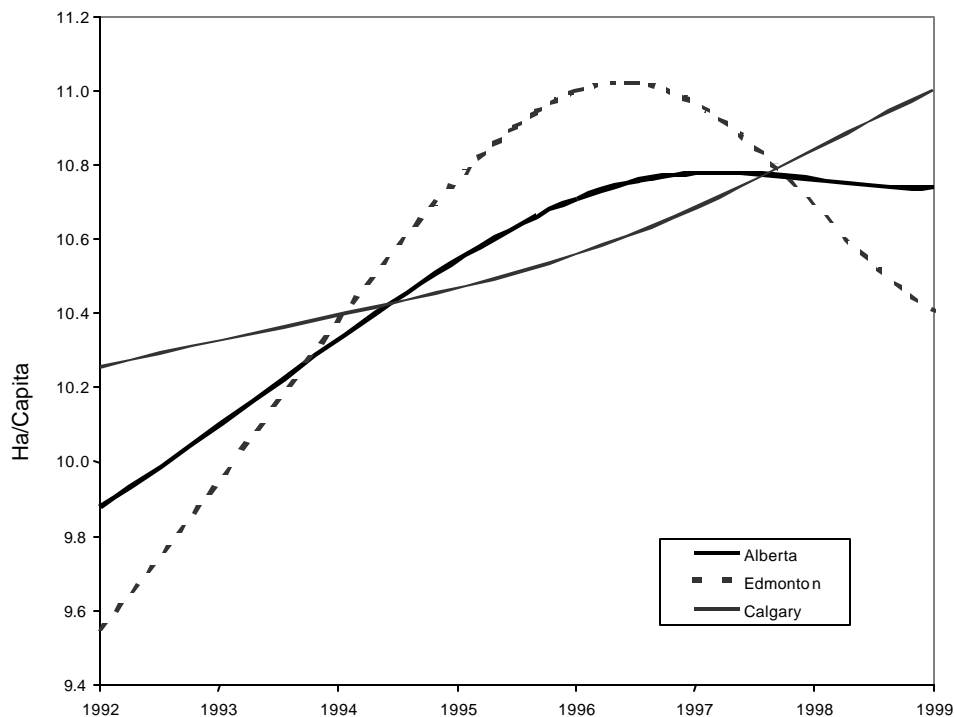
	Alberta	Edmonton	Calgary
Consumption (1999\$/capita)	\$15,412	\$15,218	\$16,285
Ecological Footprint (ha/capita)	10.7 ha	10.4 ha	11.0 ha

Figure 9: 1999 Alberta, Edmonton, and Calgary Ecological Footprints



The ecological footprints of Calgary and Edmonton have differed dramatically throughout the 1990s (see Figure 10). While Calgary's footprint saw a steady increase from 10.3 ha/capita in 1992 to 11.0 ha/capita in 1999, Edmonton's footprint increased between 1992 and 1996, from 9.6 ha/capita to 11.0 ha/capita and has since decreased to 10.4 ha/capita. These discrepancies between cities and over time could be explained by differences in disposable income and consumption spending. Calgary's economy was expanding more dramatically (due to renewed petroleum industry investments) than Edmonton's economy. With a growing population, Calgary saw an expanding real estate market and thus more personal consumption expenditures that would increase its ecological footprint. The reversal in Edmonton's ecological footprint requires more detailed analysis of disposable income and personal consumption expenditure trends, although declines in both may be the reason for the decrease in footprints.

Figure 10: Ecological Footprints During the 1990s



9. Forty Years of Alberta's Ecological Footprint

Between 1961 and 1999, Alberta's ecological footprint grew by 66 percent, increasing from 6.5 hectares per capita to 10.7 hectares per capita (see Table 9). During the same period the Canadian ecological footprint grew by 60 percent from 4.9 hectares per capita to 7.8 hectares per capita. As Figures 11 and 12 show, Alberta's ecological footprint peaked in 1997 at 10.8 hectares per capita; the energy footprint made up 6.8 hectares per capita of the total. The Canadian ecological footprint peaked in 1999 at 7.8 hectares per capita including an energy footprint of 3.6 hectares per capita.

Alberta

Increases in footprint size from 1961 to 1999:

- Energy Footprint 89%
- Food Footprint 12%
- Other Footprint 126%
- Ecological Footprint 66%

Canada

Increases in footprint size from 1961 to 1999:

- Energy Footprint 82%
- Food Footprint 15%
- Other Footprint 162%
- Ecological Footprint 60%

Table 9: Historical Ecological Footprint Statistics

Alberta

(ha/capita)	First		Low		High		Last	
Energy Footprint	3.4	(1961)	3.4	(1961)	6.8	(1997)	6.4	(1999)
Food Footprint	2.3	(1961)	2.3	(1964)	3.3	(1974)	2.6	(1999)
Other Footprint	0.8	(1961)	0.8	(1961)	1.7	(1999)	1.7	(1999)
Ecological Footprint	6.5	(1961)	6.5	(1961)	10.8	(1997)	10.7	(1999)

Canada

(ha/capita)	First		Low		High		Last	
Energy Footprint	1.9	(1961)	1.9	(1961)	3.6	(1979)	3.6	(1999)
Food Footprint	2.3	(1961)	2.3	(1961)	2.8	(1979)	2.6	(1999)
Other Footprint	0.6	(1961)	0.6	(1961)	1.6	(1999)	1.6	(1999)
Ecological Footprint	4.9	(1961)	4.9	(1961)	7.8	(1999)	7.8	(1999)

Figure 11: Alberta Ecological Footprint Time Series

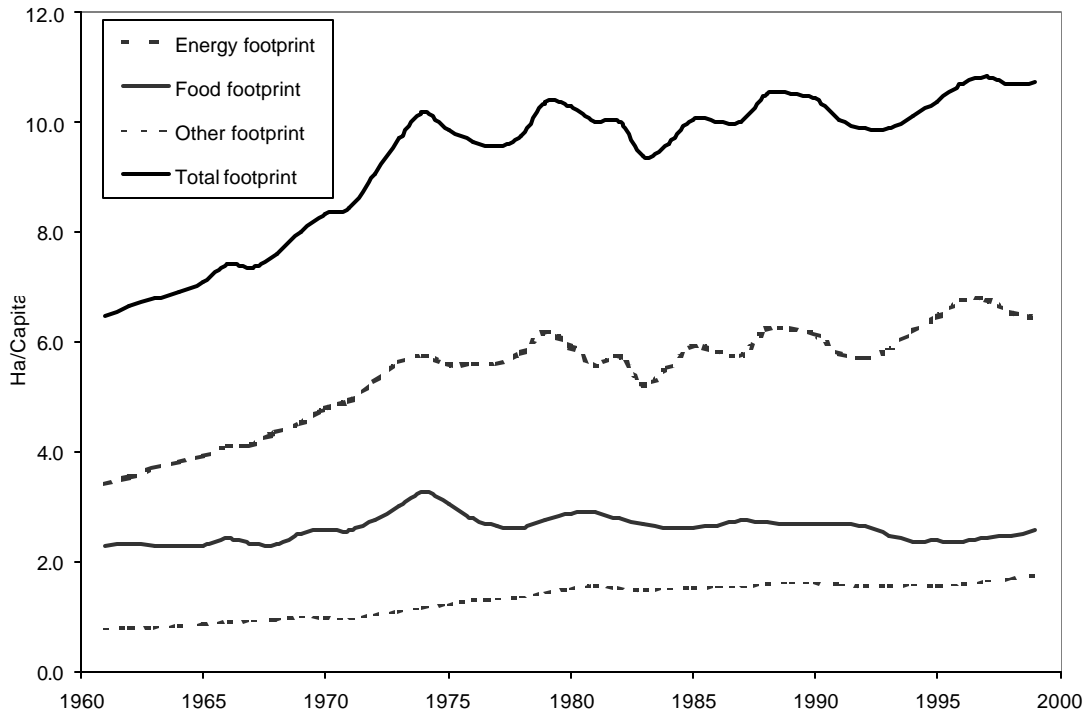
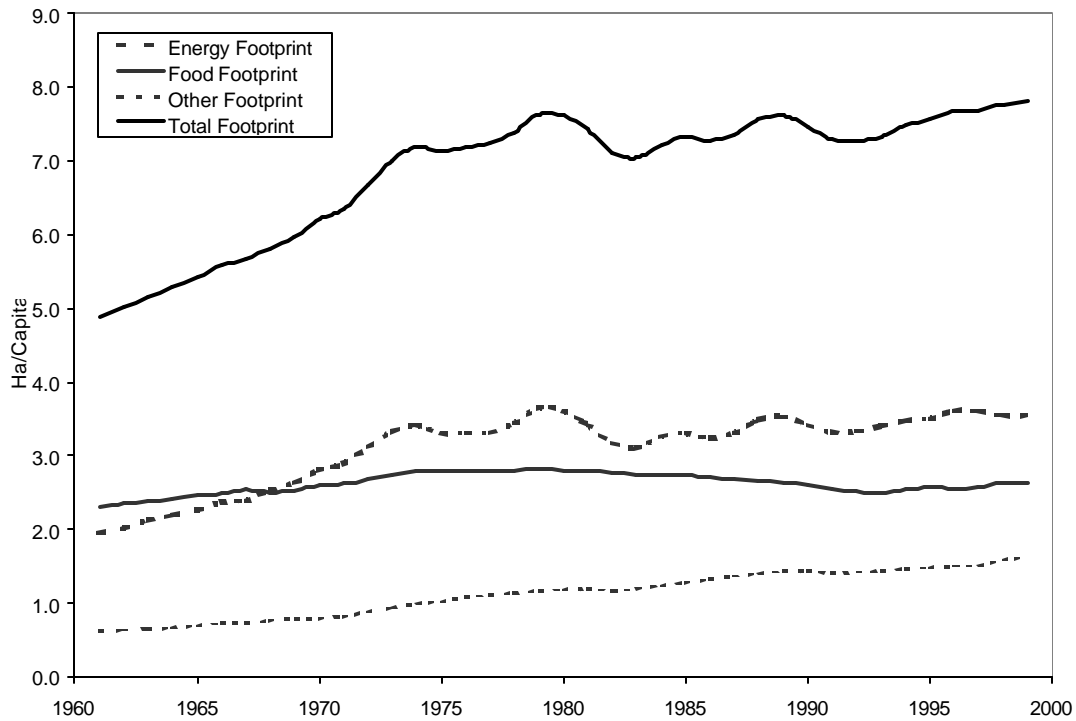


Figure 12: Canada Ecological Footprint Time Series



10. An Expanding Ecological Footprint

Based on energy use forecasts,³⁷ consumption forecasts,^{38,39} and population forecast trends,⁴⁰ the Alberta footprint will swell by an additional 17 percent during the next 20 years, to 15 hectares per capita. This means that in 2020 Albertans will require 53 million hectares to support their consumption demands. Although Alberta's ecological footprint is expected to grow at a slightly slower pace than the one percent annual growth rate projected for the Canadian ecological footprint, it will still remain over 30 percent larger than the Canadian average in 2020 (Figures 13 and 14). This amounts to 14.8 hectares per capita and 11.0 hectares per capita respectively. These forecasted projections are very conservative compared with other Canadian ecological footprint future projections. Studies by Wackernagel, Onisto and Krause (1998) suggest that the Canadian footprint could reach 11.8 ha per capita by 2015, a 33 percent increase above 1997 levels.⁴¹

Figure 13: Alberta Projected Ecological Footprint 2000 to 2020

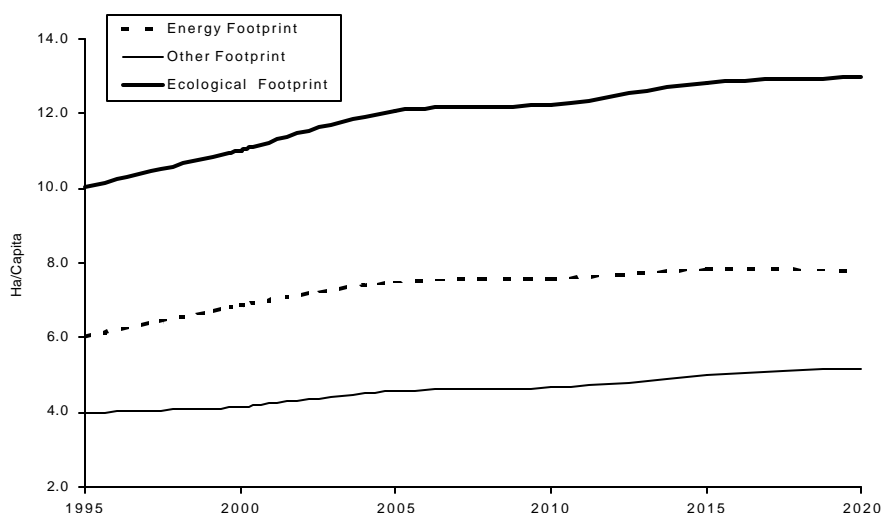
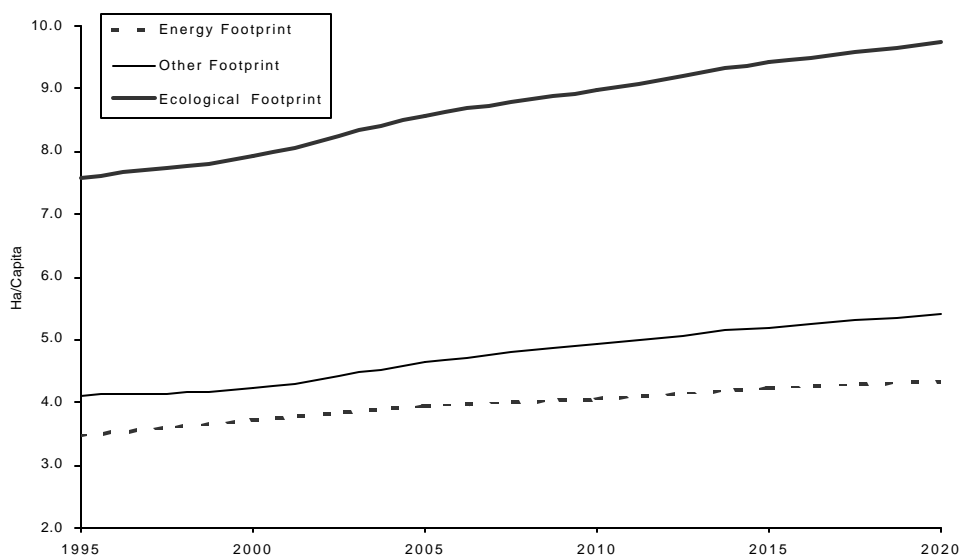


Figure 14: Canada Projected Ecological Footprint 2000 to 2020



11. The Ecological Footprint and Consumption

Our society's addiction to consumerism drives our increasing ecological footprint. Total per capita consumption expenditures (1998 constant dollars) increased 110 percent from \$8,747 in 1961 to \$18,389 in 1999 (Figure 15). During this same period, the ecological footprint grew 65 percent. Although the ecological footprint increased at a slower rate, comparing the historic growth lines of the ecological footprint and consumption expenditures demonstrates a similar trend (Figure 16).

Figure 15: Total Consumption Expenditure, per capita

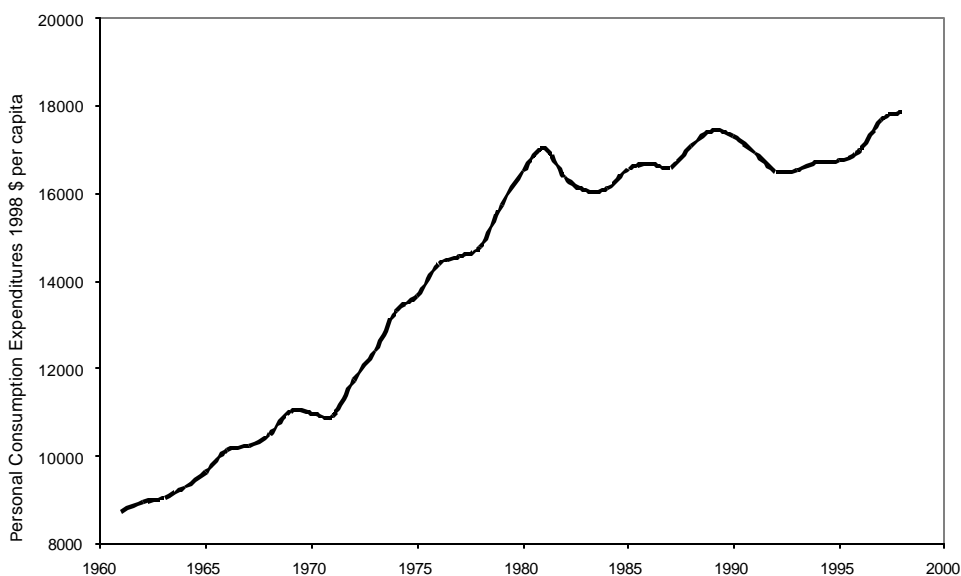
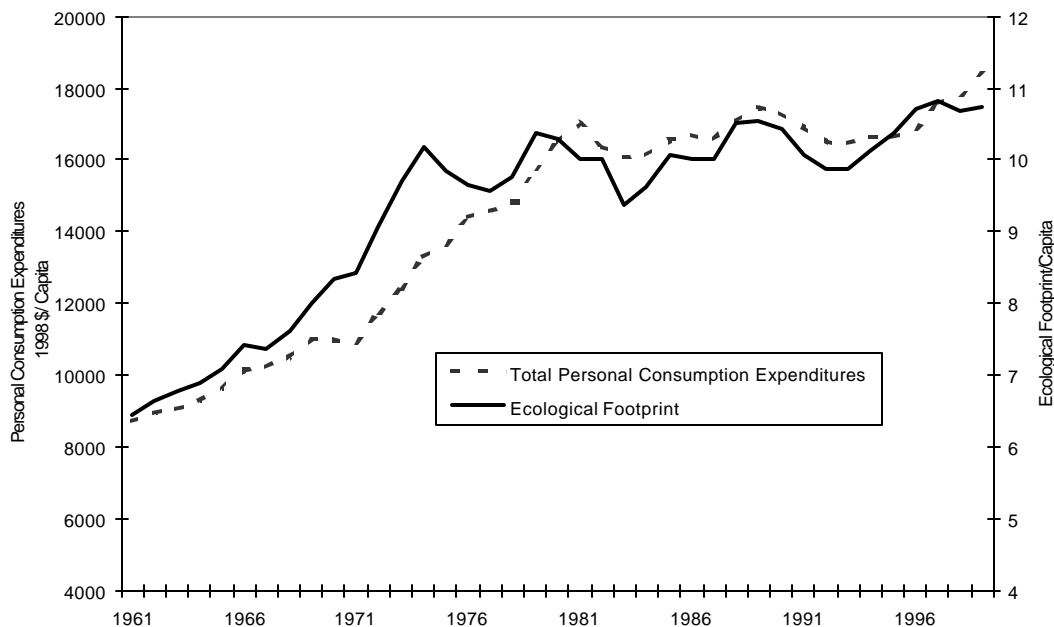


Figure 16: Consumption Expenditure vs. Ecological Footprint



Between 1961 and 1998, levels of consumption increased significantly in all major consumption expenditure categories (Table 10). The largest increases included expenditures on personal goods and services with an increase of 224 percent, and expenditures on transportation and communication with an increase of 166 percent.

Table 10: Consumption Expenditure per capita (1998 constant dollars)

	1961	1999	% change
Food, shelter and clothing	4454	7140	60%
Furniture, household equipment, and operations	973	1482	52%
Transportation and communications	1254	3330	166%
Health care	339	805	137%
Personal goods and services	1129	3655	224%
Recreation and entertainment	562	1129	101%
Taxes	1928	4477	132%
Total Consumption Expenditures	8747	18389	110%

As individuals, we can influence our ecological footprint by our consumption choices. The first choice is to exercise the right not to consume. As a society we need to reevaluate our obsession with consumerism—how much of what we consume is a reflection of need? How much of our consumption is excessive? How much is driven by marketing and advertising? How much is an attempt to fulfill missing psychological needs? We can also choose the products we are going to consume. Purchasing local foods and goods, fuel-efficient car models, and energy saving household appliances and equipment all offer a smaller footprint than the usual alternative (see Table 11).

Table 11: Ecological Footprint Reduction vs. the Usual Alternative

Choice	Reduction in Footprint
Locally produced food item vs. typical food item ⁴²	75%
Toyota Primus vs. standard compact car ⁴³	50%
Energy efficient refrigerator vs. conventional model ⁴⁴	50%
Compact fluorescent light bulb vs. standard incandescent bulb	75%

How we allocate our consumption expenditures is critical at a household level, but at least as significant at a societal level. For example, public funds can be invested in mass transit or integrated land-use and transportation planning rather than roads and highway construction; planning policies can encourage the revitalization of urban centres instead of urban sprawl, both of which will significantly reduce footprint size. In fact, without societal choices to support more sustainable household consumption practices, it becomes difficult for households to reduce their footprint to sustainable levels. Existing problems of automobile dependence, urban sprawl, use of non-renewable energy sources, and reliance on imported foods and consumer goods all inflate an individual's ecological footprint.

12. The Ecological Footprint Index

Figure 17 shows the ecological footprint and GDP in Alberta as indices. In the index, an ecological footprint of 1.8 ha per person⁴⁵ is set equal to 100, and deviations from that benchmark are measured as movement toward zero. Thus, as the ecological footprint increases relative to the benchmark of 1.8 ha per person, the index moves toward zero. While Alberta boasted a steady increase in provincial GDP over the study period, the ecological footprint index decreased, indicating a larger Alberta ecological footprint.

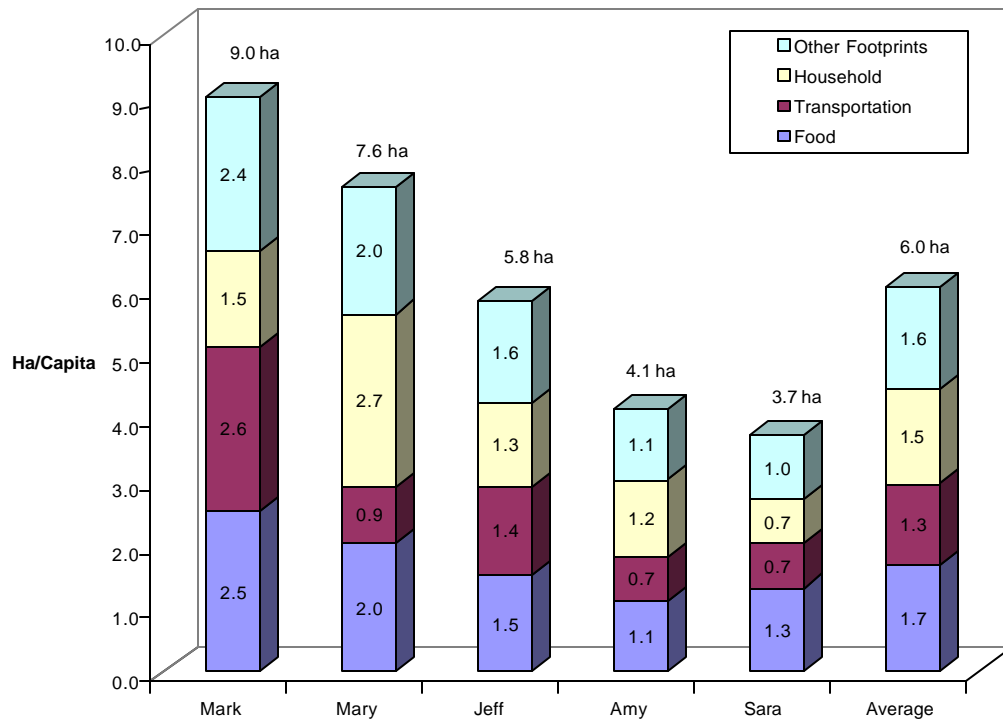
Figure 17: GDP and Ecological Footprint for Alberta as Indices, 1961 to 1999



13. The Ecological Footprints of the Authors

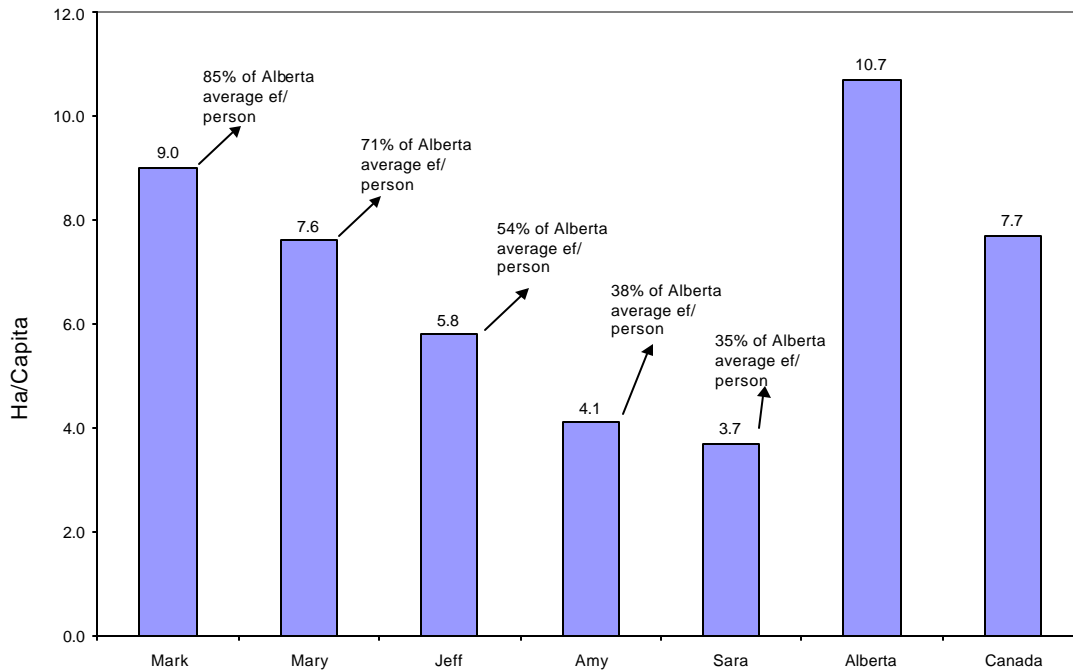
The authors of the Alberta GPI reports calculated their personal ecological footprints based on the ecological footprint calculator available at *Redefining Progress's* website, www.rprogress.org/resources/nip/ef/ef_household_calculator.html. The ecological footprints (Figure 18) ranged from a high of 9.0 hectares to a low of 3.7 hectares, with an average of 6.0 ha.

Figure 18: Ecological Footprints of the Authors



Each author's footprint was lower than the Alberta average footprint per person, ranging from 85 percent of the Alberta average to 35 percent (see Figure 19).

Figure 19: Authors' Footprints vs. Alberta Average Footprint



Even in a group of environmentally conscious individuals, the average author footprint was still 300 percent larger than the 1.8 ha per person necessary for global sustainability. Even the smallest footprint was double the global sustainability target. Due to our reliance on fossil fuels as an energy source, non-resource conscious urban design, dependency on the automobile, and energy-intensive food production and agriculture systems, it is difficult solely through individual effort to reduce our footprints in Canada to the 1.8 ha per person target. This highlights the notion that ecological footprints are about personal choices but also about societal choices. As Canadians we need to make a commitment individually and collectively to reduce our impact on nature.

14. So What? Policy Implications

Ecological footprint analysis is a powerful and intuitively appealing new idea that, combined with real data, can be an important public policy tool. While it is by no means perfect, the ecological footprint provides an important benchmark for more elegant accounting systems.

Footprint analysis would allow policy makers to examine the relative impact of different resource development and trade policy options regarding food, energy, and transportation at a local, provincial 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 Edmonton or Calgary 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.

Footprint analysis opens up 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 air travel), and buying locally can dramatically reduce our individual and collective footprint. What is exciting is that this empowers the individual or household to exercise choice. One can imagine either a regular audit or self-administered analysis of household ecological footprints of Albertans 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. 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 Albertans with an "ecological reality check" and leave us asking ourselves "what can I do today to reduce my footprint?" Individuals 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.

Appendix A. List of Alberta GPI Background Reports

A series of Alberta GPI background reports accompanies the *Alberta Sustainability Trends 2000* report and this report. These documents are being released in late 2001 and early 2002 and will be available on the Pembina Institute's website at www.pembina.org.

Alberta GPI Background Reports and Sustainability Indicators

GPI Background Reports	GPI Accounts Covered by Report
1. Economy, GDP and Trade	<ul style="list-style-type: none"> • Economic growth (GDP) • Economic diversity • Trade
2. Personal Consumption Expenditures, Disposable Income and Savings	<ul style="list-style-type: none"> • Disposable income • Personal expenditures • Taxes • Savings rate
3. Money, Debt, Assets and Net Worth	<ul style="list-style-type: none"> • Household debt
4. Income Inequality, Poverty and Living Wages	<ul style="list-style-type: none"> • Income distribution • Poverty
5. Household and Public Infrastructure	<ul style="list-style-type: none"> • Public infrastructure • Household infrastructure
6. Employment	<ul style="list-style-type: none"> • Weekly wage rate • Unemployment • Underemployment
7. Transportation	<ul style="list-style-type: none"> • Transportation expenditures
8. Time Use	<ul style="list-style-type: none"> • Paid work time • Household work • Parenting and eldercare • Free time • Volunteerism • Commuting time
9. Human Health and Wellness	<ul style="list-style-type: none"> • Life expectancy • Premature mortality • Infant mortality • Obesity
10. Suicide	<ul style="list-style-type: none"> • Suicide
11. Substance Abuse: Alcohol, Drugs and Tobacco	<ul style="list-style-type: none"> • Drug use (youth)
12. Auto Crashes and Injuries	<ul style="list-style-type: none"> • Auto crashes
13. Family Breakdown	<ul style="list-style-type: none"> • Divorce
14. Crime	<ul style="list-style-type: none"> • Crime
15. Gambling	<ul style="list-style-type: none"> • Problem gambling
16. Democracy	<ul style="list-style-type: none"> • Voter participation
17. Intellectual Capital and Educational Attainment	<ul style="list-style-type: none"> • Educational attainment
18. Energy (Oil, Gas, Coal and Renewable)	<ul style="list-style-type: none"> • Oil and gas reserve life • Oilsands reserve life
19. Agriculture	<ul style="list-style-type: none"> • Agricultural sustainability
20. Forests	<ul style="list-style-type: none"> • Timber sustainability • Forest fragmentation

The Alberta GPI Accounts: Ecological Footprint

GPI Background Reports	GPI Accounts Covered by Report
21. Parks and Wilderness	<ul style="list-style-type: none">• Parks and wilderness
22. Fish and Wildlife	<ul style="list-style-type: none">• Fish and wildlife
23. Wetlands and Peatlands	<ul style="list-style-type: none">• Wetlands• Peatlands
24. Water Resource and Quality	<ul style="list-style-type: none">• Water quality
25. Energy Use Intensity, Greenhouse Gas Emissions and Air Quality	<ul style="list-style-type: none">• Energy use intensity• Air quality-related emissions• Greenhouse gas emissions
26. Carbon Budget	<ul style="list-style-type: none">• Carbon budget deficit
27. Municipal and Hazardous Waste	<ul style="list-style-type: none">• Hazardous waste• Landfill waste
28. Ecological Footprint	<ul style="list-style-type: none">• Ecological footprint

Appendix B. Ecological Footprint Data

Alberta's Ecological Footprint and Index, where 100 is equal to the average global carrying capacity of 1.8 hectares per capita.

Year	Alberta Ecological Footprint (hectares per capita)	Index (100=1.8 ha/capita equivalent to average global carrying capacity).
1961	6.46	70.89
1962	6.64	69.75
1963	6.79	68.83
1964	6.89	68.17
1965	7.08	67.02
1966	7.42	64.88
1967	7.36	65.23
1968	7.61	63.68
1969	8.01	61.16
1970	8.34	59.12
1971	8.44	58.52
1972	9.07	54.55
1973	9.70	50.62
1974	10.18	47.62
1975	9.85	49.66
1976	9.65	50.91
1977	9.56	51.48
1978	9.75	50.32
1979	10.37	46.43
1980	10.28	46.97
1981	10.02	48.60
1982	10.02	48.65
1983	9.37	52.66
1984	9.62	51.12
1985	10.06	48.36
1986	10.02	48.65
1987	10.02	48.59
1988	10.52	45.53
1989	10.53	45.44
1990	10.43	46.07
1991	10.06	48.36
1992	9.88	49.47
1993	9.88	49.47
1994	10.13	47.96
1995	10.38	46.35
1996	10.71	44.31
1997	10.83	43.54
1998	10.68	44.49
1999	10.74	44.15

Source: Ecological footprint estimates were derived by the author based on Statistics Canada personal consumption expenditure data (by type of expenditure: energy, food, and other) that is then converted to land area equivalents using a series of conversion calculations originally developed by Wackernagel and Rees (1996). For more detailed information about the data used to derive the ecological footprint for Alberta, contact Mark Anielski (marka@pembina.org).

Appendix C. GPI Atlantic

Researchers at GPI Atlantic, in particular Jeff Wilson and Dr. Ron Colman, were the first to apply the ecological footprint analysis (developed by Dr. Mathis Wackernagel and Dr. Bill Rees) methodology at a provincial scale to the province of Nova Scotia as one of several accounts in the GPI Atlantic sustainability accounting model. Their research results can be found at GPI Atlantic's website at www.gpiatlantic.org.

The Nova Scotia Ecological Footprint (Abstract)
(100 pages including charts; March 13, 2001; \$35)

Small Province, Big Feet: Nova Scotia's Ecological Footprint

Development that is "sustainable" requires that:

1. we do not consume more resources than the planet can provide, and that we do not produce more waste than the planet can assimilate;
2. we live in such a way that the next generation will not be worse off than we are;
3. we do not consume resources at the expense of others' basic survival and livelihood.

In other words, "sustainable development" requires that we live responsibly and with awareness, so as not to deplete our natural wealth and leave a poorer world for our children and others to inherit.

Measurements of sustainable development generally look at the "supply" side of the equation – whether we are harvesting our fish, logging our forests, and growing our food in sustainable ways. But such measurements put the whole onus for sustainable development on the producer. The "ecological footprint" looks at the "demand" side of the equation and places the responsibility for sustainable development equally on the consumer. The Nova Scotia Genuine Progress Index, a pilot project for Canada that includes 22 environmental, social and economic components, measures sustainable development in both these ways.

How we eat, shop, travel, use energy and build our houses directly impacts the environment. Almost everything we do consumes natural resources and produces waste. Our ecological footprint is the amount of space we take up, or the amount of land and sea area it takes to meet our current levels of consumption. It tells us what impact our consumption patterns have on the environment and whether we are exceeding the capacity of the environment to satisfy our wants. The world has a limited supply of productive land for growing food and timber, limited supplies of fish, finite quantities of oil, gas, metals and other non-renewable resources, and a limited capacity to absorb waste. If we overload the earth's capacities, or use up resources faster than they can replenish themselves, then the natural systems that support life on earth break down.

Living Beyond our Means

Scientists tell us that as human beings, we can't use all the productive land that exists entirely for our own needs if we want to survive, and they suggest that at least 30% of land needs protection. World leaders have committed to set aside just 12% of our land to protect the millions of other species on the planet, on whom our survival ultimately depends. If we set aside that 12% to protect biodiversity, and divide the remaining 88% of biologically productive area by the current world population, then we have 1.8 hectares per person to supply all our human needs and assimilate all our waste.

Researchers at the University of British Columbia have found that our *current* global resource

consumption and waste production requires 2.8 hectares per person. That is the *average* “ecological footprint” of a human being in the world today. In other words, human beings are in a state of “overshoot,” depleting resources faster than they can regenerate and producing more waste than the world can handle.

This is like living in debt, with a gradually accumulating ecological deficit. Just as the present generation is paying for over-spending in the 1970s and 1980s with higher tuition and reduced government services, so future generations will inherit the ecological debt of current ecological overshoot. We may have already begun to see its effects in the collapse of Atlantic ground-fish stocks, global warming, higher child asthma rates, and new environmental illnesses.

But all ecological footprints are not the same size. 30% of the world’s population consumes 70% of the world’s resources, and produces 70% of the world’s waste. The average African ecological footprint is just 1.3 ha. per person, and the average North American footprint is 11.8 ha. per person. The richest one-fifth of the world’s people consumes 45% of all meat and fish, 58% of all energy and 84% of all paper, and it owns 87% of all cars. The poorest one-fifth consumes just 5% of all meat and fish, less than 4% of energy, 1.1% of paper, and less than 1% of all cars.

This GPI *Atlantic* report has found that Nova Scotia’s average ecological footprint is 8.1 ha. per person, far in excess of the 1.8 ha. per person globally available. If all the world’s people were to consume at Nova Scotian levels, we would need four additional planets earth to provide the necessary resources and waste assimilation capacity.

Of this 8.1 hectares, transportation accounts for 1.6 ha., food for 2.4 ha., residential energy use for 1 ha. and all other consumption for the remaining 3.1 ha. Just as global ecological footprints differ, not all Nova Scotian ecological footprints are the same size. The Halifax Regional Municipality has a footprint of 8.4 ha. per person, and the wealthiest 20% of Nova Scotians have a footprint of 10.7 ha. per person (compared to 6.2 ha. for the poorest 20%), because the wealthy consume more resources and produce more waste.

The Nova Scotia ecological footprint has grown by 40% in the last 40 years, and it is projected to increase by another 12% to 9.2 ha. per person in the next 20 years. Our transportation footprint is expected to increase by 25% as more cars log more kilometres. The rapid increase in fuel-inefficient SUV’s, minivans and light trucks has expanded the transportation footprint sharply, with one SUV averaging three times the impact on the environment of a small car.

Reducing our Ecological Footprint: A Million Hectare Target for 2002

This report, Canada’s first *provincial* ecological footprint analysis, concludes that Nova Scotians could quickly and easily reduce their collective ecological footprint by 1 million hectares from 8.1 ha. per person to 7 ha. per person without compromising their quality of life. Consuming less of some items, shifting certain consumption choices, and changing public policy priorities can actually improve wellbeing and quality of life while reducing our impact on the environment. Suggested personal changes recommended in the GPI report include:

- Walking and riding a bicycle whenever possible.
- Carpooling or taking public transportation to work instead of driving alone.
- Driving smaller more fuel-efficient cars, and keeping them well-maintained.
- Buying more locally grown foods and locally produced goods to reduce transportation.
- Not overeating, but consuming the calories appropriate for our age and level of activity.
- Eating more grains, vegetables and natural foods.
- Reducing household energy use by turning off lights, turning down the temperature at

- night and when not home, hanging out the laundry to dry, and using energy efficient appliances.
- Reducing water consumption by using a water-efficient showerhead, turning off the tap when not in use, and collecting rainwater to water plants and lawns; and
 - Reusing, recycling and composting trash, and reducing packaging.

Beyond such individual choices, the GPI report also points to the social and political decisions that are necessary to reduce the province's ecological footprint to *less* than 7 ha. per person, and to become a model of responsible and sustainable living. These social choices include:

- Investments in public transportation and bicycle lanes.
- Integrated land use / transportation planning to counter suburban sprawl.
- Tax incentives to support environmentally friendly Danish-style co-housing developments.
- Support for local agriculture, sustainable farming methods, and nutritional education.

Nova Scotians have already dramatically reduced their solid waste footprint by 50% in just five years, and Nova Scotia's world leadership in composting, recycling and solid waste diversion is a model of government-citizen cooperation that can show a sustainable way forward into the future. Bear River's award-winning Solar Aquatic sewage and waste water treatment system has also become a model of sustainable water use. Clearly, footprint reductions are not only possible but have already been successfully accomplished in some areas.

In the early 1980s too, Nova Scotians substantially reduced their energy footprint through switching to smaller, fuel-efficient cars, insulating their homes and other conservation measures, though the provincial energy footprint has started to creep upwards again in the 1990s. Today our total energy footprint (4.5 ha./person) is still 25% smaller than it was in 1979, but it is also 40% larger than it was in 1961. Nova Scotia today is at a crucial point in its history in developing an energy policy for the future. The innovative work of the Western Valley Development Authority in exploring wind-powered electricity generation in the Annapolis Valley could produce a model for the future that would substantially reduce the province's energy footprint

The average Nova Scotian's total ecological footprint (8.1 ha./person) is just two-thirds the size of the average American's footprint (12.2 ha./person), but it is still 30% higher than the average West European's footprint (6.3 ha./person), indicating that we might more productively look to Europe and elsewhere for workable models of sustainable development rather than to the United States. Denmark, for example, has become a world leader in wind energy; the Netherlands is actively promoting bicycle use and pesticide-free farming; BMW cars are now made with 35% recycled parts; and Curitiba, Brazil, has become a world leader in integrated land use / transportation planning and mass transit use.

In sum, for a Nova Scotia determined to reduce its ecological footprint, there is no shortage of outstanding examples of sustainable living and development, including powerful ones within its own borders. The purpose of this Ecological Footprint analysis is to encourage concrete public-private steps towards a more sustainable future that we are proud to leave to our children.

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Endnotes

¹ 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), 2000. *The Living Planet Report, 2000*, available at (www.panda.org) or (www.rprogress.org).

² 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.

³ Mathis Wackernagel and William E. Rees. 1996. *Our Ecological Footprint: Reducing Human Impact on the Earth*. New Society Publishers, Gabriola Island, BC.

⁴ Mathis Wackernagel and William E. Rees. 1996. *Our Ecological Footprint: Reducing Human Impact on the Earth*. New Society Publishers, Gabriola Island, BC. For details on the book, see <http://www.newsociety.com/oef.html>. For more details on the footprint method and its applications, visit Redefining Progress at <http://www.rprogress.org> or the Anáhuac University of Xalapa's Centre for Sustainability Studies in Mexico at <http://www.edg.net.mx/~mathiswa>.

⁵ Redefining Progress and the Center for Sustainability Studies contributed to the Living Planet Report by calculating the ecological footprint of the world's 150 countries with a population over one million, using 1996 data, as well as the ecological footprint for the world population from 1961 to 1997. Calculations are available at <http://panda.org/livingplanet/lpr00> or <http://www.rprogress.org/ef/LPR2000>. The original study of national footprints was: *Ecological Footprints of Nations: How Much Nature Do They Use? How Much Nature Do They Have?* See endnote 2. The methods are also described in 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).

⁶ Mathis Wackernagel (1998) supports this approach as indicated in his *The Ecological Footprint of Santiago de Chile* study, *Local Environment*, Vol. 3, No. 2, where he states "regional or municipal population 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" (p. 16). Nicky Chambers, Craig Simmons, and Mathis Wackernagel (2000) also support this approach in their book *Sharing Nature's Interest*. Earthscan Publications Ltd, London. "Where specific data about a city are not known then its footprint can be estimated by apportioning the per capita impact" (p.135).

⁷ The Alberta Ecological Footprint is based on the Nova Scotia Ecological Footprint methodology. Wilson, Jeffrey, 2000. *The Nova Scotia Ecological Footprint*, Genuine Progress Index Atlantic, www.gpiatlantic.org. In all cases the Alberta GPI attempted to model the same categories of study in order to create a framework for provincial comparison. The Nova Scotia and Alberta ecological footprints mark the beginning of a standardized provincial ecological footprint framework. For more information contact Jeff Wilson at info@gpiatlantic.org.

⁸ Statistics Canada web site. 2000.

⁹ The combined area of the Maritime provinces is 133,852 km² - New Brunswick (72,908 km²), Prince Edward Island (5,660 km²), Nova Scotia (55,284 km²). The area of Alberta is 661,848 km². Statistics Canada, 2000. Canadian Statistics, Land and Freshwater Area, Statistics Canada Web site, www.statcan.ca.

¹⁰ Other personal ecological footprint calculators developed in conjunction with Redefining Progress can be accessed at www.lead.org/leadnet/footprint/intro.htm sponsored by the Lead International Inc., and www.mec.ca/coop/communit/meccomm/ecofoot.htm sponsored by Mountain Equipment Co-op.

¹¹ 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).

¹² Rees, William. 2000. Personal Communication concerning recommendations on the Alberta GPI methodology.

¹³ The Living Planet Report 2000 is available at <http://panda.org/livingplanet/lpr00> or <http://www.rprogress.org/ef/LPR2000>.

¹⁴ We share this planet with over 10 million other species and should not use all the ecological space solely for human use. How much bioproductive area should be set aside for biodiversity preservation? How much is fair? As indicated, Mathis Wackernagel in his Canadian Footprint sets aside 12 percent as suggested by the politically accepted Brundtland Report, in order not to exaggerate the ecological scarcity of today. The Living Planet Report (see endnote 1) sets aside 10 percent, while conservative biologists recommend a minimum of 30 percent. The burden of this protection effort must also be shared by all of humanity and not only those regions where biologically productive spaces remain relatively untouched by humans.

¹⁵ Brundtland, G. H., 1987. *Our Common Future*, Report of the World Commission on Environment and Development, chaired by Gro Brundtland, Oxford University Press, p.166. The Alberta government in March 1995, as part of the Special Places policy aimed to increase the total protected areas in the province by an additional 2.7 percent (18,070 sq km) by the year 2000 in order to meet the 12 percent target as set out in Brundtland Report. The government has failed to reach this target with 11.3 percent of the province currently designated as a protected area. For more information please see the Parks and Wilderness report, #21 in the GPI series.

¹⁶ The global sustainability deficit is used to express the ecological footprint area above 1.8 ha. It is calculated by subtracting a region's per capita footprint from the available global ecological capacity per capita. If a region's per capita footprint is less than 1.8 ha than the global sustainability deficit will be negative. The global sustainability deficit is based ecological deficit calculated in *The Ecological Footprint of Nations Study*. See endnote 2. The concept is also used in the *Living Planet Report 2000*.

¹⁷ The population of China in 1998 was 1.26 billion (United Nations, Population Division Department of Economic and Social Affairs, www.unfpa.org). With a footprint of 10.7 hectares per capita, China would require 13.5 billion hectares of biologically productive land to support consumption demands. According to the Living Planet Report (see endnote 1), in 1996, there were 12.6 billion hectares of biologically productive land on the planet. These consisted of 1.3 billion hectares of cropland, 4.6 billion hectares of grazing land, 3.3 billion hectares of forest land, 3.2 billion hectares of fishing ground, and 0.2 billion hectares of built up land. In 1996, this amounted to 2.2 hectares per person assuming that no land is set aside to protect biodiversity.

¹⁸ Total population (1996) for countries with an ecological footprint of 1.8 ha or less = 4.0 billion. Total population (1996) for countries with an ecological footprint greater than 1.8 h = 1.8 billion. Estimates derived from Living Planet Report 2000 data tables. See endnote 1.

¹⁹ See endnote 2.

²⁰ Using 1996 base year for comparison to Mathis Wackernagel's Canadian footprint estimate. 1996 footprint - Alberta = 10.7 ha/capita; Canada = 7.7 ha/capita. 1996 footprint including 12 percent set aside for biodiversity - Alberta = 12.2; Canada = 8.7. Mathis Wackernagel's 1996 Canadian Footprint estimate was included as part of the Living Planet Report 2000. See endnote 1. Using 1999 estimates, the Alberta footprint per person (10.7 ha) is 37 percent larger than the Canadian footprint per person (7.8 ha).

²¹ National Energy Board, 1999. Canadian Energy, Supply and Demand to 2025, available at www.neb.gc.ca/energy/sd99/index.htm.

²² Statistics Canada, Quarter 4, 1999. Canadian Vehicle Survey, Catalogue no. 53F0004XIE.

²³ In Canada, there are 0.17 gasoline trucks per capita, whereas in Alberta there are 2.4 gasoline trucks per capita. Natural Resources Canada, 1999. Canada's Emissions Outlook: 1997-2020 Determinants of Transportation Demand, available at www.nrcan.gc.ca/es/ceo/update.htm.

²⁴ Alberta has an average number of 6.5 rooms per dwelling with an average of 0.4 persons per room. Canada has an average of 6.1 rooms per dwelling with an average of 0.4 persons per room. Statistics Canada, 1996. "Selected Characteristics for Census Divisions and Census Subdivisions," 1996 Census, Catalogue no. 95-190.

²⁵ Alberta energy source breakdown: 86.4 percent coal and 12.0 percent oil. Canada energy source breakdown: 29 percent coal and 3.2 percent oil. Sectoral energy use breakdown from National Energy Board, 1999. *Canadian Energy, Supply and Demand to 2025*.

- ²⁶ In 1996, Alberta hydroelectricity consumption made up 0.5 percent of total Albertan energy consumption. Canada hydroelectricity consumption made up 11 percent of total Canadian energy consumption. Statistics Canada, 1996. *Primary Energy Supply And Demand ANN NRCDA*, Cansim Matrix 2481.
- ²⁷ Mathis Wackernagel and William E. Rees. 1996. *Our Ecological Footprint: Reducing Human Impact on the Earth*. New Society Publishers, Gabriola Island, B.C. p. 69.
- ²⁸ Statistics Canada. 1996. *Primary Energy Supply And Demand ANN NRCDA*, Cansim Matrix 2481.
- ²⁹ National Energy Board. 1999. *Canadian Energy, Supply and Demand to 2025, Appendix 3*, available at www.neb.gc.ca/energy/sd99/index.htm.
- ³⁰ Pape-Salmon based his estimates for Alberta on the work by Thomas Johansson, H. Kelly, A. Reddy, and R. Williams. 1993. "Renewable Energy Sources for Fuels and Electricity." Island Press, Washington D.C. "Utilities Strategies for Using Renewables" (final chapter: p. 1011).
- ³¹ See endnote 32.
- ³² Based on assumption that renewable energy sources would have a 0.001GJ (ha/capita) ratio.
- ³³ Chambers, Nicky, Craig Simmons, and Mathis Wackernagel. 2000. *Sharing Nature's Interest*. Earthscan Publications Ltd, London, p. 140.
- ³⁴ This is based on Mathis Wackernagel's (1998) Footprint distribution in Santiago de Chile chart in *The Ecological Footprint of Santiago de Chile*, Local Environment, Vol. 3, No. 2. Wackernagel used income distribution data. The Alberta footprint distribution is based on expenditure information, which this author felt was more proportional to an individual's purchasing habits.
- ³⁵ Mathis Wackernagel and William E. Rees. 1996. *Our Ecological Footprint: Reducing Human Impact on the Earth*. New Society Publishers, Gabriola Island, B.C. p. 102.
- ³⁶ Wilson, Jeffrey. 2000. *The Nova Scotia Ecological Footprint*, Genuine Progress Index Atlantic, www.gpiatlantic.org.
- ³⁷ National Energy Board. 1999. *Canadian Energy, Supply And Demand to 2025, Appendix 3, Table A3.7a: Demand, Case 1* available at www.neb.gc.ca/energy/sd99/index.htm.
- ³⁸ Statistics Canada. 1998. *Provincial Economic Accounts, Annual Estimates*, Table 17, Catalogue no. 13-213-PPB.
- ³⁹ Natural Resources Canada. 1999. *Canada's Emissions Outlook: 1997-2020* available at www.nrcan.gc.ca/es/ceo/update.htm
- ⁴⁰ Statistics Canada- Projected population, Projection 2: Medium-growth scenario, by age group and sex, Canada, provinces and territories, 1999-2026, July 1 (based on 1999 estimates).
- ⁴¹ Wackernagel, M., L. J. Onisto, E. Krause. 1998. *How Big is Toronto's Ecological Footprint? Using the concept of Appropriate Carrying Capacity For Measuring Sustainability*, Center for Sustainable Studies and The City of Toronto, Toronto, Canada.
- ⁴² This considers only the transportation related costs. The definition of a local produced good is debatable. Suggested definitions include the local bioregion, the province, or the prairie provinces. This paper assumes that a locally produced good has travelled no more than 500 km. According to the National Round Table on Environment and Economy the average food item in Canada travels over 2,000 kilometres to get to the dinner table. National Round Table on the Environment and the Economy. 1997. *The Road to Sustainable Transportation in Canada*, Renouf Publishing Co., Ottawa.
- ⁴³ USPIRG. 1999. *Big Cars, Dirty Air*, available at www.uspirg.org.
- ⁴⁴ Based on table in *The Nova Scotia Ecological Footprint*, Genuine Progress Index Atlantic (2000). See endnote 38.
- ⁴⁵ 1.8 ha per person is the amount of biocapacity or footprint space available per person if we take all the global biocapacity and divide by the global population. See endnote 20.