Comprehensive Wealth

COMPREHENSIVE WEALTH IN CANADA - MEASURING WHAT MATTERS IN THE LONG RUN

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PREFACE

As Canadians, we are not as wealthy as we think. We assume that our economy is doing well because quarterly and annual indicators like gross domestic product (GDP) tell us so. Indeed, Canada's per capita GDP, one of the highest in the world, has been on an upward trend for a very long time. But this represents a narrow view of Canada's progress.

Much has changed since GDP was first developed as an indicator of economic progress. Climate change and biodiversity loss have progressed at frightening speeds. Technological innovation has transformed our lives, but also resulted in job losses and stagnating wages. Globalization has generated vast amounts of wealth, but the benefits have not been shared equally. Facing these challenges requires new ways of conceptualizing and measuring progress. This report offers a new approach using a powerful concept called comprehensive wealth.

The report examines in considerable detail the four parts of Canada's comprehensive wealth: our produced, natural, human and social capital. The evidence reveals strains in each category. Despite more people than ever obtaining higher levels of education, growth in per capita human capital has been stagnant over the past 30 years. Canada's natural capital has declined by one-quarter per capita, while 70 per cent of all investment in produced capital has been clustered in two volatile areas: housing and oil and gas.

The challenges of addressing these trends will not be easily overcome. However, by exposing the underlying structural changes underway in Canada, this report helps to chart a better path forward.

High on the list is preservation of our natural capital. Canada cannot continue for another three decades to draw down on its natural capital at the rates revealed in this study. In parallel, strategic investments in education and training, among other areas, are needed to kick-start growth in our stagnant human capital. Canada's workforce must be better positioned to champion higher value-added and innovative sectors. The lack of diversification in produced capital is locking in Canada's reliance on the oil and gas sector at a time when businesses are investing in clean energy pathways.

We hope that—in demonstrating the value of a comprehensive wealth approach—this work serves to motivate Canada to adopt it as a systematic barometer of national progress. We don't judge our personal well-being solely by our output at work. Likewise, we should not view the progress of the nation through such a narrow lens.

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President, International Institute for Sustainable Development

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Every effort has been made to ensure that the report is free from errors in interpretation, analysis or presentation. Any errors that remain in spite of this are the sole responsibility of the IISD project team.

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EXECUTIVE SUMMARY

WHY WE SHOULD MEASURE COMPREHENSIVE WEALTH

Canadians are constantly bombarded with data, from apps measuring our footsteps to indicators of public health, nutrition, crime and sports stats. The challenge today is not a lack of data. It is whether we have the right kind of information to foster knowledge about our families, communities and nation.

Perhaps the most pervasive and influential measurement is gross domestic product, or GDP.

GDP, which measures national income, emerged from the need to better understand economic challenges following the Great Depression and to help track critical supply chains during the Second World War. Ever since, it has played a key role in tracking economic performance within and between countries.

Just as GDP evolved during a period of change when new measures were called for, there are calls today to complement GDP with other measures. The great challenges of today—from climate change to global trade tensions, income inequality and the remarkable growth of information technologies—are far removed from the concerns of GDP's founding architects.

Accordingly, Canadians need new ways to measure how the nation is progressing. They need measures that focus not only on short-term income growth but also on longer-term development prospects. The chief economist of the World Economic Forum recently summed up the need well when she posed the question, "[Are we] living at the expense of tomorrow" by "building up debts that we will simply leave to future generations?" (Blanke, 2016). The answers to such long-term questions lie not in measures of income but in measures of wealth—and more particularly, *comprehensive wealth* (Text Box ES1).

Text Box ES1. What is comprehensive wealth and why does it matter?

Every country has strengths to build upon in creating well-being for its citizens. Some countries have sophisticated machinery and infrastructure that allow them to create high-value products and ship them to the four corners of the world. Others have holdings of stocks and bonds that generate large financial returns. Still others have an environment that provides valuable natural resources and opportunities to enjoy unspoiled nature. Every country has citizens with knowledge and skills that can be used to run businesses and institutions and norms that create the trust needed for people to engage in society and the economy.

Each of these strengths can be thought of as a type of capital, or a set of assets. Machinery and infrastructure are examples of **produced capital**, so called because they have to be produced by people. Holdings of stocks, bonds and other financial assets represent **financial capital**. The land, resources and ecosystems that make up the environment can be thought of as **natural capital**. Knowledgeable and skilled citizens represent a stock of human capital. Finally, societal norms and the trust and cooperation they engender make up **social capital**.

Together, these forms of capital represent what has come to be known as comprehensive wealth. Different countries have different levels and mixes of comprehensive wealth. Some have a lot of natural capital but less produced capital, or vice versa. Likewise, the amounts of financial, human and social capital will vary from place to place. In total, some countries have substantial comprehensive wealth portfolios and others have smaller ones. But all countries have at least some assets in each of the five categories of the portfolio.

The per capita value of the comprehensive wealth portfolio is an important indicator because wealth is the foundation for much of national well-being. Nearly all the goods and services people enjoy—pretty much everything produced in the market plus many goods and services produced outside of it—are produced using the assets in the comprehensive wealth portfolio. The enjoyment—or consumption—of these goods and services contributes in many ways to well-being. Things like nourishment, shelter and mobility are obvious factors. Well-being is enhanced by the fruits of the comprehensive wealth portfolio in less familiar ways too, such as the enjoyment of a beautiful sunset and the freedom to walk city streets safely at night.

Tracking the evolution of comprehensive wealth over time is key to understanding whether growth in assets is keeping pace with growth in income or whether wealth is declining due to inadequate investment. This matters very much, especially in the long run. Only when comprehensive wealth growth keeps pace with income growth will the latter be sustainable in the long run. If comprehensive wealth declines over time due to inadequate investment, income growth may eventually come to a halt, putting well-being at risk (Hamilton & Clemens, 1999; Dasgupta & Mäler, 2000; Dasgupta, 2014).

To the extent wealth is measured—which is hardly at all in most countries—reporting focuses only on produced and financial capital. Comprehensive wealth goes well beyond this to include natural, human and social capital. Though less well known than produced and financial capital, these other forms of capital are just as essential to the nation's well-being as machinery, buildings and bonds.

Tracking the value of the nation's comprehensive wealth "portfolio" is important because of the link between wealth and long-term development prospects: that is, its capacity to create and sustain well-being for its citizens.

The assets that make up the comprehensive wealth portfolio are the basis for producing nearly all goods and services that people consume—obvious things like food, electricity and health care, but also clean air, healthy forests and safe communities. The consumption of these goods and services is a large part of what creates individual well-being. That is why comprehensive wealth is so important. Text Box ES1 expands on these points.

Development requires sustaining consumption opportunities over time. More consumption today at the expense of less consumption tomorrow is not development at all. Understanding whether the nation is truly developing, therefore, requires understanding how comprehensive wealth, and not just how quickly GDP, is evolving. Yet no country, including Canada (Text Box ES2), currently measures comprehensive wealth.

Several international bodies have called on countries to go beyond GDP and begin measuring comprehensive wealth to gain greater insight into development and its sustainability. After all, they point out, GDP was never intended as a measure of well-being. The United Nations (UNECE, 2009) and the Commission on the Measurement of Economic Performance and Social Progress chaired by Nobel Prize-winning economist Joseph Stiglitz (Stiglitz et al., 2009), have both called for measures of comprehensive wealth. In a similar vein, the head of the International Monetary Fund remarked at the 2016 World Economic Forum that "there are lots of things that we don't measure well. We have to […] assess, and probably change, the way we look at the economy."[I]

Though no national government yet does so, a number of other organizations have started to estimate comprehensive wealth. The World Bank published its first figures in the 1990s (Hamilton & Clemens, 1999) and it recently added a related indicator to its global development indicators. The United Nations also works in the area, releasing comprehensive wealth reports with estimates for most countries in 2012 and 2014 (UNU-IHDP & UNEP, 2012, 2014). The present study—one of the first to measure comprehensive wealth using detailed data for a single country[II]—builds upon this and other work.

[I] See https://www.weforum.org/agenda/2016/01/gdp.

[II] The first study to focus on comprehensive wealth for a single country, which also happens to have been carried out for Canada, was conducted by the Ottawa-based Centre for the Study of Living Standards (Osberg & Sharpe, 2011).

Text Box ES2. What is known about wealth in Canada?

To the extent wealth is studied at all in most countries, measures are usually limited to produced and financial capital—just two of the five components of the comprehensive wealth portfolio. Canada stands out as something of an exception here. Thanks to the efforts of Statistics Canada, Canada regularly measures produced and financial capital (the only country to do so on a quarterly basis, it is worth adding). Natural capital is also much better measured in Canada than in most other countries. Official statistics on fossil fuels, minerals, timber and land go back several decades. Though human capital is not measured on a regular basis, Statistics Canada has published high-quality research studies on the topic (Gu & Wong, 2010, 2012). It has also published ground-breaking studies of social capital (Turcotte, 2015a).

Still, despite what might be the most complete wealth data anywhere, significant gaps remain that prevent a full understanding of comprehensive wealth in Canada. Given this, one of the conclusions of this study is that the federal government should fund Statistics Canada to begin measuring comprehensive wealth on a regular basis. Text Box 8 presents a research agenda to that end. Priority should be given to measuring human and social capital, especially in monetary terms, as these are currently addressed only through research studies. After this, filling the gaps in the official measures of natural capital—commercial fisheries, water and all ecosystems—is next most important.

Comprehensive wealth is suggested as a complement for GDP, not a replacement for it. Both are necessary to assess the nation's development. But Canadians need to begin thinking more about the country's long-term trajectory. GDP says plenty about income in the latest quarter but is silent on the prospects for the future. In contrast, comprehensive wealth focuses on the long term, answering essential questions about the sustainability of development and well-being. The President of the C.D. Howe Institute put it well when he remarked recently that "GDP is so twentieth century." Measuring wealth, he went on, is "the Next Big Thing" (Robson, 2015).

Prime Minister Trudeau, for his part, has underpinned the need for a longer-term view by noting that Canada's greatest asset is not its resources but its resourcefulness—that investing in education to help people learn, think and adapt is essential to improving their lives, and that confident countries invest in their future.[III] He might well have added that confident countries measure how effective their investments are actually increasing wealth.

[III] See http://pm.gc.ca/eng/news/2016/01/20/canadian-opportunity-address-right-honourable-justin-trudeau-prime-minister-canada.

SUMMARY OF FINDINGS

Based on a suite of indicators compiled using the best data and methods available today, this study[IV] reviewed Canada's comprehensive wealth performance over the 33-year period from 1980 to 2013. This timeframe extends well beyond business and political cycles, ensuring that the results reveal trends free from the ebb and flow of markets and policies. Here is what was found.

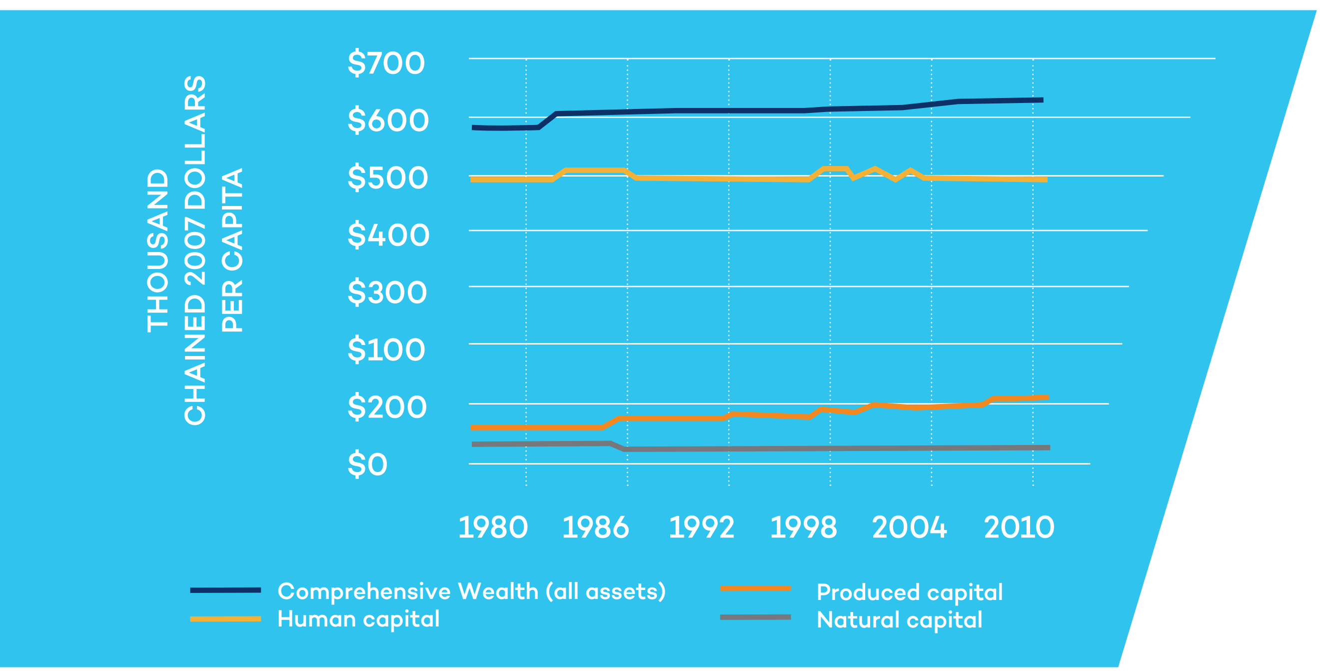
Overall, comprehensive wealth in Canada grew in real per capita terms[V] by 7 per cent from 1980 to 2013 (Figure ES1 and Table ES1). In other words, the basis for Canada's capacity to generate the goods and services needed to sustain consumption was only slightly larger on average in 2013 than in 1980. On an annualized basis, growth in comprehensive wealth was a lacklustre 0.19 per cent per year. This finding is largely consistent with the handful of other studies of comprehensive wealth that have been undertaken for Canada (Text Box ES5) provides a comparison of these studies with the results here.

At the same time, Canadians consumed far more goods and services in 2013 than in 1980. Average individual consumption grew by 54 per cent over the period, or 1.36 per cent per year.

The gap between these two trends—relatively slow growth in comprehensive wealth and much faster growth in consumption—raises several concerns about long-term sustainability.

First, consumption growth was bolstered by the drawdown of natural capital. Due to a combination of physical depletion and changing market conditions, the value of Canada's minerals, fossil fuels, timber and agricultural land per person declined by a startling 25 per cent between 1980 and 2013 (Figure ES2). More recent data signal an even greater decline due to the steep drop in global oil prices. On top of this, the series of climate and ecosystem indicators compiled for the study point to declines in other forms of natural capital.

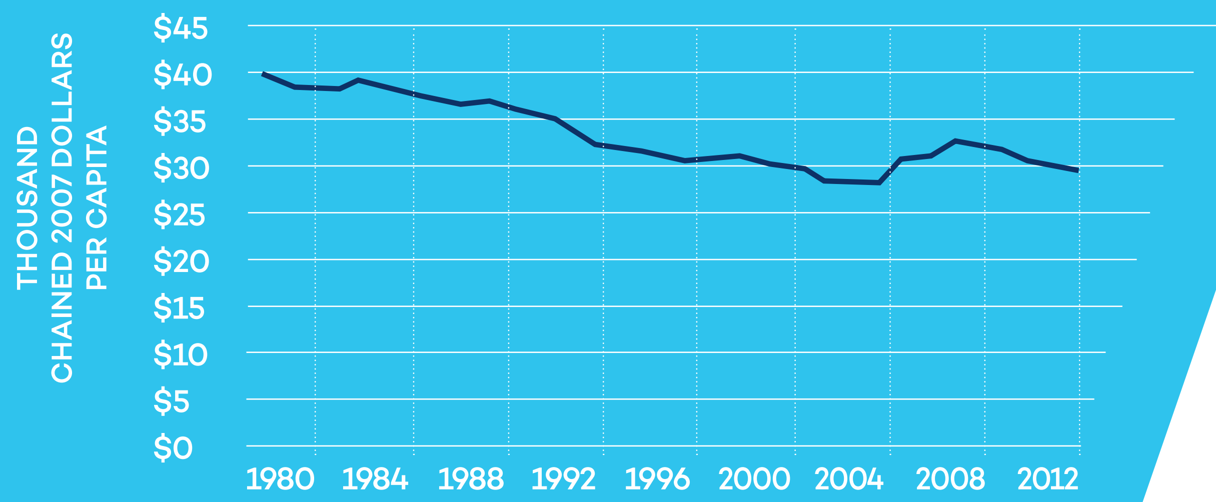
Figure ES1. **Comprehensive wealth per person, Canada, 1980–2013**



IV See Text Box ES3 for a brief overview of the concepts, data and methods used in the study.

V All wealth values in this study are expressed in real (chained 2007 dollar) terms per capita to account for the effects of growth in prices and population over time. For ease of reading, the modifiers "real" and "per capita" are not always used when values are reported. When they are not, the reader should take for granted that the figures are in real per capita terms unless otherwise indicated.

Figure ES2. Natural capital per person, Canada, 1980–2013



Human capital—the largest component of comprehensive wealth (80 per cent)—did not grow at all between 1980 and 2013 even though more Canadians graduated with diplomas. This means that, even with improved credentials, the average Canadian worker had the same lifetime earning potential in 2013 as in 1980.

Produced capital was the bright spot in the comprehensive wealth portfolio, growing by 73 per cent per person over the period, or 1.68 per cent per year. A closer look, however, reveals that this growth was highly concentrated. Some 70 per cent of the growth in total produced capital was due to expansion in just two areas: housing and the oil and gas extraction industry. This raises concerns about the concentration of the economy in areas known for volatility and that face uncertainty in today's world, especially in the case of oil and gas extraction.

Social capital, which can only be measured in qualitative terms at the moment, showed signs of stability but not growth based on the series of non-monetary indicators compiled for the study.

Text Box ES3. Concepts, data and methods used in the study

Though still new to many people, the concept of comprehensive wealth dates back to the 1990s, and thinking about the individual elements of it dates back much further than that, most famously to Adam Smith and his 18th century work on the wealth of nations. More recently, the late University of British Columbia economist Anthony Scott (1956) had already characterized the environment in natural capital terms by the 1950s. Work on measuring human capital began seriously in the 1960s (Schultz, 1960, 1961). Social capital, though somewhat newer, has been an area of active research since the 1980s (Coleman, 1988; Putnam, 1995).

To measure comprehensive wealth for Canada, this study used the best data available from Statistics Canada and, in a few cases, other sources. Global Forest Watch Canada was the main source of data used to compile the ecosystem indicators. In addition, data from the OECD were used for several indicators of human and social capital.

The methods used in the study are well established and would be familiar to anyone accustomed to working with national economic, environmental or social statistics.

Table ES1. Trends in comprehensive wealth and its components, Canada, 1980-2013

Indicator	Per capita level (chained 2007 dollars)		Growth (1980–2013)	
	1980	2013	Total	Annualized rate
Comprehensive Wealth Index	$592,000	$631,000	7%	0.19%
Produced Capital Index	$58,100	$100,700	73%	1.68%
Market Natural Capital Index	$39,800	$29,200	-25%	-0.93%
Non-Market Natural Capital Index			Unknown, but available non-monetary indicators suggest a decline	
Human Capital Index	$500,000	$500,000	0%	0%
Social Capital Index	n/a	n/a	Unknown, but available non-monetary indicators suggest stability	
Consumption*	$24,300	$37,500	54%	1.36%

* Consumption is shown for sake of comparison only; it is not a component of comprehensive wealth.

Taken as a whole, the trends in Table ES1 above paint a worrisome picture. Though Canada's development is not unsustainable—comprehensive wealth would have to be declining in real per capita terms for that to be the case—neither can it be said to rest on a robust base. Growth in comprehensive wealth has been slow, especially in comparison to growth in consumption, and its individual components show various signs of weakness. From the significant decline in natural capital to flat human capital, to highly concentrated growth in produced capital, real strength in Canada's comprehensive wealth portfolio is hard to find.[VI] Text Box ES4 expands on these concerns with additional data.

[VI] This is consistent with the recent conclusion of the federal government's Economic Advisory Council that per capita GDP growth could fall from its historic level of about 1.9 per cent annually to 0.8 per cent in the coming decades if policy changes to address the challenges associated with demographic shifts (such as ageing of the workforce) are not implemented (Advisory Council on Economic Growth, 2016a).

Though Canada has not been managing its comprehensive wealth portfolio as well as it could, the country is fortunate to remain very wealthy. In fact, thanks to its vast reserves of natural capital, the United Nations has ranked Canada first among G7 nations in terms of the level of comprehensive wealth per capita (UNU-IHDP & UNEP, 2014). This clearly puts the country in a position of strength vis à vis its peers. At the same time—and consistent with the findings of this study—the UN ranked Canada last among G7 members in terms of growth in comprehensive wealth. In other words, other countries are doing better than Canada at managing the growth of their comprehensive wealth portfolios. And they're catching up as a result. In 1990, the average per capita comprehensive wealth in other G7 countries was 72 per cent of Canada's; by 2010, this share had climbed to 83 per cent (Table ES2).

Table ES2. United Nations' estimates of comprehensive wealth for G7 countries

Country	Real comprehensive wealth per capita*			Annual growth (1990–2010)	
	1990	2010	Rank (2010)	Rate	Rank (2010)
Canada	475,846	502,972	1	0.28%	7
France	342,866	425,022	5	1.08%	2
Germany	325,513	435,655	3	1.47%	1
Italy	276,943	324,712	7	0.8%	5
Japan	361,234	432,236	4	0.9%	3
United Kingdom	345,487	409,074	6	0.85%	4
United States	411,673	463,375	2	0.59%	6

* All values expressed in thousand constant 2005 U.S. dollars.

Source: UNU-IHDP & UNEP, 2014.

Text Box ES4. Concerns regarding sustainability – further details

The fact that per capita consumption grew more quickly than per capita comprehensive wealth over the study period is a concern because consumption growth that is faster than growth in comprehensive wealth is sustainable in certain instances. One is when productivity gains are large enough to account for the gap.[XII] However, Canadian productivity growth from 1980 to 2013 was too small (0.11 per cent annually) to explain the observed divergence.[XIII]

In the absence of adequate productivity growth, the gap between growth in consumption and comprehensive wealth points to insufficient investment in the comprehensive wealth portfolio. In other words, Canadians appear to have invested too little overall or not invested in the right places for comprehensive wealth to grow at the rate needed to match the growth in consumption. This may have been because too much income was used to support current consumption and not enough set aside for investment or because the investments that were made did not create new wealth fast enough, or both.

The trend in natural capital is of particular concern, as natural resources have long been one of the engines of Canada's consumption growth. As noted above, the per capita value of Canada's natural capital fell by 25 per cent between 1980 and 2013—a decline of a quarter in little more than a generation. More up-to-date data from Statistics Canada show that its value fell even further after 2013 due to the drop in global oil prices: by the end of 2015, the total nominal value of Canada's natural capital was 75 per cent lower than at the beginning of 2014.[IV] Unless oil prices recover, this loss in wealth may not be recovered.

Also of concern is the flat trend in human capital—the largest component by far of comprehensive wealth. This trend persisted even though a greater percentage of Canadians graduated with advanced academic qualifications in 2013 than in 1980.[X] The reasons for the lack of growth in Canadian human capital are complex and further research is needed to understand them. Evidence shows that other developed countries have succeeded in increasing human capital, so the problem is certainly not universal.[XI] Part of the explanation lies in the aging of the Canadian workforce, since older workers have fewer years of work left and, by definition, lower levels of human capital. There is more to it though. It may be that increased levels of education are needed just to maintain a given level of human capital today. Or it may be that Canada has not been investing in areas of education that are translating into increased human capital. Unfortunately, available evidence on the investment in education in Canada is conflicting, so a clear answer is not possible.

Though produced capital was a relative bright spot in Canada's comprehensive wealth portfolio, growing at 1.68 per cent annually over the study period, here too there are reasons for concern. Canada's produced capital is tightly coupled with its declining natural capital base and has become more so over time. In 1980, the oil and gas extraction industry owned about 9 per cent of the stock of produced capital in the business sector. From 1980 to 2013, investment by this industry accounted for 38 per cent of all growth in business-sector produced capital.[XII] As a result, by 2013, the share of produced assets owned by this industry had more than tripled to 28 per cent.

The other engine of produced capital growth over the period was housing. Other things being equal, a growing housing stock is positive for well-being and sustainability. However, the degree to which it—along with oil and gas extraction infrastructure—accounted for growth in produced capital over the study period is worrisome from an economic diversification perspective.

[VII] Productivity measures the efficiency with which assets are used to create outputs. If productivity grows, more output can be created from the same asset base, other things being equal.

[VIII] Statistics Canada, *Multi-factor Productivity*, CANSIM Table 383-0021.

[IV] Statistics Canada, *National Balance Sheet Accounts*, CANSIM Table 378-0121.

[X] Statistics Canada, *Census of Population and National Household Survey*.

[XI] The United Kingdom, Australia and New Zealand all had growing rates of human capital during periods overlapping with the study period here, though the time series available for those countries are all much shorter. The United States, like Canada, did not show growth in human capital based on available data (Christian, 2011; Office for National Statistics, 2011; Wei, 2008; Le et al., 2006).

[XII] This figure should not be confused with the figure of 70 per cent mentioned above, which referred to the share of housing *plus* the oil and gas industry in the growth of total produced capital. The figure of 38 per cent here refers to just the oil and gas industry and to just produced capital owned by the business sector (houses being owned by the household sector).

Text Box ES5. Comparison with other studies

Comprehensive wealth has been measured for Canada in two earlier studies—the Index of Economic Well-Being compiled by the Ottawa-based Centre for the Study of Living Standards (CSLS) (Osberg & Sharpe, 2011) and a global report covering 140 countries prepared by the United Nations (UNE-IHDP & UNEP, 2014).[XIII] The table below summarizes the results of these studies and compares them with the results here. Taking account of differences in data and methods, the results of all three studies are broadly consistent.

Like this study, the study by the CSLS made use of Canadian data. It also considered essentially the same time period. The major difference between the studies is in the approach to measuring human capital. The CSLS used its own estimate of human capital based on the cost of educational investments. The estimate used here (which is taken from a Statistics Canada research study and is, arguably, better suited to the analysis of sustainability) is based on the value of lifetime earnings. This difference in approach explains nearly all of the divergence in the results of the two studies. If the CSLS's estimate of human capital is replaced with Statistics Canada's estimate, the two studies come to essentially identical conclusions.

Comparing results with the UN's global report is less straightforward because the UN measures comprehensive wealth in U.S. dollars and uses methods adapted to the production of estimates for 140 countries with widely varying data availability and quality. The UN's time series (1990–2010) is also shorter than the one here. These differences notwithstanding, the UN's findings are broadly consistent with those here. Like this study, the UN finds that Canadian comprehensive wealth grew relatively slowly in recent decades. Both studies conclude that produced capital grew strongly and natural capital declined substantially. The main difference is, again, in human capital, which UNEP estimates to have grown 0.63 per cent annually from 1990 to 2010 (based on a lifetime income approach similar to this study). The corresponding figure here is 0.0 per cent. An important reason for this discrepancy is the UN's use of a very high discount rate (8.5 per cent) to deflate future earnings. Such a high discount rate is appropriate for many of the countries in the UN's study, but not for Canada; Statistics Canada used a value of 5.1 per cent in its study. The remaining differences are likely explained by the fact that the UN used data from global databases to estimate human capital, while this study used an estimate directly from Statistics Canada.

	Centre for the Study of Living Standards		UNEP Global Report		This Study	
Indicator	Per capita level in 2013 (constant 2007 dollars)	Annual growth (1981–2013)	Per capita level in 2010 (constant 2005 U.S. dollars)	Annual growth (1990–2010)	Per capita level in 2013 (chained 2007 dollars)	Annual growth (1980–2013)
Comprehensive Wealth Index	$267,000	1.21%	$503,000	0.28%	$613,000	0.19%
Produced Capital Index	$101,000	1.55%	$108,000	2.3%	$100,700	1.68%
Market Natural Capital Index	$19,100	-0.88%	$128,000	-1.46%	$29,200	-0.93%
Human Capital Index	$154,000	1.16%	$268,000	0.63%	$500,000	0.0%

[XIII] The World Bank has also produced studies that have measured comprehensive wealth for Canada. No comparison is made with them here because they do not include direct estimates of human capital and, therefore, are less easily compared with the results here.

Text Box ES6. Trends in ecosystem, climate and green growth indicators

A number of non-monetary **indicators related to ecosystems and the climate system** were included in this study to complete the portrait of natural capital. Their trends are summarized in the table below. Overall, they point to declines in non-market natural capital on top of the decline in the value of market natural capital.

Theme	Indicator	Trend	
Ecosystems	Forests	• Slight decline in forest area between 2000 and 2011. • About 40% of forests were considered "developed" in 2011. [XIV]	↓
	Wetlands	• Wetland area declined in most parts of the country (other than the Maritimes and the North) between 2000 and 2011. • With most of the country's remaining wetlands found in northern regions, only about one fifth were considered developed.	↓
	Surface Water	• No assessment of change over time possible. • Nationally, 20% of surface water areas were considered developed, rising to 40% in NFLD, NB, NS, PEI, AB and BC.	???
	Grasslands	• Slight decline in grasslands from 2000 to 2011. • Unlike wetlands, remaining grasslands are significantly developed (95%).	↓
Climate	Precipitation	• Precipitation generally increased in Canada between 1948 and 2014, consistent with climate change predictions.	↓
	Temperature	• Temperature showed a trend similar to that of precipitation, with an overall increase nationally from 1948–2014, consistent with climate change predictions.	↓
	Snow Cover	• In spite of increased precipitation, annual average snow cover declined across the country from 1972–2011, consistent with climate change predictions.	↓
	Glacier Mass	• The mass of selected glaciers in the Western Cordillera and High Arctic declined from 1960 to 2007, consistent with climate change predictions.	↓
	Water Yield	• The annual renewal of Canada's freshwater resources declined in the southern part of the country from 1971 to 2004, consistent with climate change predictions.	↓
	Sea Ice Extent	• The extent of sea ice declined from 1968 to 2010, consistent with climate change predictions.	↓

In addition to the natural capital indicators, the study also included a **case study on green growth** using data compiled by the OECD.[XV] The case study provided some evidence that pressure on Canada's natural capital is being brought under control but also that more could be done.

Indicators related to greenhouse gas productivity and water productivity both improved in recent years, though Canada ranked only 31st out of 34 OECD member states in terms of greenhouse gas productivity in 2013.

Canada figured among global leaders in the 1990s in terms of environmental innovation, though the country stood well below the OECD average in 2013.

In terms of environmental taxes, Canada ranked second last among OECD member states in 2013, though its performance in this regard is likely to improve as the federal and provincial governments move toward placing a price on carbon emissions.

[XIV] Ecosystems are considered "developed" if they are found within 1 kilometre of a development feature such as a road, pipeline or town.

[XV] OECD, *Green Growth indicators database.*

Text Box ES7. Trends in social capital indicators

Though no monetary assessment of social capital was possible for this study, a number of non-monetary indicators were available from Statistics Canada. They are divided into indicators of civic engagement and indicators of trust and cooperative norms. In general, they are available for much shorter time periods than the monetary estimates of produced, natural and human capital compiled for this study.

Overall, only one of the indicators of **civic engagement** (*Diversity in Social Networks*) showed a strong and consistent upward trend over the period considered. None of the indicators of **trust and cooperative norms** showed a consistent upward trend over the period, with considerable inconsistencies in results across time and regions. On the basis of these indicators, social capital would appear to be stable, but not growing, during the periods studied.

Theme	Indicator	Trend	
Civic Engagement	Participation in Group Activities	• Participation in group activities rose slightly from 2003 to 2008 but then remained steady until 2013.	⇔
	Volunteering	• Volunteering rates rose slightly from 2004 to 2010 and then fell again in 2013.	⇔
	Diversity in Social Networks	• The share of people having contact with friends from visibly different ethnic groups increased steadily between 2003 and 2013.	⇑
	Control over public decisions	• The share of people feeling that they had some degree of control over public decisions increased substantially between 1993 and 2000 but then remained more or less stable until 2011.	⇔
	Voter Turnout	• Voter turnout in federal elections trended generally downward from 1979 to 2007 but rose again in the last two federal elections though not to its 1979 level.	⇔
Trust and Cooperative Norms	Generalized Trust	• Generalized trust showed essentially no change between 2003 and 2013.	⇔
	Trust in Neighbours and Strangers	• Trust in neighbours was unchanged from 2003 to 2013, while trust in strangers increased slightly; both dipped significantly in 2008 before recovering again in 2013.	⇔
	Trust that a Lost Wallet Will Be Returned	• Trust that a lost wallet will be returned was unchanged between 2003 and 2008.	⇔
	Trust in Institutions	• Trust in institutions, measured as confidence in the federal government, varied considerably from 1993 to 2011, though there was a general trend toward greater confidence.	⇔

WHAT DO THE FINDINGS MEAN FOR CANADA?

The need for Canada to measure and understand comprehensive wealth has never been greater. Its development model is based heavily on the exploitation of natural capital, and the country cannot sustain another 30 years of natural capital depletion. Short-term commodity price volatility and the longer-term global shift to a cleaner, knowledge-driven economy mean that future reliance on fossil fuels to underpin the country's growth is risky. The current debate about fossil fuel projects and pipelines needs, therefore, to include a vision of transformation toward a low-carbon economy. Given all this, it is surprising how little is understood of the role of natural capital within the overall economy. Comprehensive wealth measures promise to shed greater light on this role.

Inevitably, Canada will have to diversify its economy and focus on growing all components of the comprehensive wealth portfolio to ensure that its development remains sustainable. The range of possible actions to accomplish this is obviously broad and complex, touching upon aspects of tax, fiscal, industrial, trade, natural resource, climate, environmental, education and health policies to name but a few. Given this complexity, detailed policy suggestions are beyond the scope of this study. However, there are a few obvious areas in which actions will be necessary.

First, Canada must reverse the trend in its natural capital, both to ensure continued flows of resource commodities and to ensure the on-going provision of environmental benefits like clean air and water. Climate change represents a major threat to the latter, and more research is needed to understand its potential impacts on Canadians and their well-being.

Second, Canada must grow its human capital. Better education and training are key here, but so too are efforts to increase productivity. This is a particularly complex area, and one where more data of the sort provided by comprehensive wealth would be very welcome.

Third, the country needs to diversify its produced capital so that housing and oil and gas infrastructure are less dominant in the overall mix. Investments in housing, while obviously important to well-being in many ways, can hamper it in the long term if they crowd out investments elsewhere in the economy or if housing values are diminished because of market corrections. The value of oil and gas extraction assets is tightly coupled with the value of Canada's fossil fuel assets, which have fallen rapidly in recent years and, as noted, face serious obstacles in the long term. Diversification of produced capital is needed to hedge against these risks. The recent recommendation from the federal government's Economic Advisory Council for significant and broad investment in the country's infrastructure is welcome in this regard: as the Council noted, "governments at all levels have not invested enough to support long-term economic growth" (Advisory Council on Economic Growth, 2016b, p. 4).

Finally, Canada needs to begin systematically measuring comprehensive wealth to track its success in making these and other changes necessary to ensure continued growth in the nation's wealth. As noted, Statistics Canada already keeps one of the most detailed sets of wealth figures in the world, so Canada is well placed to play a leadership role in this emerging area. To this end, the federal government should fund Statistics Canada to begin regular reporting of comprehensive wealth measures following the same cycle as GDP (see Text Box ES8 for further research recommendations).

Simply publishing new measures of comprehensive wealth is, of course, not enough. Decision makers must at the same time increase their focus on comprehensive wealth, using the new measures both to guide and evaluate their efforts in ensuring its growth. Public and private efforts have long been focused on ensuring growth in GDP, and the country has enjoyed much success in this regard. The question of whether the comprehensive wealth portfolio—which is, after all, the basis for GDP—is sustainable has received less attention. The time has come to change that.

Text Box ES8. Research agenda

Though among the best in the world, Statistics Canada's measures of wealth remain incomplete and, in some instances, are based on research studies rather than official statistics.

> *The federal government should fund Statistics Canada to regularly publish comprehensive wealth measures. These should include timely and complete estimates of produced, natural, human and social capital in monetary and non-monetary terms to be published alongside quarterly GDP. All of these measures should be compiled for Canada as a whole and for each province/territory, by sector of the economy and by income level (to reflect the distribution of wealth).*

Two components of the comprehensive wealth portfolio stand out as needing particular attention: human capital and social capital. Human capital accounts for about 80 per cent of comprehensive wealth in Canada. Given this large share, the fact that per capita human capital did not grow between 1980 and 2013 is a special concern. Canada is a wealthy, technologically advanced country competing in a global market where other countries are succeeding in increasing human capital. Sustaining development in the face of static human capital is a challenge. Better data than those currently available are needed to address this challenge.

> *Research is needed to understand the reasons for Canada's human capital performance. To facilitate this, the federal government should, as a priority, fund Statistics Canada to elevate its research program on human capital to a fully-fledged set of official statistics.*

Social capital is the least well understood and measured component of the comprehensive wealth portfolio. The fact that no monetary valuation of social capital is possible means the measures of comprehensive wealth presented in this study are not truly comprehensive.

> *Research is needed to better understand social capital and its relation to other forms of capital. In particular, research into means of valuing social capital to permit its inclusion in monetary measures of comprehensive wealth is needed.*

Next to human and social capital, research on natural capital is the most urgently needed. As noted earlier, the values of important natural assets—commercial fisheries, water and all ecosystems—aren't currently measured by Statistics Canada. In measuring the value of these assets, the potential impact of climate change should be taken into consideration. Fish stocks, forests, agricultural land, lakes and rivers, wetlands, permafrost, glaciers and other natural assets are all at risk of disturbance from a changing climate. This has implications for water, food and timber supplies, tourism and recreation, flood protection, transportation, cultural and spiritual well-being, not to mention the well-being of non-human species. The impacts are not necessarily limited to natural capital either; produced capital, in particular, is tightly coupled with natural capital in Canada. Degradation of natural capital due to climate change may therefore lead to "knock-on" losses in other asset categories.

> *Research is needed to fill the gaps in Statistics Canada's measures of natural capital. In this, the possible impacts of climate change on Canada's natural capital should be considered. The research should also consider how changes to natural capital stocks as a result of climate change might impact the value of other capital stocks; for example, how the loss of timber stocks due to more severe pest infestations or forest fires might impact the value of produced, human and social capital.*

Beyond the need to regularly measure comprehensive wealth and its components, there is a need to review the way in which productivity is measured in Canada. Statistics Canada's broadest measure of productivity considers only the efficiency with which human capital and produced capital are employed in creating output. The exclusion of natural capital from this measure may mean that productivity growth is underestimated.

> *Statistics Canada should study the inclusion of natural capital as an explicit input in the calculation of multi-factor productivity. Most of the data required to do so already exist. The major gaps requiring filling in the short term are the value of commercial fish stocks and water resources (e.g., hydroelectric and irrigation reservoirs). The value of ecosystem services such as pollination of crops, surface water flow regulation and pollution absorption could be added in the longer term.*

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LIST OF ABBREVIATIONS

AHCCD	Adjusted and Homogenized Canadian Climate Database
CANSIM	Statistics Canada's on-line database[1]
CES	Canadian Election Study
CSERA	Canadian System of Environmental and Resource Accounts (of Statistics Canada)
GDP	Gross domestic product
GFWC	Global Forest Watch Canada
GSS	General Social Survey (of Statistics Canada)
IHDP	International Human Dimensions of Global Environmental Change Program (of the United Nations)
IIP	International investment position
IPCC	Intergovernmental Panel on Climate Change
IWR	Inclusive Wealth Report
LCTS	Land Cover Time Series
MFP	Multi-factor productivity
OECD	Organisation for Economic Co-operation and Development
PIAAC	Programme for the International Assessment of Adult Competencies (of the OECD)
PIM	Perpetual inventory method (for calculating produced capital stock estimates)
PISA	Programme for International Student Assessment (of the OECD)
SNA	System of National Accounts
UNU	United Nations University
UNEP	United Nations Environment Program
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change

[1]The acronym no longer has a meaning. It has simply become the name of the database.

Comprehensive Wealth

PART I:

UNDERSTANDING COMPREHENSIVE WEALTH

1 INTRODUCTION

1.1 Why This Report?

This report represents one of the first efforts to measure comprehensive wealth in Canada.[2] It seeks to introduce the concept of comprehensive wealth to Canadians in detail and outline why it should be considered an essential complement to the other measures (such as gross domestic product) commonly used to report on national progress. The report introduces a potential ideal suite of comprehensive wealth indicators and presents the results of an effort to compile them using the best data available today.

Briefly, *comprehensive wealth* is the value of all the assets the nation has at its disposal: *produced capital* like buildings and machinery; financial capital, like stocks and bonds; *natural capital* like forests and mineral deposits; *human capital* in the form of an educated and productive workforce, and social capital in the form of effective systems of cooperation.

Comprehensive wealth matters because it is the basis upon which the sustainability of our collective well-being[3] rests. Some of this well-being is derived from the income we earn from the use of our assets in market production. Some results as well from the use of assets in activities that occur outside of the market, such as the benefits of a simple walk in the woods. Importantly, comprehensive wealth tells us as much about the prospects for future well-being. In this way, it is quite different from—and therefore an essential complement to—existing measures like GDP that focus only on how well off we are today.

In spite of comprehensive wealth's importance as a lens on future well-being, Canada does not routinely measure it. In fact, no country does. Yet every country measures GDP and a variety of related short-term measures. This results in an imbalance in the information decision makers have at their disposal to guide decisions. A great deal of information regarding progress in ensuring current well-being can be found, but much less exists to reveal whether this progress can be sustained in the future. This is reason for concern. Businesses do not run this way—business accountants keep both income statements (GDP) and balance sheets (wealth). There are many reasons to argue that countries, too, should keep both income statements and balance sheets. Knowing what a nation has on hand in its on-going quest to improve well-being—that is, its assets—is surely no less important than knowing how much income its citizens earned last year. Yet national balance sheets are not maintained by most nations in the world. Fortunately for Canadians, Canada is one of the exceptions to this. Statistics Canada maintains a balance sheet measuring the nation's produced capital and some of its natural capital, though not its human or social capital. Thus, even with one of the most advanced statistical agencies in the world, comprehensive wealth is only partially measured in Canada. Even the measures that are produced do not receive nearly the attention GDP and other measures of short-term progress do.

Conversations about the importance of moving beyond GDP are already beginning. The Chief Economist of the World Economic Forum, for one, has recently asked, "Are we building up debts that we will simply leave to future generations? Are we living at the expense of tomorrow?" (Blanke, 2016). In a similar vein, the head of the International Monetary Fund remarked in a forum at the 2016 World Economic Forum that "there are lots of things that we don't measure well. We have to [...] assess, and probably change, the way we look at the economy."[4] Here in Canada, the President of the C.D. Howe Institute, has pointed

[2] Comprehensive wealth in Canada has been measured in three earlier studies – the *Index of Economic Well-being* compiled by the Ottawa-based Centre for the Study of Living Standards (Osberg & Sharpe, 2011), a series of global reports covering 140 countries prepared by UNEP (UNU-IHDP and UNEP, 2012 and 2014) and a series of World Bank reports measuring "the wealth of nations" (World Bank, 2006 and 2011).

[3] See Text Box 1 for definitions of basic concepts.

out that “GDP is so twentieth century” (Robson, 2015). Measuring wealth, he went on, is “the Next Big Thing.”

Though “so twentieth century,” the goal here is not to replace GDP with measures of comprehensive wealth. Both are needed to assess progress. Rather, the hope is to add comprehensive wealth to the suite of measures that regularly get reported in Canada. There is much to be gained from doing so in terms of an improved basis for decision making. It really does matter what gets measured and, right now, an important element is missing.

Ultimately, it is the role of government—more specifically, of Statistics Canada—to measure comprehensive wealth. As noted, we are fortunate in Canada to have a national statistical agency with a global reputation for innovation and quality. Statistics Canada already measures more of the components of comprehensive wealth than its counterparts in nearly any other country. But its measures are far from complete, with large parts of natural capital and all of human and social capital missing. What is needed is for Statistics Canada to complete its measures and publish them routinely, as it has long done with GDP, the unemployment rate, the inflation rate and a host of other influential but short-term measures.

Simply publishing measures of comprehensive wealth would not, of course, be enough. Canadians and their leaders would also have to focus on efforts to maintain and grow comprehensive wealth, using the new measures of comprehensive wealth both to guide and evaluate their efforts to do so. Policies have long been focused on ensuring growth in GDP and the country has enjoyed considerable success. Whether the asset base on which such growth rests is sustainable has received much less attention, at least in part because the statistics required to answer this question are incomplete and not widely known or used.

Evidence is mounting that this approach can no longer work. Climate change, concerns about the competitiveness of the workforce and worries over social cohesion are just some of the reasons for concern about the sustainability of well-being. And, as is shown in Part II of this report, the trend in comprehensive wealth based on the results of the analysis here suggests there may be reason for concern about the sustainability of Canada’s well-being.

1.1.1 Reading the Report

This report is divided into three parts. **Part I** includes this introduction to comprehensive wealth and its importance, plus four detailed discussions of each of the major categories of capital (produced/financial, natural, human and social capital). The discussions of produced and financial capital (Section 2) are relatively short, since those forms of capital—which have long been studied and analyzed by economists and statisticians—are familiar to many people. The three subsequent sections on natural, human and social capital respectively are much longer. Each of the four sections begins with a discussion of basic concepts and then goes on to discuss how the capital type in question is measured, both in theory and in practice, in Canada. The sections then conclude with a proposed “ideal” set of indicators for the capital type in question. Part I will be of particular interest to anyone wishing to know the conceptual and technical details of comprehensive wealth and its measurement.

Part II (beginning on page 46) presents a high-level summary of the study’s findings and discusses their significance for sustainable development in Canada (Section 6). It then discusses the meaning of the findings and suggests an agenda for further research based on them (Section 7). Part II can be read as a stand-alone piece for those interested only in the study’s main findings. Readers already familiar

[4] See https://www.weforum.org/agenda/2016/01/gdp.

with the concept of comprehensive wealth and its measurement will be able to read Part II without first reading Part I. Those for whom these are unfamiliar issues may better understand the findings after first reading Part I.

Part III (beginning on page 73) is devoted to presenting the individual comprehensive wealth indicators. It begins with a narrative overview of the indicators and a graphical summary of their trends. This is followed by presentation of the indicators themselves in five sections, one each for overall comprehensive wealth (page 80), produced capital (page 84), natural capital (page 87), human capital (page 123) and social capital (page 134).[5]

The indicators are presented in individual discussions covering:

- The geographic scope of the indicator
- The time series for which the indicator has been compiled
- The frequency with which the indicator can be compiled
- A description of the indicator
- The relevance of the indicator to comprehensive wealth
- The methods and data sources (and their limitations) used to compile the indicator
- The statistical reliability of indicator,[6] and
- An analysis of the trends in the indicator.

Though this report is largely about assessing the status of the asset stocks that make up comprehensive wealth, it is recognized that stocks are just part of what is relevant to comprehensive wealth. Changes in stocks are the result of flows to and from them; for example, the flow of timber out of forests and the flow of education and skills training into human capital. Understanding comprehensive wealth is, then, as much about measuring flows as it is about measuring stocks. A complete assessment of all the flows related to comprehensive wealth would have made the report unmanageable in size and scope, however, so it was not undertaken. To demonstrate what such an assessment might look like, the natural capital indicators are supported by a case study on "green growth" indicators that considers some of the flows relevant to natural capital (page 115). The case study makes use of the green growth indicators framework proposed by the OECD (OECD, 2011b).

[5] There is no section devoted to financial capital, since it could not be measured in real per capita terms, the form required for inclusion in this study. See Text Box 3 for further details.

[6] Statistical reliability is a qualitative assessment made on the basis of the report's authors' knowledge of data quality and conceptual and methodological soundness. Indicators are rated as either "very reliable", "reliable" or "acceptable." Indicators are considered to be "very reliable" when they are characterized by source data that are mainly derived from highly reliable sources like Statistics Canada surveys or from other sources that are considered to be highly reliable and by concepts and methods that are based on accepted environmental, economic or statistical theory and do not require arbitrary or subjective decisions regarding important parameters. Indicators that meet all but one of the above criteria are deemed to be "reliable." Those that fail to meet two or more of the criteria are deemed to be "acceptable."

1.2 Why What We Measure Matters

All Canadians would agree that a primary goal of public policy is to make life better for those alive today. Many would go further and argue that ensuring well-being for future generations should also be a central concern. This is all the more the case today, with evidence mounting that current economic development may be neither environmentally or socially sustainable.

However, ensuring that life improves for those alive today remains the chief preoccupation of policy-makers. We see this reflected in the measures used to gauge policy success, such as the unemployment rate, the inflation rate and gross domestic product (GDP). All these measure how well the economy and society are doing today. The unemployment rate reveals how many Canadians want work today but cannot find it. The inflation rate shows how quickly life is getting more expensive—today. GDP measures how much income there is to spend—again, today.

None of these well-known and influential measures says anything directly about how well off future generations might be. Indeed, few of the measures used to guide policy-making directly reveal how well off our children and grandchildren might be.

Looking at GDP—the value of national income—more closely, everyone knows that it is an important and frequently cited measure of economic progress. But in spite of its importance it alone cannot tell the story of national progress. Canadians may earn plenty of money today but this is no guarantee of high income in the future. Depletion of natural resources may reduce our ability to gain export earnings. Insufficient investment in education may jeopardize Canada's place in the competitive global economy. Eroding social structures may reduce the cooperation needed for the economy to work efficiently. None of these trends would be revealed by GDP—not, at least, until they had already begun having an impact on income.

Knowing where we are headed in the long term—i.e., knowing whether well-being is *sustainable* or at risk from losses in our productive base—requires measures other than GDP and its short-term companions.

What matters in the long run is *wealth*: more specifically, comprehensive wealth.

Text Box 1. Basic definitions

An *asset* is a valuable economic resource, such as a machine or an oil deposit, owned by an individual, business or country. Assets are durable and can be used repeatedly. But they do eventually require replacement.

Income is the money received from the sale of goods and services produced through the use of capital. At the level of the nation as a whole, income is measured as GDP.

Comprehensive wealth is the value of all the assets a nation has at its disposal: produced capital like buildings and machinery; financial capital like stocks and bonds; natural capital like forests and mineral deposits; human capital in the form of an educated and productive workforce and social capital in the form of effective systems of cooperation.

Well-being is the satisfaction derived from consumption of goods and services produced through the use of one's personal assets and the assets provided by the society in which one lives. It is important to note that well-being is generated from the consumption of goods and services produced both within and outside the market. Consumption is therefore understood broadly to include the enjoyment of any valued good or service, including the consumption of highly abstract services like the beauty of a scenic vista.

Development is a situation in which aggregate well-being increases over time within a given society.

Sustainable development requires the maintenance of the asset stocks that make up the comprehensive wealth portfolio, as they are the basis for the consumption that leads to well-being. To the extent that assets may be substituted by one another, sustainability need not require that each asset stock is maintained separately. Some may grow while others decline, so long as the total portfolio does not decline. Some assets are considered "critical", however, and must be separately maintained to ensure sustainability (*e.g.*, the ozone layer). The concept of critical capital is pursued further on Page 11. Because well-being is an individual concept, it is not just the overall size of asset stocks that matters but the assets available *per capita*.

Comprehensive wealth is the combined value of all the assets the country has at its disposal: produced, financial, natural, human and social.

Comprehensive wealth is the precondition for well-being. It is the productive base referred to above. If comprehensive wealth is growing, development is almost certainly sustainable and well-being will increase over time. If wealth is declining, well-being will eventually follow suit.

Despite its importance, comprehensive wealth is not among the measures routinely monitored by governments in Canada or around the world. This is, however, beginning to change.

A few countries have begun developing broader (if not truly comprehensive) wealth estimates to complement more traditional measures of development. Countries that do so will be better placed to guide development—in both the short and long terms—than countries that do not. Canada is taking steps in this direction, even if its efforts to date fall short of a complete estimate of comprehensive wealth.

Thanks to Statistics Canada, Canada has long had a national balance sheet with robust estimates of produced capital (machinery, buildings and other infrastructure), financial capital, agricultural land and built-up land. Innovatively, the agency added the value of some natural assets to the quarterly National Balance Sheet Account in late 2015—the first statistical agency in the world to do so. Experimental estimates of the value of the human capital have also occasionally been produced, though these do not form part of the national balance sheet (Gu & Wong, 2010, 2012). Social capital remains largely unmeasured, though the agency recently released a report based on a series of non-monetary indicators (Turcotte, 2015a).

Though incomplete, all of this work positions Canada as a potential leader in this emerging and important field. This report is a step toward ensuring that Canada capitalizes on its potential to lead the measurement of comprehensive wealth in the 21st century.

1.3 What Is Comprehensive Wealth?

As noted above, comprehensive wealth is the sum of all the assets the country has at its disposal. These assets fall into four categories:

- Produced capital
- Financial capital
- Human capital
- Natural capital, and
- Social capital.

Most people are familiar with *produced capital* and *financial capital*. They are what normally come to mind when thinking of a nation's assets: roads, railways, ports, houses, machinery and the wide variety of other manufactured assets found in the economy along with stocks, bonds and other forms of financial assets. Investments by governments, businesses and households are often aimed at building up stocks of produced and financial capital.

Natural capital includes resources such as timber, minerals, oil and gas. It also includes ecosystems of all kinds, e.g., wetlands that help create clean drinking water and forests that act as carbon storehouses. Ecosystems are not only important for supporting life—they are also economically valuable. On average, natural capital accounts for about 30 per cent of wealth globally.

The collective knowledge, skills and capabilities of the labour force make up *human capital*—the result of lifelong learning in both formal and informal settings. Formal education is an important source of human capital but on-the-job learning and what we learn from our families and peers are equally important. Educated individuals are themselves more productive and increase the productivity of their coworkers. They also contribute more fully to society as a whole. Human capital is the largest source of wealth in most countries and in developed countries in particular.

Social capital is another broad component of comprehensive wealth. Our systems of laws and governance shape society and the economy. Cultural norms play an important role at home and in the workplace. Social ties and networks provide support for people trying to get ahead or overcome hard times. The social and cultural institutions that make up social capital dictate the use, distribution and value of the other capital assets and therefore play an important role in creating wealth. Some consider social capital to be it to be an enabling factor that contributes to the value of the other forms of capital (UNU–IHDP & UNEP, 2012).

1.4 Why Measure Comprehensive Wealth?

Every country has, to a greater or lesser extent, assets that fall into each category of the comprehensive wealth portfolio. The way in which this portfolio is managed over time has much to do with the sustainability of the nation's development. Allowed to decline, the comprehensive wealth portfolio will support lower levels of consumption (broadly understood as in Text Box 1) and, therefore, well-being. Managed for growth, it will support increased consumption and well-being. At the moment, it is hard to tell which destination a given country might be headed toward, since comprehensive wealth is not yet routinely measured anywhere.

GDP, which is measured by nearly every nation, says little about sustainability. Consumption today is no guarantee of consumption in the future. Yet GDP remains the most widely used indicator of economic development and, implicitly, of well-being. Measuring economic development has focused on GDP ever since the measure was developed in the 1940s. There is no denying that it has been a valuable guide. Post-war growth in consumption has been impressive in much of the world. However, measuring increases in consumption is only half of the development story. Equally important is understanding whether there is accompanying growth in the productive base that supports consumption—that is, the produced, human, natural and social capital assets of the comprehensive wealth portfolio. As already noted, growing consumption that is not accompanied by matching growth in comprehensive wealth may not be sustainable in the long run.

GDP obviously is—and will remain—relevant in guiding governments' decisions. As noted earlier, the goal should not be to replace it, but to ensure that complementary indicators reflecting the prospects for long-term well-being are developed and used in decision making. New measures are needed to help manage the economy in a way that allows short-term consumption growth to go hand-in-hand with protecting human health, ensuring greater equality, protecting the environment and safeguarding other elements of long-term well-being. Comprehensive wealth is both a conceptually robust and empirically promising possibility for such a measure.[7]

[7] Other useful measures include the various efforts to build indicator suites that measure current well-being. An important example of this in Canada is the work on the *Canadian Index of Well-being* centred at the University of Waterloo.

Though not yet widespread, a growing body of knowledge and practice exists around the measurement of comprehensive wealth. The World Bank began efforts in this direction in the 1990s (World Bank, 2006) and has recently made an indicator related to comprehensive wealth part of its suite of global development indicators.

The United Nations Environment Programme's (UNEP's) inclusive wealth framework[8] is another extensive program of work in the area. UNEP released global comprehensive wealth reports in 2012 and 2014 (UNU–IHDP & UNEP, 2012, 2014) that explored the concept in detail. The latest report included experimental estimates for 140 countries, including Canada.

As part of its Index of Economic Well-Being, the Ottawa-based Centre for the Study of Living Standards was the first to publish estimates of comprehensive wealth for Canada (Osberg & Sharpe, 2011).

Several global reports related to the measurement of sustainable development have called for measures of comprehensive wealth, including the report of the French Commission on the Measurement of Economic Performance and Social Progress (the so-called Stiglitz Commission; Stiglitz, Sen, & Fitoussi, 2009) and the report of the UN Economic Commission for Europe (UNECE) on statistics for sustainable development (UNECE et al., 2009).

Despite these ground-breaking efforts, few countries make the effort to measure any national assets at all, let alone measuring comprehensive wealth. This is not just questionable public policy. It is also at odds with practice in the business community. Business leaders know that tracking their assets provides important insights into the health of their companies today and—more importantly—their potential for growth in the future. This is why the value of corporate assets, such as machinery, buildings, resource reserves and patents, is recorded in a balance sheet that complements every corporate income statement. Balance sheets and income statements taken together allow businesses to do robust long-term planning. The same is true in principle for nations.

Measuring comprehensive wealth should be understood as important for nations because it provides the basis for a nearly ideal indicator of sustainability (see the following section for the reason why this is so). This alone would justify its consideration as a core measure of national progress.

UNEP defines sustainable development formally as "a pattern of societal development along which intergenerational well-being does not decline" and notes that well-being depends on the assets that make up comprehensive wealth (UNU–IHDP & UNEP, 2012, p. 15). This is consistent with the basic definitions adopted in this report (see Text Box 1). As shown in Figure 1, well-being results from the consumption of the goods and services produced by economic and ecological systems. The ability of these systems to produce goods and services is, in turn, dependent on the assets that comprise them.

[8] UNEP, in fact, refers to what is here called comprehensive wealth as "inclusive wealth." The two terms are synonymous.

It is clear from this that measures of comprehensive wealth are needed to assess the sustainability of development. Unless a nation knows how its wealth is evolving, it cannot be sure whether the well-being enjoyed by its citizens is sustainable. In a country like Canada, where well-being levels are high and much is at stake, knowing whether we are on track to maintain our well-being is doubly important.

As noted earlier, Canada is fortunate in that it already measures some of the elements of comprehensive wealth. Statistics Canada's national balance sheet—one of the most advanced in the world—includes quarterly estimates of produced capital and some elements of natural capital. Though further ahead than most countries, Canada remains a long way from regular and complete measures of comprehensive wealth. Compiling such measures—as has done for decades with GDP and other traditional economic measures—would have a number of benefits for national decision making.

First, tracking comprehensive wealth would help Canadians know if they are getting the most out of the country's assets while not endangering the sustainability of their well-being. Put another way, they would know if consumption was being maximized without running down the nation's asset endowment. At the moment, Canadians cannot be sure that national consumption does not rest partly on using up some of that endowment because the data required to assess this are incomplete.

Intergenerational equity requires that every generation leave assets to the next generation of at least the same value as those it inherited (UNU–IHDP & UNEP, 2012). Consumption that is generated today by running down assets reduces opportunities for future generations. Although needs and wants may vary over time as social norms and institutions change, the basis for meeting them (comprehensive wealth) does not. Passing on stable or growing wealth permits future generations to meet their needs and wants and pursue their own definition of well-being.

Second, measuring comprehensive wealth would reveal whether we are managing our overall portfolio of assets wisely. This is largely a question of assessing trade-offs, as the case of forest resources demonstrates (Text Box 2).

Text Box 2. Assessing trade-offs in forest uses

Forest products are an important part of Canada's economy. The industry contributed $19.8 billion to Canada's GDP in 2013. At the same time, Canada's forests provide an array of ecosystem services that are sometimes threatened by use of forests for timber supply.

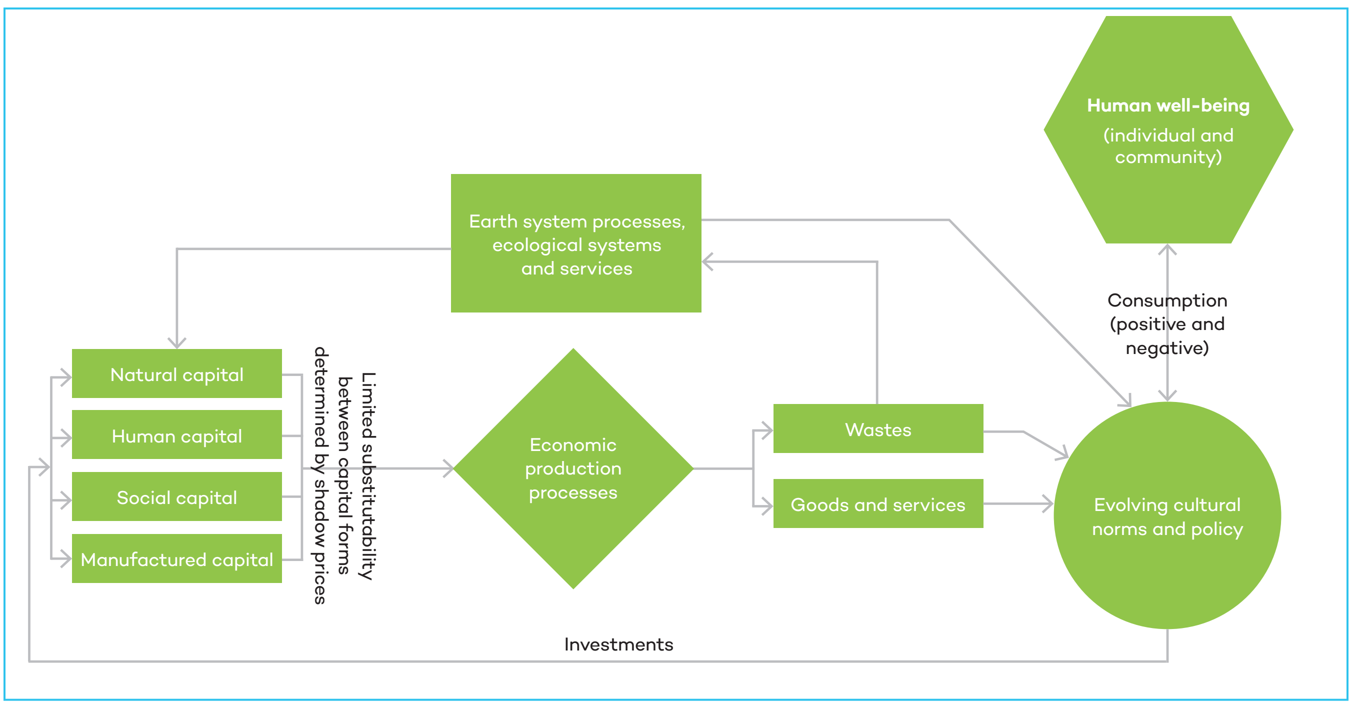
Comprehensive wealth estimates can perform a role in evaluating the trade-offs between the economic benefits of timber harvesting and its ecological costs. A fully developed forest wealth account would reveal the value of forests as a source of timber and their value as a source of ecosystem services.

Canada has a central role to play in the global move to sustainability, in no small part because the country is steward to so many of the world's natural resources and ecosystems. It is home to 8 per cent of the world's forests, 3.2 per cent of the world's arable land and 25 per cent of the world's wetlands (Federal, Provincial and Territorial Governments of Canada, 2010). There is a lot to gain from these resources. Used sustainably, they will provide benefits for generations to come by, for example, generating income that can be reinvested in urban infrastructure, health and education. Only by measuring comprehensive wealth will we know if reinvestment of the proceeds from using natural capital is the exception or the norm.

Third, a focus on comprehensive wealth will allow for more balanced management of the economy, environment and society. It is clear that development remains unsustainable in many parts of the world, especially resource-dependent developing countries, because it is driven by depletion of natural capital. There are signs that this may be true in Canada as well. The results presented in Part II of this report suggest that some of Canada's consumption may rest on an unsustainable drawing down of natural capital in particular.

One of the forces that can lead to unsustainable development is the fact that much of what contributes to well-being is not priced by the market and is therefore invisible in traditional economic measures. A healthy environment and robust social structures are essential to well-being, even if the goods and services they yield often come without a monetary price. Measures of comprehensive wealth would shed light on the importance of these by valuing them or, where valuation is not possible, measuring them with non-monetary physical indicators. This leads naturally to the next section, which focuses on the ways in which comprehensive wealth can be measured.

Figure 1. Human Well-being and comprehensive wealth



Source: Adapted from UNU–IHDP & UNEP, 2012.

1.5 How Comprehensive Wealth is Measured

The assets that comprise comprehensive wealth can be measured in two ways. For assets that are tangible, like forests, there is first the possibility of using physical units of measure. A forest can be measured in terms of its area, for example. Other physical features of the forest might also be measured, such as species composition and age.

Some assets are poorly suited to physical measurement however, either because they are intangible or because keeping track of them in physical terms would simply be too daunting a statistical task. Social capital, in particular, is not easily captured in physical terms because it is intangible. The same is true of human and financial capital. Much produced capital would also be difficult to measure in physical terms even if it is tangible and can, in principle, be counted. It would be a challenge, for example, to measure the housing stock in terms of the numbers of houses and their individual characteristics. For these sorts of assets, the alternative is monetary measures.

In fact, all assets, both tangible and intangible, can in principle be measured in monetary terms. This is a distinct advantage in comparison to physical measures, which apply only to tangible assets and then only with considerable difficulty in certain instances. A further advantage of monetary measures is the ability to "add up" the value of assets of different sorts. The value of a forest can be added to the value of a pulp mill to come up with an overall value for natural and produced capital owned by a forest company. Further, since prices reflect relative values, monetary valuation has the advantage of automatically weighting different assets according to their contribution to well-being.

In spite of these advantages, not all assets can, or should, be expressed in monetary terms (Stiglitz et al., 2009). Some assets are critical to well-being. Any degradation in them imposes direct and irreplaceable costs on well-being and their monetary value is, therefore, not relevant. They are, effectively, priceless. For this reason, it is both appropriate and sufficient to provide physical measures alone for critical assets (see the following section for more on this point).

For those assets that can be appropriately valued (that is, those that are not critical and can be substituted for one another without concern for well-being), what is needed is an estimate of their full social value. The social value of an asset takes into account the costs and benefits of its use not just for its owner but for society as whole. Education, for example, provides benefits to the individual in the form of higher wages or the enjoyment of learning. But it also provides benefits to society as a whole, as educated individuals are more likely to engage productively in society.

In some cases, market prices can be used to approximate the social value of assets.[9] However, markets often do not function perfectly and, as a result, do not always reflect the full value an asset holds for society. For instance, the price of education might not reflect the broad benefits of more engaged citizens. The market value of assets that have negative consequences when used—such as creating pollution—might be too high if the costs of those consequences are not reflected in their prices. This may well be true for fossil fuel assets, for example, since climate change impacts are not fully reflected in their prices.

There are other assets for which market prices simply do not exist. The market generally does not, for example, price wetlands and their benefits. The social value of wetlands is, of course, considerably higher than zero, the value ascribed to them by the market. For these kinds of assets, indirect methods of estimating value are available—and increasingly capable of yielding useful results.

[9] More formally, the price that corresponds to the full (or social) value of an asset is known as a "shadow price." It is the price for the asset that reflects both its private and societal values.

Assuming that all assets that should be valued can be measured in terms of their social value, the aggregate value of a nation's comprehensive wealth can be estimated. Such an aggregate is highly desirable as a measure of progress. As noted at the beginning of the previous section, it provides the basis for a nearly ideal measure of sustainable development: the real (inflation-adjusted)[10] value of comprehensive wealth per capita,[11] or what is called here the Comprehensive Wealth Index (Hamilton & Clemens,1999; Dasgupta & Mäler, 2000; Dasgupta, 2014).

The Comprehensive Wealth Index is a powerful indicator of sustainability because the assets that make up by the index are the basis for producing all the goods and services consumed by Canadians. This consumption serves, in turn, as the basis for a great deal of well-being. [12]

It is worth recalling that "goods and services" and "consumption" are used differently from their generally understood meanings here. The goods and services produced by the assets comprising comprehensive wealth include the market goods and services that are traditionally associated with the phrase. They extend far beyond that, however, to include a wide range of goods and services produced and consumed outside the market. These include tangible goods, such as subsistence food derived from the environment, that are very much like market goods. They also include services that contribute to market production but for which no payment is made (such as pollination of crops freely provided by wild insects or the transaction-cost reducing benefits of societal trust). Included as well are services that contribute to well-being directly; recreational opportunities, provision of clean air and water, aesthetic enjoyment, cultural and spiritual experiences, a variety of human skills and abilities (parenting skills, for example) and the well-being generated by an engaged citizenry living in a context of trust and accepted norms (a sense of security and belonging, for example).

The broad coverage of the Comprehensive Wealth Index in terms of well-being enhancing assets is what makes it such a powerful indicator of sustainability. If the real per capita value of comprehensive wealth is increasing over time, development (that is, increasing well-being) is likely sustainable, since the basis for generating well-being is growing. If it is falling over time, development is very likely unsustainable and well-being will fall at some point in the future.

It is relatively straightforward to estimate the value of *produced capital*, as market prices are available and reflect social value reasonably well. Monetary measures of produced capital are, for this reason, already well-developed in most industrialized countries. Such measures have long been reported by Statistics Canada as part of the national balance sheet.

Statistics Canada has also long measured the value of financial assets, though it does so only in nominal rather than real (inflation-adjusted) terms. The latter is what is required for the purposes of analyzing comprehensive wealth, so financial capital cannot currently be measured as part of comprehensive wealth in Canada. See Text Box 3 for further details.

Valuing *natural capital* is less straightforward (and, as noted earlier, inappropriate in cases of critical natural assets). UNEP breaks natural capital into five categories—forests, fisheries, fossil fuels, minerals and agricultural land—and seeks to include all benefits of the assets, including ecosystem services (UNU–IHDP & UNEP, 2014). However, due to measurement difficulties, UNEP primarily measures natural assets

[10] Measurement in inflation-adjusted terms is necessary to permit meaningful analysis of the trend in comprehensive wealth over time. What matters is growth in the actual amount (or quantity) of wealth available, which can be obscured by price inflation. Inflation can cause the apparent (nominal) value of wealth to increase even when there is no change in the underlying asset quantities.

[11] Per capita measurement is required because population growth can undermine sustainability if the rate of increase of comprehensive wealth is less than the rate of growth of the population. In other words, it is not just the total quantity of wealth that determines whether well-being will be sustained in the future, but the wealth per Canadian.

[12] Not all well-being can be provided by the assets that make up the Comprehensive Wealth Index because critical assets (of which there are relatively few) cannot be valued and therefore cannot be incorporated into the index. In addition, some well-being obviously comes from within individuals themselves (such as pure spirituality). Beyond these, the basis for all other well-being is, in principle, captured in the Comprehensive Wealth Index.

for which there is a market price. The same is true for the measures produced by Statistics Canada. The agency publishes official estimates of the value of fossil fuels, minerals, timber and land dating back to the 1960s, but only experimental estimates of ecosystem services have been attempted and those have been nearly exclusively in physical terms.

Most approaches to valuing *human capital* focus on the benefits of education in terms of creating a productive and competitive workforce. The OECD has been a leader in developing human capital estimates, and several of its member countries have begun to develop estimates of their own. The approach generally adopted by OECD countries uses the present value of lifetime-income to estimate the value of human capital. Statistics Canada has not published official estimates of human capital, though it has produced research studies with experimental estimates based on the lifetime-income approach (Gu & Wong, 2010, 2012) and, more recently, on the basis of investments in education and training (UNECE, 2016).

The valuation of *social capital* is less well-developed. Its value is sometimes calculated residually by subtracting “bottom-up” estimates of produced, human and natural capital from a “top-down” estimate of comprehensive wealth, leaving social capital as a residual. Improving on this approach is an area of active research in the wealth literature. Statistics Canada recently released its first foray into the measurement of social capital but avoided valuation altogether by using a variety of non-monetary indicators (Turcotte, 2015a).

Overall, the prospects for estimates of comprehensive wealth are reasonably good in most industrialized countries with well-established statistical systems; this would include most if not all member states of the OECD. Canada, as has already been discussed and as will be seen in Parts II and III of this report, is arguably the best positioned of any country to do so.

1.6 Comprehensive Wealth Indicators for Canada

Building on the efforts of UNEP, the World Bank, the OECD, the Centre for the Study of Living Standards, UNECE, the Stiglitz Commission, Statistics Canada and others, this report proposes an “ideal” suite of comprehensive wealth indicators for Canada (here in Part I) and then presents the results of an initial effort at their compilation based on the best data available today (Part II and Part III). The proposed suite is summarized briefly in Table 1. The rationale for the specific indicators chosen is explained in the remainder of this section. The other sections of Part I delve into each of the categories of comprehensive wealth and the chosen indicators in much more detail.

Starting with an ideal suite of indicators rather than simply presenting the currently feasible indicators of comprehensive wealth is intended to help avoid a shortcoming of many indicator-based reports: the selection of indicators based on data availability rather than conceptual relevance. Too often this results in reports presenting only what can be measured rather than what should be measured. Comprehensive wealth is a rigorously defined concept that lends itself well to measurement through a carefully chosen suite of indicators. Not to offer a proposal for what this suite should ideally be composed of would be a missed opportunity to build upon the thought and effort that has been put into the development of comprehensive wealth as a concept.

The proposed ideal suite begins with the Comprehensive Wealth Index. Complementing this overall index are indexes of the real per capita value of capital in each of the five categories of the comprehensive wealth portfolio (produced, financial, natural, human and social capital indexes). The inclusion of these five complementary indexes reflects the reality that, while the overall value of the comprehensive wealth portfolio is a key measure of sustainability, trends in the composition of comprehensive wealth matter too. Changes in the relative shares of the different categories within the portfolio would not matter only if different assets could in all cases be substituted for one another. If a bit less natural capital, for example, could always be offset by a bit more produced or financial capital without any negative impact on well-being, then only the total value of comprehensive wealth and not its composition would matter.

This principle of substitutability holds true in most cases of small changes in the relative shares of different assets (what economists call changes at the "margin"). As noted, a small loss of natural capital (such as the harvest of one timber stand from a large forest) that is used to fund the expansion of produced capital or improved education of children to increase human capital is likely to leave well-being no worse and quite possibly even improve it.

Substitution has its limits, however, and there are cases where trading one form of capital for another will lead inevitably to a decline in well-being. The loss of the last hectare of a rare ecosystem, for example, probably could not be compensated for through increases in other assets. Similarly, the complete collapse of some aspect of social capital (say, trust in the justice system) could not by replaced with more buildings or higher education.

The terms "weak" and "strong" sustainability have been coined to address the issue of substitutability (Pearce & Atkinson, 1993; Neumayer, 2003). The so-called "weak" sustainability variant rests on the notion that substitution faces no absolute limits, and therefore what matters is simply that the total value of comprehensive wealth is non-declining. The "strong" variant—which is the one adopted in this report—accepts that some assets are effectively irreplaceable and must not be substituted by other assets. Doing so is a guarantee that well-being will be lowered. As noted earlier, the term "critical" is applied to assets that must not be substituted. This term has most often been used in the context of natural capital (for example, the ozone layer) but applies in principle to other forms of capital as well.

Measuring strong sustainability cannot be accomplished with aggregate monetary indicators alone. Critical assets, because they cannot be substituted, must not be measured along with other assets in aggregate indicators; separate measurement, whether in monetary or non-monetary terms, is called for. In many cases, physical measurement is most appropriate, particularly in the case of critical natural assets. For this reason, the proposed ideal suite of comprehensive wealth indicators here includes physical in addition to monetary measures. The physical measures have been chosen to capture those elements of the comprehensive wealth portfolio where critical assets are most likely found (ecosystems, the climate and social systems).

Another reason why the proposed suite includes physical measures is, as discussed above, the practical impossibility of measuring some assets in monetary terms today even if such measures are theoretically possible and conceptually meaningful. Social capital, in particular, is very difficult to measure in monetary terms with existing concepts, methods and data. The main efforts in this direction (see, for, example, World Bank, 2006) have estimated the value of social capital as the residual when estimates of the values of produced, natural and human capital are deducted from estimates of total comprehensive wealth. Such approaches are not fully satisfactory for a number of reasons and are not pursued in this report.[13] Beyond social capital, monetary measures of some forms of natural capital that could, in principle, be valued (for example, commercial fish stocks) are impossible in Canada today due to data gaps.

Much more is said about the reasons for the choice of the indicators in the proposed ideal suite in sections 2, 3, 4 and 5 that follow in the remainder of Part I.

[13] Residual approaches to measuring the value of social capital underestimate its value because the starting point for such approaches is an estimate of the value of comprehensive wealth derived from the present value of an assumed future stream of GDP. Ignoring the difficulties in predicting the future, this approach implicitly rests the notion the GDP as currently measured is sustainable (UNU–IHDP & UNEP, 2012)

Table 1. **Proposed ideal suite of comprehensive wealth indicators**

Comprehensive Wealth	
Theme	**Indicator**
Overall comprehensive wealth	• *Comprehensive Wealth Index*, quarterly, by province/territory (partly feasible) $$$
Produced Capital	
Theme	**Indicator**
Overall produced capital	• *Produced Capital Index*, quarterly, by province/territory (partly feasible) $$$
Financial Capital	
Theme	**Indicator**
Overall financial capital	• *Financial Capital Index*, quarterly, by province/territory (not feasible) $$$
Natural Capital	
Theme	**Indicator**
Market natural capital	• *Market Natural Capital Index*, quarterly, by province/territory (partly feasible) $$$
Non-market natural capital	• *Non-market Natural Capital Index*, quarterly, by province/territory (not feasible) $$$
Ecosystems	• *Quality-adjusted Forest Extent*, annual, by province/territory (partly feasible) • *Quality-adjusted Grassland Extent*, annual, by province/territory (partly feasible) • *Quality-adjusted Tundra Extent*, annual, by province/territory (partly feasible) • *Quality-adjusted Coastal Zone Extent*, annual, by province/territory (not feasible) • *Quality-adjusted Surface Freshwater Extent*, annual, by province/territory (partly feasible) • *Quality-adjusted Wetland Extent*, annual, by province/territory (partly feasible) • *Quality-adjusted Groundwater Extent,* annual, by province/territory (not feasible)
Climate	• *Precipitation*, annual, by region (feasible) • *Temperature*, annual, by region (feasible) • *Snow cover*, annual, by region (partly feasible) • *Glacier mass*, annual, by region (partly feasible) • *Water yield, annual*, by region (partly feasible) • *Sea Ice Extent*, annual, by region (partly feasible)
Human Capital	
Theme	**Indicator**
Overall human capital	• *Human Capital Index*, quarterly, by province/territory (partly feasible) $$$
Educational inputs	• *Educational Spending Index*, annual, by province/territory (partly feasible) $$$
Educational outcomes	• *Educational Attainment*, annual, by province/territory (partly feasible) • *Adult Skills*, annual, by province/territory (partly feasible)

Table 1. Proposed ideal suite of comprehensive wealth indicators (continued)

Social Capital	
Theme	**Indicator**
Overall social capital	• *Social Capital Index*, quarterly, by province/territory (not feasible) $$$
Civic engagement	• *Participation in Group Activities*, annual, by province/territory (not feasible annually) • *Volunteering*, annual, by province/territory (not feasible annually) • *Diversity in Social Networks*, annual, by province/territory (not feasible annually) • *Engagement with Public Institutions,* annual, by province/territory (not feasible) • *Control Over Public Decisions*, annual, by province/territory (not feasible annually) • *Voter Turnout*, most recent election, by province/territory (feasible)
Trust and cooperative norms	• *Generalized Trust*, annual, by province/territory (not feasible annually) • *Trust in Neighbours and Strangers*, annual, by province/territory (not feasible annually) • *Trust that a Lost Wallet Will Be Returned*, annual, by province/territory (not feasible annually) • *Trust in Institutions*, annual, by province/territory (not feasible annually) • *Belief in Helpfulness of Others*, annual, by province/territory (not feasible) • *Willingness to Help Others*, annual, by province/territory (not feasible) • *Acceptance of Others*, annual, by province/territory (not feasible)

2 PRODUCED CAPITAL[14] AND COMPREHENSIVE WEALTH

2.1 Basic Concepts

Produced capital comprises the manufactured assets that are owned by households, businesses and governments and used in the production of goods and services.[15] Included are residential and non-residential buildings; roads, dams and other infrastructure; machinery and equipment; and intangible assets such as patents. What distinguishes produced capital from other manufactured inputs in the production process is the fact that it can be used over and over again in the same process. Inputs that are used just once are referred to as intermediate inputs.

Produced capital is conceptually the most straightforward of the four categories of comprehensive wealth. It is also the most studied, having been the subject of a great deal of theoretical and empirical work by economists and statisticians dating back at least to the 18th century. In common parlance, "capital" is generally taken to mean produced (or financial) capital. The extended notion of capital used in this report that includes the natural, human and social variants in addition to produced capital is a relatively new concept still known mainly within research circles, though this report hopes to begin changing that.

2.2 Measurement of Produced Capital

Produced capital stocks and the investment flows that create them have long been measured, as economists have long understood that the quantity of produced capital available is a key determinant of the level of economic output. The relationship between produced capital and economic growth (that is, growth in GDP) is one of the most studied in economics. The view that produced capital "has called the tune" of economic growth since the 19th century (Samuelson, Nordhaus & McCallum, 1988, p. 795) underpins nearly all of mainstream economics. Thinking about the role of produced capital in the growth process hit its apogee with the work of Robert Solow (1957) and others on "growth accounting" in the 1950s.

Although most produced capital is tangible and can in principle be measured in physical terms (so many machines of type X, so many miles of roadways, so many buildings of size Y and so on) doing so would be beyond the capabilities of any statistical system. It would also result in a confusing jumble of incommensurable statistics, as it is not possible to sum numbers of machines and miles of roadways in any meaningful way. Added to this is the impossibility of trying to meaningfully account for intangible assets (such as patents) in physical terms. For these reasons, the measurement of produced capital is for all practical purposes only undertaken in monetary terms, at least in the world of national statistics.

Given the enormous heterogeneity of the produced capital used in a modern economy, producing accurate estimates of its overall value is not straightforward. Data are required on the value of investments in

[14] This section is devoted largely to produced capital but touches upon financial capital briefly as well (Text Box 3). Financial capital is treated only briefly because 1) it is familiar to many people and 2) Statistics Canada does not produce estimates of financial capital in real (i.e., inflation-adjusted) terms, so it has not been possible to include the value of financial capital in the analysis of comprehensive wealth here.

[15] Services should be understood here to include the shelter service provided by the residential housing stock.

different categories of assets, the expected service lives of those assets, the relationship between the value of assets and their age and more. These data must be broken down not only by category but also by sector of the economy (businesses, governments and households). Capital stocks must be measured not only in current (or nominal) dollars (which include the influence of price inflation) but also in real (inflation-adjusted) terms, as the latter are required to understand the evolution in the overall quantity of produced capital available to the economy (for use in productivity studies, for example).

To make this challenge tractable, most statistical agencies rely on an approach called the "perpetual inventory method" (or PIM) in which capital stocks are measured as the accumulated flow of investments over time less retirements of capital. A great deal of detail on the measurement of capital can be found in the OECD (2009) manual *Measuring Capital*.

2.3 The Status of Produced Capital Measurement in Canada

Statistics Canada has been involved in one way or another in the measurement of produced capital since the agency's earliest days. The produced capital measurement program is one of the agency's most developed, and has an international reputation. It provides very long time series of consistently measured estimates of produced capital stocks and investment flows. Many surveys are devoted to the collection of the basic statistics required to support the program.

The agency produces annual produced capital measures (stocks and investment flows) in nominal and real terms, for a large range of asset types broken down by industry, sector and province for the period 1961 to 2014. Since 2009, it has also produced quarterly estimates of stocks and flows for a subset of these variables.

Produced capital stock data in nominal terms are incorporated into the National Balance Sheet Account[16], where they form part of the estimate of Canada's net national worth, which is equal to national wealth[17] less the value of Canada's net foreign financial liabilities (what is owed to non-residents less what non-residents owe to Canadians). Text Box 3 discusses the relationship between financial assets and comprehensive wealth further.

Text Box 3. Financial capital and comprehensive wealth

Financial capital is different from other forms of capital when it comes to comprehensive wealth. Unlike non-financial assets, every financial asset has a corresponding liability. A savings account represents an asset for the account holder but a liability for the financial institution where it is held. A loan represents an asset for the lender and a liability for the recipient.

At the national level, domestic financial assets and liabilities owned by Canadians cancel one another out; that is, domestic financial assets held by Canadians are exactly equal to the corresponding domestic financial liabilities held other by Canadians. As a result, domestic financial assets and liabilities held within the country have no impact on comprehensive wealth.

See next page...

[16] CANSIM Table 378-0121

[17] National wealth is simply a more restricted measure of comprehensive wealth. National wealth as measured by Statistics Canada includes only produced capital and selected natural capital.

Text Box 3. Continued…

Foreign financial assets and liabilities are another matter. The difference between the value of foreign financial assets owned by Canadians and the value of domestic financial assets owned by non-residents represents Canada's net foreign financial assets. This figure is referred to Canada's international investment position and is measured on a quarterly basis by Statistics Canada.[18]

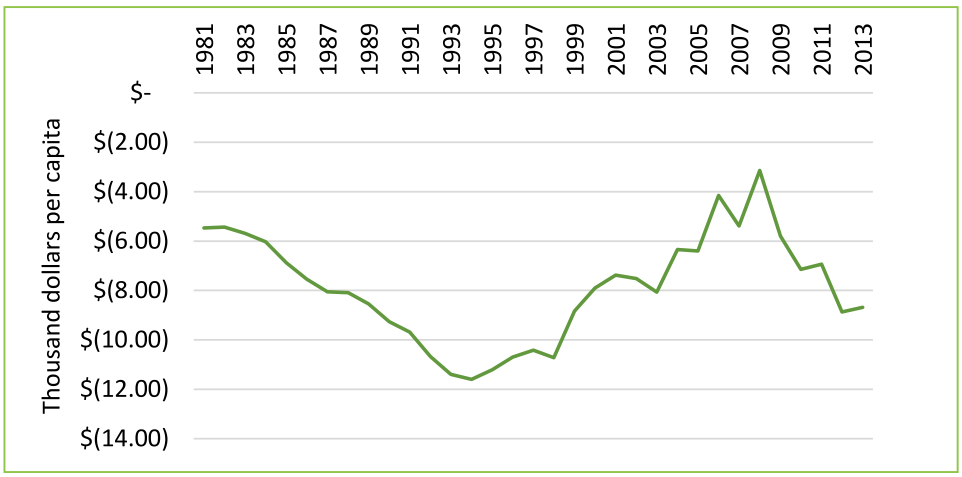
The international investment position (IIP) does have an impact on wealth, since net foreign financial assets represent a store of wealth a country can use to support its well-being, just as produced, natural human and social capital do. If a country's IIP is positive, the country is a net lender, and its wealth is higher by the amount of the IIP than it would otherwise be. If, on the other hand, it is negative, the country is a net borrower and its wealth is lowered.

Canada has for almost all of its history[19] been a net borrower; that is, our holdings of foreign financial assets have been smaller than non-residents' holdings of Canadian financial assets and our IIP has been negative. As a result, Canada's wealth[20] has, in general, been lowered by our IIP.

The IIP is measured by Statistics Canada in nominal terms only, as there is no straightforward basis for adjusting the value of financial assets to account for inflation. Since the measures of comprehensive wealth presented in this report are all in real (inflation-adjusted) terms, the IIP has not been included in the analysis. A look at the data in nominal terms suggests that the exclusion of the IIP from the analysis is not quantitatively very significant.

In nominal terms, the IIP per capita (book value) varied considerable from 1981 to 2013 (Figure 2). In 2007, the base year for the real estimates of comprehensive wealth, the IIP per capita was -$5,390 compared with comprehensive wealth per capita of $630,000 (see Indicator CW1 on page 81). Coincidentally, 2007 also happened to be a year with a relatively favourable IIP; over the period, the IIP per capita was generally considerably lower. Thus, had it been possible to include the IIP in the analysis, it would likely have made the story of comprehensive wealth's growth marginally worse than what is reported here.[21]

Figure 2. Net International Investment Position per capita, Canada, 1981–2013



18 Statistics Canada, *International Investment Position*, CANSIM Table 376-0142.

19 According to Statistics Canada, Canada's IIP has been consistently negative (in book value terms) since at least 1945 and likely since 1926, the earliest year for which data are available in CANSIM (data are sporadic between 1926 and 1945). Historically, the IIP switched from negative to positive in the fourth quarter of 2014 and has remained so since, at least in market value terms; IIP remains negative in book value terms.

20 Wealth is not, strictly speaking, the correct term here. Economists and statisticians refer to the concept of wealth as "national net worth" when it includes net foreign financial assets. "Wealth" in the traditional economic/statistical use of the term is the value of all assets other than financial assets.

21 Osberg and Sharpe (2011) of the Centre for the Study of Living Standards, in fact, make an estimate of Canada's IIP in real terms for the purposes of their Index of Economic Well-being. They find that the real per capita IIP to be about -$7,800 in 2013 (2007 constant dollars) in comparison to total real comprehensive wealth per capita of about $267,000. See Section 6.6.1 for further discussion of Osberg and Sharpe's estimates and a comparison with the results here.

2.4 Proposed Ideal Produced Capital Indicator

Given that all produced capital is measured in monetary terms, it is possible to propose just one indicator as the ideal basis for including produced capital in comprehensive wealth. This is the quarterly real (inflation-adjusted) per capita value of produced capital by province, which is labelled here the Produced Capital Index (Table 2).

The Produced Capital Index is the produced capital component of the Comprehensive Wealth Index that was noted in the preceding section to be a nearly ideal indicator of the sustainability of well-being. From the point of view of a report focused on measuring comprehensive wealth, no other indicator of produced capital is required.

At the moment, the Produced Capital Index is feasible as proposed, though the possibility for measuring it quarterly extends only back to 2009 and only at the national level.

Table 2. Proposed ideal produced capital indicator

Theme	Indicator
Produced capital	• *Produced Capital Index*, quarterly, by province/territory (partly feasible)

3 NATURAL CAPITAL AND COMPREHENSIVE WEALTH

3.1 Basic Concepts

The environment is the basis of human well-being. Forests, wetlands, lakes, rivers and grasslands provide food, clean water and air and places to live and play. All of these have immense value for society, whether on social, cultural or economic grounds. Recently, the environment's value has come to be recognized as a form of wealth.

In some ways, thinking of the environment in wealth terms is straightforward. Land, timber, fish and minerals are taken directly from natural stocks and sold on in the market. Stocks of these resources can be readily seen to be assets for their owners.

The wealth associated with other environmental benefits is less obvious. Wetlands absorb pollutants, creating clean water. Forests capture and store carbon emissions, helping to mitigate climate change. These benefits are invisible to most people, however, so it is not immediately clear that wetlands and forests are also valuable assets. As a result, their value is often not included in decision-making processes. The concept of natural capital recognizes these values and attempts to make it visible so it can be used in decision making.

Natural capital can be broadly divided into three types (United Nations et al., 2014):

- **Land** – provides space for human and natural activities.
- **Subsoil resources** – underground stocks of minerals, fossil fuels and water that provide flows of raw materials and energy.
- **Ecosystems** – self-maintaining natural systems that provide on-going flows of a wide variety of ecosystem goods and services (e.g., timber and carbon sequestration).

Ecosystems are the most difficult form of natural capital to conceptualize and measure. The Millennium Ecosystem Assessment (2005) defines ecosystems as dynamic complexes of (biotic) plant, animal and microorganism communities interacting with the (abiotic) nonliving environment as a functional unit. The interaction of biotic and abiotic ecosystem elements gives rise to ecosystem goods and services. Ecosystem goods and services are commonly broken down into provisioning, regulating, cultural and support services (see Text Box 4).

Conceiving of the environment as a form of capital allows comparison with other assets and a fuller assessment of the trade-offs of development. Using natural capital results in a stream of benefits, both market and

Text Box 4. Categories of ecosystem goods and services

Provisioning flows are the material goods or energy obtained from ecosystems. This includes food and wood as well as genetic resources and biochemicals.

Regulating flows are the benefits obtained from the ability of ecosystems to regulate our climate, water supply, and air quality. This category also includes natural pest control provided by predators and biodiversity as well as the pollination of agricultural crops (and aesthetically pleasing plants) by bees.

Cultural flows are the nonmaterial benefits people receive from ecosystems. This can be in the form of spiritual enrichment, recreation, or due to the aesthetic value of nature.

Supporting flows are those services that are necessary to support the production of all other ecosystem services. The benefits of supporting services are often more indirect than the other categories of services. Examples of supporting services include nutrient cycling in watersheds and soil formation.

non-market.[22] However, overuse can lead to depletion of natural assets, which may represent a loss of wealth.[23] If a portion of the proceeds from natural capital use is reinvested in other assets, wealth can be maintained—in some cases. For example, revenue from oil extraction can be invested in produced capital by constructing homes, hospitals and factories or in human capital by funding education. So long as these new assets are as valuable as the lost oil, there need be no loss in wealth (though see Text Box 5 for further discussion of natural capital and substitutability).

Certain functions of ecosystems can also be replaced with produced capital. For instance, installation of sea walls can help prevent coastal erosion in cases where wetlands, which provide the service naturally, are removed. This sort of substitution has taken place throughout human history but the scale at which it is currently taking place is unprecedented (Dasgupta, 2012). Substitution can carry its own risks for the environment. Pesticides have been used to replace the pest control services of ecosystems as agricultural activity has expanded. However, pesticides have detrimental effects on many species, and their overuse threatens other vital services, such as pollination. Some aspects of the environment are also irreplaceable—or critical—as they are vital for sustaining life on earth and have no substitute. Such

Text Box 5. Natural capital and substitutability

According to the substitutability concept, a natural asset used in a given process may be replaced by another asset, either another natural asset or a different type of asset altogether, with no loss of well-being. For example, in previous centuries the perfectly straight trunks of old-growth white pine trees were valued for use as masts on sailing ships. Technological change eventually saw steam and internal combustion engines replace masts and sails aboard ships. This was an example of the maintenance of well-being through substitution: the service of moving ships was shifted from a technology reliant mainly on natural capital to one reliant mainly on produced capital.

There is diverging opinion about the extent to which the substitutability of natural capital holds today. In one current of thought—known as “weak sustainability”—the possibilities for substituting natural assets are essentially limitless (Pearce & Atkinson, 1993; Neumayer, 2003). From this viewpoint, there is no natural asset for which a suitable replacement cannot be found given the need to do so. The “need to do so” normally arises because some particular asset has grown to be in short supply, spurring a quest to find a suitable substitute through technological change.

The opposing viewpoint (which is adopted here)—so-called “strong sustainability”—is that the possibilities for substitution of natural capital are limited (Pearce & Atkinson, 1993; Neumayer, 2003). The case of fish stocks provides a good example. Up to a certain point, declines in stocks can be compensated by more efficient fishing gear. There comes a point, however, when further technological gains do no good. At this point, catches may fall to zero and both the fish and the gear become worthless. The fish and the gear are said to be complementary assets in this example. There are many such examples in the real world.

There are more extreme limitations on substitution as well. Some forms of natural capital provide services that are essential to human well-being and for which there does not (and may never) exist any substitute. Examples of this type of service are few but undeniably important; global atmospheric systems that provide the services of climate regulation and protection from solar radiation are one. True wilderness, with its matchless psychological value, is, arguably, another. The term critical natural capital is applied to such assets.

The two viewpoints regarding substitution have important implications for measurement. If the possibilities for substituting natural assets are essentially limitless, then there is a compelling argument for measuring all natural assets using a common metric, which, for all intents and purposes, would be dollars. When assets are all measured in monetary terms, it is possible to meaningfully compare trade-offs when one is substituted for another. This possibility is valuable in a decision-making context, where assessing trade-offs is an everyday occurrence.

In contrast, if the possibilities for the substitution of natural capital are strictly limited for critical forms of capital, there is no case to be made for measuring these assets using dollars. Critical natural assets cannot be traded off against other forms of capital, so their measurement should be undertaken using whatever metric is best suited to them. In most instances, this would mean the use of physical units.

[22] Market benefits are realized in the form of cash or subsistence income. Non-market benefits are realized in the form of well-being derived from consuming the various goods and services the environment provides freely and are not mediated by markets (e.g., freely available timber, clean air and water, scenic views and “walks in the woods”).

[23] In the case of non-renewable resources such as coal and iron, any use necessarily leads to physical depletion of the asset.

critical assets can exhibit non-linear behaviour, degrading at different rates so that critical tipping points are difficult to predict. A system may appear to be working well but a combination of overuse can cause it to collapse all at once (Dasgupta, 2012). Text Box 5 further discusses the issues around natural capital and substitution and the implications for measurement.

3.2 Measurement of Natural Capital

3.2.1 Measuring Commercial Natural Assets

Many natural assets (or the goods they provide) are bought and sold in markets. Commercial and residential land often trades hands, and the prices paid in these transactions provide a direct measure of its value. Commercial land is, therefore, the simplest type of natural asset to value.

Timber, minerals, fish, agricultural products and other goods extracted from subsoil resources or produced by ecosystems are all traded in markets and have established market prices as a result. There is reason to argue that the market prices assigned to these goods offer a reasonable approximation of their full social value. In other words, market prices can be taken to come close to the theoretically ideal shadow prices mentioned above (see Footnote 8 and the accompanying text) (UNECE et al., 2009). This is particularly the case in a country with well-established and open markets like Canada.[24] Market prices for natural resources can, therefore, be used as the basis for valuing the underlying assets; timber prices, for example, can be used as the basis to value the standing timber asset in the commercial forest. This approach rests on the concept of resource rent, which is the value of the natural asset's contribution to the resource production process. Resource rent can be used in principle to value all subsoil resource assets. Annex 1 outlines the relevant technical details.

Even if valuation is appropriate and desirable as a basis for measuring land and subsoil assets, physical measures offer useful complements. Values are influenced by a variety of forces, not all of which have anything to do with the size of the underlying physical asset. Evaluating the sustainability of these assets is therefore most soundly based on both physical and monetary measures.

Commercial land of different types (urban land, farmland, roads and other transportation networks) is readily measured in terms of area. Subsoil mineral and energy assets are measurable in terms of the in situ quantities of reserves of different grades (proven, probable, inferred). Groundwater quantity is more difficult but can, in principle, be measured as the volume of aquifers and soil water. Physical measures of commercial natural assets are discussed further in Section 3.4.2.

3.2.2 Measuring Ecosystems

Measuring ecosystems and their services, especially in monetary terms, is more difficult. Market prices generally do not exist, so other methods must be used if monetary values are to be assigned.

The first step in measuring the value of ecosystems is to value the goods[25] and services they provide. Then, as with subsoil resource assets (see Annex 1), the value of the ecosystems themselves can be estimated by projecting the value of the service flows through time and calculating a present value of these flows (Tallis, Polasky, Lozano, & Wolny, 2012).

[24] If markets functioned perfectly, shadow prices and market prices would be equal. However, perfectly functioning markets don't exist in reality. "Externalities" exist that cause gaps between market prices and shadow prices. Externalities are effects of activities on people who do not directly benefit from them. For instance, farmers may drain wetlands in order to expand agricultural land, but the loss of wetlands may impact other people in the watershed through, for example, increased flooding. The extent to which market and shadow prices diverge is, then, a question of the pervasiveness and seriousness of externalities.

[25] Ecosystems provide a variety of goods, including timber and non-timber forest products, water, wild animals and fish.

Barbier (2012) points out three important steps for valuation of ecosystems services. First, it is necessary to determine how to characterize the change in ecosystem structure, functions and processes that produces changes in the ecosystem service being valued. Second, it is necessary to know how the changes to ecosystem structures, functions and processes influence the quality and quantity of ecosystem services. Third, standard valuation techniques can be used to value ecosystem services.

A number of standard techniques are available to value non-market ecosystem services: production function methods; revealed cost methods; stated preference methods and revealed preference methods. These methods are limited in applicability, with the exception of stated preferences methods, which can be widely used (Barbier, 2012). They can also be expensive and time-consuming to apply and often focus on localized ecosystems (e.g., a given watershed or ecoregion). As a result, methods have been developed to allow values derived from them to be transferred to different ecosystems or scaled up to larger areas.

Though valuation of ecosystem services is increasingly common, the additional step of valuing ecosystems themselves as assets is not. There are several reasons for this. First, ecosystems are complex and provide many different goods and services, not all of which are readily valued. Second, valuation of ecosystem services is, as noted, often localized; estimating the value of spatially extensive ecosystems on the basis of localized values is problematic. Third, valuation methods do not all yield comparable values. Some, yield so-called "exchange" values (values based on what a willing buyer and seller in a competitive market would agree to) and others yield "welfare" values that include additional elements.[26] Finally, valuation of ecosystems requires projections of service values into the future, which may require complex ecological modelling.[27]

Even if valuation were more feasible than it is, it would be inappropriate as the sole basis for measuring ecosystem assets. Valuation is only appropriate (or necessary) in the case of natural capital that can be substituted by other forms of capital. As noted earlier, not all natural capital is substitutable (see Text Box 5 and the discussion in Section 1.5). The strong sustainability view taken here suggests that substitution possibilities for natural capital stocks—critical ecosystems in particular—are limited even in the face of technological progress. Small (marginal) changes in natural capital may be dealt with through substitution or, in the case of critical assets, simply by accepting lower levels of ecosystem services. Human impacts on the environment are, as already noted, becoming less and less marginal. As impacts increase, we move further from the point where substitution can be assumed to apply and closer to the point where living with reduced natural capital stocks will impose heavy costs. Careful tracking of individual natural capital stocks, especially critical ecosystems, is therefore called for by the strong sustainability view. This suggests that measurement of natural capital cannot rest on monetary indicators alone. Additional indicators of capital stocks measured in physical units are required (UNECE et al., 2009). Section 3.4.2 discusses what such physical indicators should be in the case of ecosystems.

[26] Specifically, production function and revealed preference methods are based on market prices that eliminate "consumer surplus," i.e., the amount that some buyers are willing to pay for a good over and above the market price. Stated preference methods do not always eliminate consumer surplus, and therefore cannot always be combined with the other methods.

[27] As with the valuation of commercial natural assets (see Annex 1), there is the option to assume that the current value of ecosystem services will hold in the future for the purposes of the present value calculation. Ecosystems are far more dynamic than subsoil resources, however, so the validity of such an assumption is more questionable in the case of ecosystem valuation.

3.3 The Status of Natural Capital Measurement in Canada

Canada is a pioneer of natural capital measurement. Formal work on the Canadian System of Environment and Resource Accounts (CSERA) began at Statistics Canada in 1992. The goal of the CSERA is to provide physical and monetary statistics describing natural capital compatible with the System of National Accounts. These statistics are aimed at quantifying the link between the economy and the environment and encouraging the sustainable use of natural capital. The CSERA includes Natural Resource Stock Accounts, Material and Energy Flow Accounts and Environmental Protection Expenditure Accounts. An in-depth description of these accounts can be found in *Concepts, Sources and Methods of the Canadian System of Environmental and Resource Accounts* (Statistics Canada, 1997).

The Natural Resource Stock Accounts are the most relevant to the discussion here. They are divided into Subsoil Asset Accounts, Timber Asset Accounts and Land Accounts. The Subsoil Asset Accounts include physical and monetary estimates for stocks of oil, natural gas, coal, metals and potash. The Timber Asset Accounts provide physical and monetary estimates of those timber stocks that are designated for commercial harvesting. Other forest services such as recreation and wildlife habitat are not currently measured. The Land Accounts include physical information on land cover for all of Canada, which is an important step toward ecosystem accounts, and monetary estimates for agricultural and built-up land.

As of late 2015, Statistics Canada (2015a) began including an aggregate estimate of the value of selected natural assets,[28] allocated by sector of the economy, in its quarterly National Balance Sheet Account.[29] This is a first for a statistical agency anywhere in the world and provides insight into the effective ownership of natural resources in Canada.

As for the measurement of other forms of natural capital, relatively few monetary estimates exist (especially when it comes to the assets themselves) but considerable information is available in physical terms. Some of this is available from Statistics Canada, but much more is available from other federal, provincial and territorial agencies.

Statistics Canada has produced a variety of one-time studies that are relevant to measuring ecosystems and related goods and services. Two of these looked at the variability in temperature and precipitation over recent decades (Fritzsche, 2011a, 2011b). Another measured trends in water yield, providing a view of changes in the climate's capacity to renew our fresh water. Yet another pair (Fritzsche, 2010; Henry, 2012) considered trends in glacier mass balance and snow cover, both providing insight into the relationship between climate and freshwater availability (much of Canada's freshwater flows are associated with summer runoff from snow and ice). Importantly, Statistics Canada is working toward the development of ecosystem accounts that will considerably expand and improve the available data. A first effort in this direction, *Human Activity and the Environment: Measuring Ecosystem Goods and Services* (Statistics Canada, 2013a) laid out a conceptual framework for the measurement of the stocks of ecosystems and accompanying flows of ecosystem goods services and presented initial findings.

Notable efforts to measure natural capital and the factors influencing it from other federal, provincial and territorial agencies include:

- Environment Canada's Canadian Environmental Sustainability Indicators program
- Natural Resources Canada's *State of Canada's Forests Report*
- Fisheries and Oceans Canada's *State of the Oceans Report*

[28] Minerals, fossil fuels and timber.

[29] Statistics Canada, CANSIM Table 378-0121.

- Biodivcanada's *Ecosystem Status and Trends Report*
- Prince Edward Island's *State of the Environment* reports
- Ontario's *State of Protected Areas Report*, *State of the Forest Report* and *State of Biodiversity Report*
- Saskatchewan's *State of the Environment* reports
- Alberta's *State of the Environment* reports
- British Columbia's *State of the Environment* reports
- Yukon's *State of the Environment* reports
- Northwest Territories' *State of the Environment* reports

These reports present a great deal of useful information for understanding natural capital and its evolution. At the same time, they suffer to varying degrees from a number of shortcomings: out-of-date information; infrequent and irregular publication; missing data; inconsistency in approach and coverage from one jurisdiction to the next; inaccessibility and lack of meta-data.

A number of independent ecosystem valuation studies have been carried out for specific regions in Canada. Many such studies aim to value the flows of ecosystem services. A few also estimate values for the natural assets that provide these flows. Ducks Unlimited Canada and the Nature Conservancy of Canada supported a study of the value of natural capital in several regions, including the Fraser Valley, the Grand River Watershed in Ontario, and the Upper Assiniboine watershed in Manitoba and Saskatchewan (Olewiler, 2004). The Canadian Boreal Initiative supported studies on the boreal forest, including a full economic valuation using a wealth accounting framework (Anielski & Wilson, 2006) and a valuation of the Mackenzie River watershed (Anielski & Wilson, 2009). These two studies include the value of market and non-market ecosystem services of the boreal forest. The David Suzuki Foundation studied the value of natural capital in British Columbia's lower mainland (Wilson, 2010) and Ontario's Golden Horseshoe (Wilson, 2013).

3.4 A Proposed Suite of Natural Capital Indicators

A mixed approach to measuring natural capital is proposed here, with a balance between monetary and non-monetary indicators. This reflects both the state of development of natural capital valuation methods and the fact that some forms of natural capital—those that are critical to survival—are not suited to monetary measurement. The indicators are described below in their "ideal" form; that is, the form in which they would be measured in the absence of conceptual, methodological or data gaps. The versions of the indicators actually presented in Part II of this report (beginning on page 46) do not in any case meet the ideal, though some come close. A brief discussion of feasibility is given for each indicator to show how close it is possible to come to the ideal today. The indicators are summarized in Table 3.

3.4.1 Monetary Indicators

- **Market Natural Capital Index (quarterly, by province/territory)** – This indicator measures the real (inflation-adjusted) per capita value of Canada's market natural capital stocks (minerals, fossil fuels, timber, marine resources, water, farmland and built-up land). Measurement in real terms eliminates the effect of price inflation, providing a basis for determining whether or not the quantity of market natural capital available to the economy is growing over time. Measurement in per capita terms ensures the indicator measures the trend in market natural capital in isolation from growth in the population.

This is an important indicator because of what it says about the on-going capacity of the environment to contribute to comprehensive wealth. Comprehensive wealth measures the basis upon which much well-being rests and, therefore, a measure of natural resource wealth is a key measure of the link between environmental quality and well-being.

The Market Natural Capital Index also addresses a central challenge with tracking natural resource assets in physical terms: the fact that they may be measured in any one of a number of different physical units (tonnes, litres, hectares, etc.). These disparate units mean that the various stocks cannot be added together to give an overall estimate of the physical extent of natural resource assets. This problem is dealt with in the volume indicator by weighting the individual resource stocks by their relative contribution to resource wealth (that is, their value) in a base year and then aggregating the weighted stock measures to produce the indicator. Though not strictly a monetary indicator, it relies on monetary measures for its compilation and so is included under this heading.

This indicator is **partly feasible** today based on a methodology developed by Statistics Canada (Islam, 2007), though estimates of the value of marine resources and water are not currently available for inclusion and the indicator can be compiled annually (not quarterly) and only for some provinces.

- **Non-market Natural Capital Index (quarterly, by province/territory)** – This is the non-market equivalent of the preceding indicator. It measures the real per capita value of natural capital that provides benefits outside of direct market transactions. This includes the asset value of any provisioning flows that occur outside the market (e.g., harvesting of forest mushrooms) plus the asset values associated with regulating and cultural services of ecosystems.

  This indicator is **not feasible** today due to data gaps and methodological shortcomings.

3.4.2 Non-Monetary Indicators

A complete assessment of natural wealth must include all natural capital types, not just those amenable to monetary valuation. And even those that are amenable to valuation can be usefully complemented with non-monetary indicators. Natural capital is, after all, essentially physical in nature. Non-monetary indicators provide, therefore, an essential counterpoint to monetary measures even where the latter are possible. Moreover, in some cases non-monetary measures are the only possibility. For so-called “critical” natural capital—natural assets for which no other form of capital may substitute—monetary valuation is inappropriate. These assets are in effect “priceless” and only non-monetary indicators have any meaning. Examples of this type of service are few but undeniably important; global atmospheric systems that provide the services of climate regulation and protection from solar radiation are one. True wilderness, with its matchless psychological value, is, arguably, another.

Critical natural capital is both simpler and more challenging to measure than substitutable capital. It is simpler because there is no need to produce both monetary and physical measures, only the latter. It is more challenging because there is no obvious way of combining measures across different critical assets to come up with aggregate indicators in the same way as proposed for market natural capital. Thus, rather than capturing all that is relevant about critical assets in just a few indicators, measuring critical capital requires unique indicators for each critical asset. Fortunately, as noted, such assets are relatively few in number, so the number of indicators proposed is not unmanageable. Ecosystems are really the only category of natural capital that produce critical ecosystem goods and services flows and, depending on which classification of ecosystem types is used, there would be fewer than 10 distinct ecosystem types for which indicators would be required.

The capacity of ecosystems to deliver ecosystem goods and services flows is a function of their absolute size but also of their quality. For example, carbon sequestration—an important and critical ecological service of forests—is partly a function of a forest's physical extent: less forest, less carbon sequestration, all things being equal. However, the qualitative characteristics of the forest count too. The ages and types of trees, their health, precipitation, soil conditions and other characteristics all play a role in determining the rate at which forests will sequester carbon.

Thus, when considering a measure of the ability of Canada's forests to sequester carbon, an ideal indicator is *quality-adjusted extent of forestland*. Such an indicator would capture at once the evolution of both the size and quality of Canada's forest assets from the perspective of carbon sequestration. It would measure the actual physical extent of forests (in hectares) weighted by a relative quality index set arbitrarily to unity in a base year. Quality in subsequent years would be assessed relative to that in the base year and expressed as an index relative to 1. The index would be multiplied by the actual physical extent of forest to come up with a new quality-adjusted extent measure in each measurement period.

Similar quality-adjusted extent indicators would serve as an ideal basis for measuring other ecosystems as well.

Annual measurement by province/territory is proposed for the indicators, listed below:

- ***Quality-adjusted Forest Extent*** **(annual, by province/territory)**
- ***Quality-adjusted Grassland*** **Extent (annual, by province/territory)**
- ***Quality-adjusted Tundra Extent*** **(annual, by province/territory)**
- ***Quality-adjusted Coastal Zone Extent*** **(annual, by province/territory)**
- ***Quality-adjusted Wetland Extent*** **(annual, by province/territory)**
- ***Quality-adjusted Surface Freshwater Extent*** **(annual, by province/territory)**

The above indicators (with the exception of the coastal zone and groundwater indicators, for which adequate data do not exist) are all **partly feasible** today based on a Global Forest Watch Canada database of land cover and degree of "development." Development in this context refers to the proximity of natural land cover types (ecosystems) to human land uses. Ecosystems that are within 1 km of a human development (be it a roadway, a town, an industrial site, a utility corridor or some other use) are considered developed. Obviously, degree of development does not capture all of the qualitative characteristics that are important to ecosystem functioning. It is, however a reasonable proxy for ecosystem intactness, which is a useful starting point for considering ecosystem quality. At the moment, Global Forest Watch Canada's database does not permit analysis of development over time: only data for 2011 are available.

In addition to the ecosystems listed above, the climate system also provides essential natural capital services. However, it does not lend itself to a quality-adjusted extend indicator in the same way as terrestrial or aquatic ecosystems. For this reason, indicators based on the long-term trends in key climatic parameters (precipitation, temperature, snow cover, glacier mass, water yield and sea ice cover) are proposed as part of the ideal suite here. The precipitation and temperature indicators are both **feasible**; the others are only partly feasible, as they cannot be produced annually due to intermittent data collection.

- ***Precipitation* (annual, by region)**
- ***Temperature* (annual, by region)**
- ***Snow Cover* (annual, by region)**
- ***Glacier Mass* (annual, by region)**
- ***Water Yield* (annual, by region)**
- ***Sea Ice Extent* (annual, by region).**

Table 3. Proposed ideal suite of natural capital indicators

Theme	Indicator
Market natural capital	• *Market Natural Capital Index*, quarterly, by province/territory (partly feasible) $$$
Non-market natural capital	• *Non-market Natural Capital Index*, quarterly, by province/territory (not feasible) $$$
Ecosystems	• *Quality-adjusted Forest Extent*, annual, by province/territory (partly feasible) • *Quality-adjusted Grassland Extent*, annual, by province/territory (partly feasible) • *Quality-adjusted Tundra Extent*, annual, by province/territory (partly feasible) • *Quality-adjusted Coastal Zone Extent*, annual, by province/territory (not feasible) • *Quality-adjusted Surface Freshwater Extent*, annual, by prov-ince/territory (partly feasible) • *Quality-adjusted Wetland Extent*, annual, by province/territory (partly feasible) • *Quality-adjusted Groundwater Extent*, annual, by province/territory (not feasible
Climate	• *Adult Skills*, annual, by province/territory (partly feasible)

Note: Indicators marked with $$$ are measured in monetary terms.

4 HUMAN CAPITAL AND COMPREHENSIVE WEALTH

4.1 Basic Concepts

The possibility of treating an individual's skills and abilities as a kind of capital began to be explored seriously in the 1960s, though it actually dates back to Adam Smith and his seminal 18th century work *An Inquiry into the Nature and Causes of the Wealth of Nations* (1776). Modern discussions of human capital have stressed the economic value of investing in improved skills and abilities. This was largely driven by interest in the quality of the labour supply. Schultz (1960, 1961), for example, was interested in differentiating skilled and unskilled labour. Human capital came to be seen as a synonym for the traditional economic input of labour.

Over time human capital research broadened from its narrow focus on economic returns to a more inclusive concept. Human capital is today understood to have non-economic benefits as well, benefits that are just as important as economic benefits, if not more so. Non-economic benefits can accrue to either the individual or to society as a whole. Personal benefits include better physical and mental health and greater subjective well-being. Social benefits include a more informed citizenry and a greater willingness to cooperate (UNU–IHDP & UNEP, 2014).

The OECD (2001, p.18) recognizes both kinds of benefits in its definition of human capital:

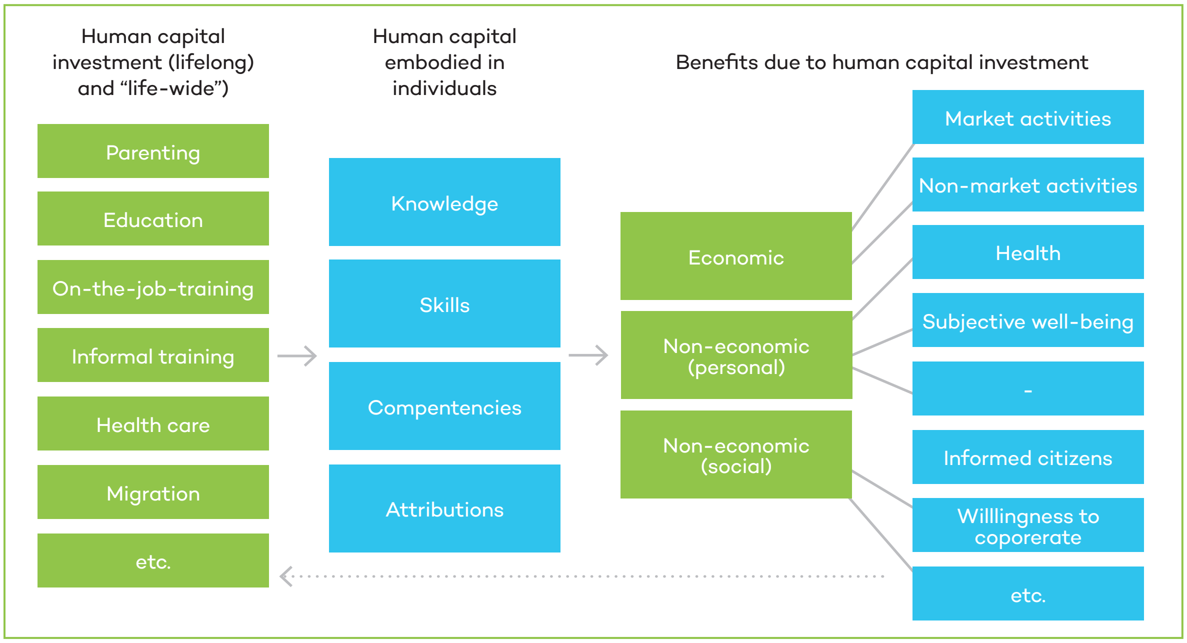
> "the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being."

This broad definition allows for skills gained through learning and experience but also includes innate abilities, motivation and behaviour. It reflects well how human capital relates to economic success and to well-being more broadly.

Human capital can accumulate and deteriorate like other forms of capital. It accumulates in many ways, both *life-wide* and lifelong. *Life-wide* learning refers to the fact that people learn through formal education as well as while on the job, volunteering and in interactions with family and friends. Lifelong learning simply reflects the fact that people are constantly learning and developing new skills. Human capital is created through parenting, education, on-the-job training, health care, informal learning, migration and many other avenues (Boarini, Mira D'Ercole, & Liu, 2012). Investments in these areas come to be embodied in individuals as skills, knowledge and competencies. These skills can be specific to situations or industries, as in the skills learned by aerospace engineers. Or they can be general and applicable in many situations, as in communications. Human capital can also deteriorate as people forget or lose unused skills and knowledge, or if their health fails, since physical and mental health are important not only to worker productivity but also to personal well-being (Liu, 2011).

Figure 3 summarizes the links between investments, the types of human capital created and their economic and non-economic benefits.

Figure 3. Human capital



Source: Adapted from UNU–IHDP and UNEP, 2014.

4.2 Measurement of Human Capital

While the broad definition of human capital advanced by the OECD suitably captures the wide variety of skills, knowledge and abilities that support economic productivity and well-being, in practice it is difficult to measure. Most ways of measuring human capital take a more restrained approach. Two in particular have received the greatest attention, one focusing on the importance of education and the other on the measurement of outcomes.

Human capital as it relates to education may be measured using a number of different methods, though a broad distinction can be made between monetary and non-monetary approaches. The non-monetary method is divided into qualitative and quantitative indicators, with the former focused on the quality of education and the latter on, for example, enrolment numbers and average levels of education reached.

There are two main monetary approaches. A cost-based method examines the value of investments in education, while an income-based approach looks at the value of lifetime-income for people of different education levels—both will be explored in more detail below. A significant challenge for monetary measures of human capital is the impact of changes in educational quality. Adjustments can be made for both cost-based and income approaches using data on the quantity and quality of inputs, such as class sizes and the number of experienced teachers, as well as data on classroom outputs, such as test scores (Gu & Wong, 2012).

4.2.1 Non-Monetary Approaches

A variety of non-monetary indicators can be used to measure human capital, including adult literacy rates, school enrolment and average years of education.

Direct tests of people's skills have become popular as indicators of human capital (Boarini et al., 2012). Two such tests are:

- The OECD's Programme for International Student Assessment (PISA), which tests 15 and 16 year olds' reading, mathematics, science and problem solving skills, and
- The OECD's Programme for International Assessment of Adult Competencies (PIAAC), which tests adults for competency in literacy, numeracy and ability to solve problems using technology.

While these tests can be informative, they are resource-intensive to perform and are done infrequently. The results are also not directly comparable with indicators of other types of capital (UNU–IHDP & UNEP, 2014).

The most widely used indicator approach was developed by Barro and Lee (1993). Barro and Lee's conception of human capital consists of years of schooling completed for people aged 25 and older. They measure this using data on average formal education attainment in five-year increments beginning at the age of 15 in four categories (no formal education, primary, secondary and tertiary).

Though a single indicator would be desirable for simplicity's sake, one non-monetary indicator alone cannot provide a complete measure of human capital. Dashboards of indicators that present a variety of individual measures are sometimes used in order to better capture the complexity of human capital. While dashboards provide a wide array of information, they employ a variety of units of measure, and the indicators cannot be easily aggregated into summary measures. This makes it difficult to compare across countries and over time. Dashboard indicators are also not comparable with other types of capital (Boarini et al., 2012).

4.2.2 Monetary Approaches

Cost-Based Approaches

Cost-based approaches such as those developed by Kendrick (1976) and Eisner (1985) offer direct monetary measures of human capital. Estimates are made by looking at past investments in education and training made by individuals, households, employers and governments. These are the costs that go along with the production of human capital. They can take the form of money or non-market inputs such as time devoted to education by students.

One benefit of cost-based approaches is that they are relatively easy to apply, at least when limited to market inputs. There is a wide variety of readily available data on public and private expenditures on formal education. It is also possible to include investments in on-the-job training (Boarini, et al., 2012).

However, cost-based approaches have several drawbacks. They have been criticized on conceptual grounds because they value human capital based on the costs of its creation. It has been argued that the value of human capital should be determined by considering supply and demand instead. There is not necessarily any relationship between investment in human capital and the quality of outcomes. More innately skilled people may require less investment to develop human capital. Cost-based approaches also ignore the fact that education is a long process subject to appreciation and depreciation. Appreciation of human capital in early years is ignored in the cost-based approach. Estimates of human capital are also sensitive to the depreciation rate, which is arbitrarily set (Le, Gibson, & Oxley, 2003).

Income-Based Approaches

Income-based approaches to measuring human capital provide monetary estimates based on lifetime earnings of individuals in society. While cost-based approaches look at the input side, income-based approaches look at the output side of education in the form of wages earned by an individual. This has the benefit of valuing human capital based on supply and demand using market prices of wages (Boarini et al., 2013).

The income-based approach developed primarily by Jorgenson and Fraumeni (1989, 1992) has become one of the primary approaches used for measuring human capital. The Jorgenson–Fraumeni lifetime-income approach makes use of the neoclassical theory of investment, which states that the price of a capital good should equal the present (discounted) value of all future services derived from its use. Thus, an individual's human capital can be estimated by measuring the discounted value of their expected lifetime-income.

The Jorgenson–Fraumeni approach uses data on the working age population, survival rates, school enrolment rates, educational attainment and annual earnings. An important advantage of the lifetime-income approach is that the results may be structured in a way similar to the produced capital accounts in the SNA. This makes it easier to compare the different capital types. The Jorgenson–Fraumeni approach also includes the value of both market and non-market labour.

However, the lifetime-income approach also has drawbacks. In order to calculate future earnings, a number of subjective choices must be made about discount rates, real income growth and other factors (Boarini et al., 2012). Labour markets do not always function perfectly, so wage rates may not be equal to the actual value of labour (Le et al., 2003)—labour unions may win their workers wage premiums in certain sectors, or economic downturns may allow business owners to depress wages.

The Jorgenson–Fraumeni approach has also faced criticism over its treatment of non-market labour. Full labour income is defined as the sum of market and non-market labour compensation, with non-market compensation estimated by opportunity cost. This means that the employment rate does not impact the total value of human capital but rather just the distribution between market and non-market. Unemployment is essentially treated as though it were voluntary (Le et al., 2003).

In its global inclusive wealth reports (UNU–IHDP & UNEP, 2012, 2014), UNEP uses an income-based approach based on work by Arrow, Dasgupta, Goulder, Mumford & Oleson (2012) and Klenow and Rodriguez-Clare (2004). This methodology uses average formal educational attainments, average wages, total employed adults, total adult population and average expected remaining working years. Barro and Lee's (2013) data are used for average educational attainment. Like Jorgenson–Fraumeni's lifetime-income approach, the UNEP methodology yields results that are comparable to other types of capital. It has the advantage of being less intensive in its requirements for population data.

Combined Approaches

It can be worthwhile to include non-monetary indicators alongside monetary ones. Monetary indicators may hide underlying changes in value or volume. Price changes in scarce resources may impact the cost of education inputs or the wages in certain sectors. High earnings for highly educated people may offset concentration of educational opportunities. It is useful to understand how underlying trends such as changes in enrolment or wages are reflected in monetary measures (Boarini et al., 2012).

4.3 Measurement of Human Capital in Canada

There have been few estimates made of human capital in Canada. Laroche and Merette (2000) used an income-based approach to measure the stock of human capital from 1971 to 1996 based on educational attainment and the number of years of working experience. This approach differs from the Jorgenson–Fraumeni approach in that it uses current rather than lifetime-income.

Statistics Canada has published research papers on human capital but never published official estimates. One research paper in the Economic Analysis Research Paper Series (Gu & Wong, 2010) provides an estimate of market-based human capital from 1970 to 2007 using a modified Jorgenson–Fraumeni (lifetime-income) methodology. The value of human capital in Canada is estimated as the net present value of earnings over the lifetimes of the population aged 15 to 74. The approach includes only the value of market activities—non-market activities are not considered.

Gu and Wong found that the aggregate value of human capital in real (volume) terms rose at an annual rate of 1.7 per cent over the study period; in per capita terms, the annual growth rate was just 0.2 per cent, with nearly all the growth occurring between 1970 and 1980. Growth was due to both the increased working age population of Canada and rising education levels. However, the increasing average age of the working population had a significant negative impact on the growth of human capital.

As part of its Index of Economic Well-Being, the Ottawa-based Centre for the Study of Living Standards has published a measure of Canada's human capital using a cost-based approach that considers the value of investments in education (Osberg & Sharpe, 2011). They found that the real per capita value of human capital in Canada increased at an average rate of 1.12 per cent annually from 1981 to 2010. In comparison, Statistics Canada (Gu & Wong, 2010) found essentially no growth at all in human capital over the same period measured using the lifetime-income approach. In more recent work (UNECE, 2016; Gu, personal communication), Statistics Canada found that human capital increased at 3.6 per cent annually from 1981 to 2010 using a cost-based approach similar to that of Osberg and Sharpe focused on educational investments.

The fact that the cost-based approaches both show growth in real per capita human capital over time while the lifetime-income approach does not may be explained in part by the need to "keep up with the Joneses"; that is, it is likely that increasing educational investments are needed in today's world just to maintain human capital at a given level. It could also be that the quality of education has declined over time, so that individuals have more academic qualifications but are not necessarily better educated than in the past. It is also possible that Canadians truly are better educated than in the past but that for reasons having nothing to do with education this does not translate into increased lifetime-income. Finally, it is not necessarily expected that the two measures would grow at the same rate. The cost-based approach really measures the *inputs* into the formation of human capital, while the lifetime-income approach measures its *output*. While theoretically the two measures should be close (in the absence of market failures), there are a number of reasons why they are not so in practice, including the difficulty in measuring all of the inputs on the cost side (UNECE, 2016). Further research would be required to validate these hypotheses.

4.4 A Proposed Suite of Human Capital Indicators

This report proposes a combined and focused approach to measuring human capital. The central measure would be a monetary indicator of aggregate human capital based on the lifetime-income approach—a small number of non-monetary indicators would provide complementary information. This reflects the fact that the lifetime-income approach is a well-developed and widely applied method for estimating the monetary value of human capital. It also recognizes that human capital, which is intangible, is less well suited to measurement with non-monetary indicators than, say, natural capital. Text Box 6 explains why the lifetime-income method of valuing human capital is preferred here over an approach based on the cost of educational investments.

The proposed human capital indicators are described below in their "ideal" form—that is, the form in which they would be measured in the absence of conceptual, methodological or data gaps. The versions of the indicators presented in Part III of this report (beginning on page 123) are largely able to meet this ideal. A brief discussion of feasibility is given for each indicator to indicate how close it is possible to come to the ideal today. The indicators are summarized in Table 4.

4.4.1 Monetary Indicators

- **Human Capital Index (quarterly, by province/territory)** – This indicator measures the real (inflation-adjusted) per capita value of Canada's human capital using a modified version of Jorgenson–Fraumeni lifetime-income approach. Measurement in real terms eliminates the effect of price inflation, providing a basis for determining whether or not the quantity of human capital available to the economy is growing over time. Measurement in per capita terms ensures that the indicator measures the trend in human capital in isolation from the growth in the population.

  This is an important indicator because of how it describes the on-going capacity of the Canadian workforce to contribute to comprehensive wealth. Comprehensive wealth is the basis upon which well-being rests: a measure of human capital is therefore a key link between the capabilities of the workforce and well-being.

  This indicator is **partly feasible** today based on research by Statistics Canada (Gu & Wong, 2012). Data are not available quarterly or by province.

- **Educational Spending Index (annual, by province/territory)** – This indicator measures the real (inflation-adjusted) per-pupil value of spending on education by governments, private organizations and households. Measurement in real terms eliminates the effect of price inflation, providing a basis for determining whether the quantity of human capital available to the economy is growing over time or not. Measurement in per-pupil terms ensures the indicator measures the trend in human capital in isolation from the growth in total enrolment.

  Spending on education is an important indicator of human capital investment.

  This indicator is **partly feasible** today based on data collected by Statistics Canada. Data are available for public and private spending on formal education in elementary/secondary schools, community colleges and universities.

4.4.2 Non-Monetary Indicators

In addition to the monetary indicators of human capital, a small set of supplementary indicators relating to educational outcomes are proposed:

- **Educational Attainment (annual, by province/territory**) – Educational attainment includes the number of people attaining formal degrees, certificates and accreditation. Both the public education system and on-the-job training are important investments in human capital, and measuring them provides a clearer picture of how it is developed in Canada.

  This indicator is **partly feasible** today based on data collected by Statistics Canada. Data are readily available for attainment in the public education system, by province, age level and other demographic characteristics. Data for on-the-job training are not readily available.

- **Adult Skills (annual, by province/territory)** – An indicator of the skills of adult Canadians in the areas of adult literacy, numeracy and the ability to solve problems.

  This indicator is **partly feasible** today based on data for Canada from the OECD's PIAAC test (Statistics Canada, 2013b). Administering the test is resource-intensive and therefore done intermittently, so data are not available annually.

Text Box 6. Measuring Human Capital – The lifetime-income versus the cost-based approach

Two main approaches to valuing natural capital are available: the lifetime-income approach of Jorgenson and Fraumeni (1989, 1992) and the educational investment (cost-based) approach of Schultz (1960) and Kendrick (1976). Both approaches have been the subject of much research and are well-developed conceptually, methodologically and empirically.

Both approaches are conceptually sound, though the lifetime-income approach is more consistent with economic theory and provides a better measure of productive base needed for future production, which is very much the focus of comprehensive wealth. Additionally, the methodology of the lifetime-income approach requires construction of a database with all the basic elements required to construct a volume index of human capital. This provides a sound basis for deflating the estimates to measure real change over time, again of central importance in the context of comprehensive wealth. In contrast, the cost-based approach requires choice of an exogenous price index to deflate education expenditures, a choice that can be challenging. Also difficult is the choice of the rate at which to depreciate investments in education, as little empirical evidence exists to provide guidance. The lifetime-income approach, in contrast, does not require a depreciation rate (UNECE, 2016).

The two central choices required in the lifetime-income approach are the rate at which to deflate future income and the assumed rate of growth of future income. Both of these are arbitrary to some extent, though there is theoretical and empirical reasoning that can help guide the decision. Both decisions have an impact on the level of human capital but not on change in the level over time (UNECE, 2016).

In theory, the two approaches should yield similar results (in the absence of market imperfections), though in practice the results are generally quite different. The value of human capital as estimated by the cost-based approach is usually considerably smaller than that estimated by the lifetime-income approach. The reasons for this include the difficulty in identifying all of the costs related to creating human capital, the fact that some human capital is likely innate (and not created by explicit investments), and the possibility that the lifetime-income approach overestimates the value of human capital (UNECE, 2016).

Given the above, the lifetime-income approach appears best suited to the analysis of comprehensive wealth. It likely comes closer to measuring the true value of human capital, with cost-based estimates offering more of a lower bound on the value. Importantly, the lifetime-income approach is likely better suited to assessing real change over time, as it is based on a sounder approach to deflation, and the major assumptions underlying it do not have an impact on temporal change.

It is important to note that neither approach is perfect, and both could benefit from additional conceptual and methodological research and empirical testing. By either method, the value of human capital is large in comparison to the other elements of comprehensive wealth, so getting the value "right" —both in terms of its level and even more importantly in terms of change over time—is important. It is hoped that this and similar reports will spur additional work in the area. The recent publication of a draft guide to human capital measurement for statistical agencies by the UN Economic Commission for Europe (2016) is an important step in the right direction.

Table 4. Proposed ideal suite of human capital indicators

Theme	Indicator
Human capital	• *Human Capital Index*, quarterly, by province/territory (partly feasible) $$$
Educational inputs	• *Educational Spending Index*, annual, by province/territory (partly feasible) $$$
Educational outcomes	• *Educational Attainment*, annual, by province/territory (partly feasible) • *Adult Skills,* annual, by province/territory (partly feasible)

Note: Indicators marked with $$$ are measured in monetary terms.

5 SOCIAL CAPITAL AND COMPREHENSIVE WEALTH

5.1 Basic Concepts

The concept of social capital originates from realization that social connections, shared values, institutions, trust and participation, are vital components of a well-functioning society (Coleman, 1988). Laws and governance systems shape society and the economy, while cultural norms play important roles at home and in the workplace. Social ties and networks provide support for people to satisfy their personal needs, to connect with others, to advance their efforts in getting ahead or to receive support in hard times.

There are many interpretations of social capital. Factors considered to influence its formation include trust, social connections, reciprocity and cooperative norms (Ostrom & Ahn, 2003). Common to all these are relationships between individuals and the social networks they form (Lin, 2000). The reciprocal relationship between civic participation and interpersonal trust is also seen as central (Brehm & Rahn, 1997). As individuals engage in their communities they learn to trust others, which, in turn, increases their willingness to participate. This creates a virtuous circle in which trust promotes cooperation and cooperation promotes trust.

In its global inclusive wealth reports, UNEP considers social capital as a set of assets (institutions, culture, religion) that enable the production and allocation of produced, natural and human capital. Social capital is essential for efficient resource allocation and is therefore reflected in the prices of other assets. For example, “the shadow price of a piece of farming equipment would be low in a country racked by civil conflict, whereas it would be high elsewhere, other things being equal” (UNU–IHDP & UNEP, 2014, p. 17).

As acknowledged by UNEP, this approach to social capital is imperfect: “Explicit estimates on the quantification of social capital are still missing from the IWR 2014, despite our efforts to extend our capital asset groups to include this category” (UNU–IHDP & UNEP, 2014, p. 40).

Recent work by the OECD (Scrivens & Smith, 2013) has analyzed the various interpretations with the goal of creating an internationally comparable framework for social capital. They outline four major interpretations of social capital in a matrix with the possible “locations” where social capital resides (i.e., in individuals or in groups) on one axis and the essential nature of social capital (i.e., a set of networks and related activities or a set of productive resources to be drawn upon) on the other axis (see Table 5).

Table 5. Four interpretations of social capital

	Network structure and activities	Productive resources
Individual	Personal relationships	Social network support
Collective	Civic engagement	Trust and cooperative norms

The two individual approaches focus on social capital as an “individual resource mainly benefiting the members of social networks,” whereas the two collective approaches see social capital as “a characteristic of communities, whether it is neighbourhoods, cities, regions or countries” (Turcotte, 2015a, p. 4).

For the purpose of this report, the collective interpretation of social capital focused on productive resources (i.e., social capital as trust and cooperative norms) is the most relevant. As Scrivens and Smith (2013, p. 40) note, “trust and cooperative norms represent the most appropriate concept to be considered social capital in a *sustainability* context” (emphasis added). This is so because trust and cooperative norms are pure public goods and are relatively persistent over time. This means they can, in principle, be passed from generation to generation, which is a basic condition for sustainability. At the same time, Scrivens and Smith (2013, p. 20) recognize that civic engagement can be “a driver of levels of trust and cooperative norms within a society.”

Trust in others (and in institutions and cooperative norms) reflects how people behave and expect others to behave. Trust in others, particularly in strangers and people who are different, is referred to as *generalized trust*. Some degree of trust in strangers is necessary for the creation and maintenance of productive social norms. Generalized trust “is often considered an element facilitating social contracts: higher levels of trust mean lower transaction costs and improved likelihood of productive interactions” (Turcotte, 2015a, p. 15).

Trust in institutions (the electoral system, parliament, the judicial system, or government more broadly) is essential for the smooth functioning of society. Like generalized trust, trust in institutions reduces transaction costs. It also affects peoples’ relationship with the state; for instance, the extent to which they are willing to vote in elections (OECD, 2015), or pay their taxes (Putnam, 2001).

Cooperative norms are the values and shared understandings of how people are expected to behave in society. This includes sanctions – the negative consequences that should be expected for not following norms. Examples of important norms include “willingness to help each other, tolerance and respect for neighbours” (Siegler, 2014, p. 14) (i.e., reciprocity and tolerance) and behaviours such as not cheating on taxes or returning a lost wallet.

Civic engagement comprises “actions and behaviours that can be seen as contributing positively to the collective life of a community or society” (Scrivens & Smith, 2013, p. 28). People volunteer, join groups, vote, donate blood, do favours for strangers and support community-minded activities. In addition to the direct contributions these actions and behaviours provide to society,[30] they are linked to increased individual well-being and improved performance of institutions. They are also, as noted earlier, arguably a channel through which trust and cooperative norms are built.

It is important to note the types of linkages made via civic engagement. The distinction between links among similar people/groups (bonding social capital) and among different people/groups (bridging social capital) is important. Bonding social capital helps create more tightly knit groups. Bridging links are important for sharing knowledge, ideas and the creation of consensus among diverse groups.

5.2 Measurement of Social Capital

5.2.1 Monetary Measurement

As with the other capital categories, it is ideal to track social capital in monetary terms so that its evolution can be compared with that of other categories. However, the complexity of human relationships and the abstract nature of the features of social capital (such as trust and norms) make it challenging to define simple monetary indicators. For this reason, monetary measurement of social capital is not well-developed.

[30] For example, the time that Canadians devoted to volunteering in 2010 reflected “a volume of work that is equivalent to just under 1.1 million full-time jobs” (Vezina & Crompton, 2012, p. 37).

Helliwell and Barrington-Leigh (2010) have studied valuation of social capital in terms of how income changes might reflect differences in levels of life satisfaction associated with different levels of trust and social network size. Another approach, associated primarily with the work of the World Bank (2006), is to calculate the value of social capital indirectly by subtracting "bottom-up" estimates of produced, human and natural capital from a "top-down" estimate of total wealth. Any residual that remains could be interpreted theoretically to include the value of social capital (though it would likely include elements of other capital types as well).

It is also difficult to put an overall monetary value on social capital because—as with critical natural capital discussed in Section 3.2.2—some aspects of social capital have no substitutes and are therefore effectively "priceless." However, there are examples where the financial value of certain elements of social capital can be observed, e.g., at the corporate level in things such as reduced corruption and transparent accounting systems. At the societal level, the value of social capital is partly revealed in the values of volunteering, charitable donations and willingness to pay taxes (Foster, 2013). These represent only a small subset of the benefits attributable to social capital, and they need to be measured carefully to avoid misinterpretation[31] and/or double-counting.[32]

5.2.2 Non-Monetary Measurement

The OECD's *How's Life* reports assess the various dimensions of social capital through a range of non-monetary indicators in order to understand the determinants of "a good or better life." The reports approach the topic of social capital through the lens of well-being with a specific focus on "civic engagement" and "social connections," each of which is measured via various indicators that are compiled across OECD countries (OECD, 2011a; Table 6).

Table 6. OECD social capital indicators

Civic engagement	Social connections
• Voter turnout	• Social network support
• Participation in other types of political activities	• Frequency of social contact
• Consultation on rule-making	• Time spent volunteering
• Trust (confidence) in institutions	• Trust in others

The OECD's *How's Life* reports are not the only initiative to approach social capital measurement through the use of non-monetary indicators. Generic frameworks have also been developed and promoted by organizations such as the World Bank, national statistical agencies (e.g., Statistics Canada, Australian Bureau of Statistics), universities (e.g., the University of British Columbia's *Social Capital Survey* and University of California, Los Angeles's *Loneliness Scale*) and academics (Rosenberg, 1965; Pearlin & Schooler, 1978; Cheek & Buss, 1982; Franke, 2005).

[31] For example, high levels of charitable donations may reflect donors' unwillingness to develop more meaningful connections with certain groups of people in their communities.

[32] As noted earlier, social capital can be seen an enabling asset. To the extent this is the case, its value is embedded to a certain extent in the value of produced, natural and human capital and any effort at directly valuing social capital could lead to double counting.

The advantage of non-monetary indicators is their relative flexibility. Non-monetary indicators can serve as proxies for various aspects of social capital, allowing comparison over time and across communities. Such indicators are flexible enough to be modified to take into account situations specific to certain communities, which in turn allows more targeted and thus more relevant measurement systems.

5.3 Measurement of Social Capital in Canada

In Canada, as in many industrialized countries, social capital has been an increasing focus of attention for the last two decades. Early initiatives such as the Federation of Canadian Municipalities' Quality of Life Reporting System and the University of British Columbia's Social Capital Survey are examples of projects that have contributed significantly to these developments.

- **Federation of Canadian Municipalities' Quality of Life Reporting System**: This system focused on measuring quality of life in Canadian cities. It established a set of indicators to measure community well-being in 18 different municipalities in Canada. While it was not focused on social capital per se, it included indicators associated with social capital (e.g., political participation and donations to the United Way) (van Kemenade, 2003).
- **University of British Columbia Social Capital Survey**: Initiated in the late 1990s by Professor Richard Johnston the Social Capital Survey was the first Canadian study to exclusively focus on social capital (van Kemenade, 2003).

The following initiatives by Statistics Canada have greatly contributed to the understanding of social capital in Canada:

- **National Survey of Giving, Volunteering and Participating** – This survey was initiated in 1997 and has been undertaken every three years since. The indicators cover issues regarding unpaid volunteer activities, charitable giving and participation.
- **Canadian Community Health Survey** – This survey was started in September 2000 and is still conducted on a biennial basis at national and provincial levels. Indicators cover personal support networks, neighbourhood safety and community affiliation.
- **The General Social Survey of Canada** – This survey, active since 1985, represents Statistic Canada's principal effort to gather data on social trends over time. Using telephone surveys, it covers respondents spanning a cross-section of Canadians from every province and different socioeconomic strata. Undertaken annually, every cycle of the survey focuses on a different set of social issues. Core content is also collected every five years to provide information on the evolution of key variables. Cycle 17 (2003) represented Statistic Canada's first attempt to include measures directly associated with social capital (Turcotte, 2015a). Issues covered by the survey in recent years include giving, volunteering and participation, family transitions, social networks and engagement and community support.

Statistics Canada's seminal publication *Trends in Social Capital in Canada* (Turcotte, 2015a) summarizes the findings from the General Social Survey under the following key themes:

- Social capital embodied in individuals as measured by the size of their networks of close friends/acquaintances/neighbours, frequency of contact with others in their network and network diversity
- Collective social capital of Canadians as measured by participation in organizations and associations and trust between different groups of people such as neighbours and strangers.

This publication ranks among the best efforts by national statistical agencies to measure social capital and continues Statistics Canada's record of leadership on extended measures of capital.

Internationally, a number of surveys have examined aspects of social capital in Canada. Examples include the World Values Survey (n.d.), which has asked Canadians questions about trust since 1981 and the Gallup World Poll (n.d.), an annual survey started in 2005 that has asked questions around subjects such as civic engagement and trust in institutions.

5.4 A Proposed Suite of Social Capital Indicators

Reflecting the complexity of social capital, the indicators proposed to measure social capital here draw upon the various approaches and efforts outlined above, while focusing on indicators of civic engagement and trust/cooperative norms. It is worth noting that the indicators reported by Statistics Canada in *Trends in Social Capital in Canada* (Turcotte, 2015a) largely align with the thinking of the OECD and others and are consistent with the objectives here. The proposed suite therefore uses Statistics Canada's indicators wherever possible.

It important to acknowledge the view put forth by UNEP that social capital might best be considered an enabler of other assets. At the same time, the view here is that until theory is better worked out in this domain it is best to treat social capital as a category unto itself, albeit one that is closely connected to produced, natural and human capital.

It is also important to acknowledge the fact that social capital has significant value and may therefore be measurable through monetary indicators. At the same time, the lack of success in this regard in the published literature suggests caution. The authors therefore propose a mixed approach, erring on the side of non-monetary indicators. Where possible, the value of specific components of social capital is highlighted with monetary measures but, for the most part, the proposed indicators are non-monetary. This, of course, limits the comparability of the proposed social capital measures with those for other categories of capital.

The proposed indicators are described below in their "ideal" form—that is, the form in which they would be measured in the absence of conceptual, methodological or data gaps. The versions of the indicators presented in Part III of this report (beginning on page 134) are only partly able to meet this ideal. A brief discussion of feasibility is given for each indicator to illustrate how close it is possible to come to the ideal today. The indicators are summarized in Table 7.

5.4.1 Indicators of Civic Engagement

- **Participation in Group Activities (annual, by province/territory)** – The percentage of Canadians that participate in or are members of groups, organizations or associations

  This indicator is **partly feasible** based on data from Statistics Canada's General Social Survey. Data are not available annually.

- **Volunteering (annual, by province/territory)** – The percentage of Canadians that volunteer their time and the hours spent doing so (along with their economic value).

  This indicator is **partly feasible** based on data from Statistics Canada's General Social Survey. Data are not available annually.

- **Diversity in Social Networks (annual, by province/territory)** – The percentage of Canadians that meet people from different ethnic backgrounds through membership in groups, organizations or associations.

  This indicator is **partly feasible** based on data from Statistics Canada's General Social Survey.[33] Data are not available annually.

- **Engagement With Public Institutions (annual, by province/territory)** – An indicator of the extent to which people are involved in government decision making.

  This indicator is **not feasible** due to lack of data.

- **Control Over Public Decisions (annual, by province/territory)** – The percentage of Canadians that feel they have control in the public decisions that affect their everyday lives.

  This indicator is **partially feasible** based on data from the Canadian Election Study (Fournier, Cutler, Soroka, & Stolle, 2011). Data are not available annually.

- **Voter Turnout (most recent election, by province/territory)** – The percentage of eligible voters that turns out in federal, provincial and municipal elections.

  This indicator is **feasible** based on data from federal, provincial and municipal election offices.

5.4.2 Indicators of Trust and Cooperative Norms

- **Generalized Trust (annual, by province/territory)**[34] – The percentage of Canadians who believe that, generally speaking, most people can be trusted.

  This indicator is **partly feasible** based on data from Statistics Canada's General Social Survey. Data are not available annually.

- **Trust in Neighbours and Strangers (annual, by province/territory)** – The percentage of Canadians who believe that neighbours and strangers can be trusted a lot.

  This indicator is **partly feasible** based on data from Statistics Canada's General Social Survey. Data are not available annually.

- **Trust that a Lost Wallet Will Be Returned (annual, by province/territory)** – The percentage of Canadians who believe a lost wallet or purse would be returned with the money in it by someone who lives close by.

  This indicator is partly feasible based on data from Statistics Canada's General Social Survey. Data are not available annually.

- **Trust in Institutions (annual, by province/territory)** – The percentage of Canadians who have high confidence in federal/provincial/municipal governments.

  This indicator is **partly feasible** based on data from the Canadian Election Study (Fournier et al., 2011). Data are only available for trust in the federal government and are not available annually.

- **Belief in Helpfulness of Others (annual, by province/territory)** – The percentage of Canadians who believe people try to be helpful most of the time.

  This indicator is **not feasible** due to lack of data.

[33] The General Social Survey provides a limited view of diversification in social networks, so additional data are required.

[34] Since there may be some uncertainty in interpreting the results of the proposed generalized trust indicator (how do respondents interpret "most people"; what kind of situations are they considering), two additional indicators of trust are proposed.

- **Willingness to Help Others (annual, by province/territory)** – The percentage of Canadians who have helped a stranger in the past month.

  This indicator is **not feasible** due to lack of data.

- **Acceptance of Others (annual, by province/territory)** – The percentage of Canadians who would say that Canada's cultural life is generally enriched by people coming to live here from other countries.

  This indicator is **not feasible** due to lack of data.

Table 7. Proposed ideal suite of social capital indicators

Theme	Indicator
Overall social capital	• *Social Capital Index*, quarterly, by province/territory (not feasible) $$$
Civic engagement	• *Participation in Group Activities*, annual, by province/territory (not feasible annually) • *Volunteering, annual,* by province/territory (not feasible annually) • *Diversity in Social Networks*, annual, by province/territory (not feasible annually) • *Engagement with Public Institutions*, annual, by province/territory (not feasible) • *Control Over Public Decisions*, annual, by province/territory (not feasible annually) • *Voter Turnout*, most recent election, by province/territory (feasible)
Trust and cooperative norms	• *Generalized Trust*, annual, by province/territory (not feasible annually) • *Trust in Neighbours and Strangers*, annual, by province/territory (not feasible annually) • *Trust that a Lost Wallet Will Be Returned*, annual, by province/territory (not feasible annually) • *Trust in Institutions*, annual, by province/territory (not feasible annually) • *Belief in Helpfulness of Others*, annual, by province/territory (not feasible) • *Willingness to Help Others*, annual, by province/territory (not feasible) • *Acceptance of Others*, annual, by province/territory (not feasible)

[35] Although the possibility of compiling an indicator of the real per capita value of social capital is a long way from feasibility (and may never be feasible), it is included here for conceptual completeness and consistency with the other categories of capital.

Comprehensive Wealth

PART II:

DISCUSSION OF FINDINGS AND SUGGESTED RESEARCH AGENDA

6 DISCUSSION OF FINDINGS

This second part of the report summarizes the findings of the analysis of comprehensive wealth in Canada, and this section discusses their possible implications for the sustainability of development. Section 7 discusses the meaning of the findings, offering some suggestions to address the research issues arising from them. Detailed findings on an indicator-by-indicator basis are presented in Part III of the report beginning on page 73.

6.1 Main Findings

Based on the best data and methods available today, comprehensive wealth in Canada appears not to be evolving in the direction it must if Canada is to continue developing sustainably. Though Canada's development is not currently unsustainable, neither can it be said to rest on a robust base. If trends in produced, natural, human and social capital over the last three decades were to continue, Canada could find its per capita comprehensive wealth beginning to decline. This would have negative consequences for the country's ability to increase well-being for Canadians. This conclusion is based on the evidence and interpretation summarized below; additional discussion is contained in the following parts of this section.

- The value of comprehensive wealth grew relatively slowly (0.19 per cent annually) from 1980 to 2013 in real per capita terms.[36]
- Of the individual components of the portfolio, only produced capital grew in real per capita terms over the time period (see Table 8 for a summary).
  - **Human capital**, the largest component of comprehensive wealth, did not grow at all in real per capita terms over the period.
  - **Market natural capital** declined in value by 0.93 per cent annually in real per capita terms.
  - **Non-market natural capital** also declined based on a series of non-monetary ecosystem and climate indicators (see Table 11 and indicators NC2 to NC11).
  - **Produced capital** grew in real per capita terms (1.68 per cent annually), though its growth was highly concentrated in housing and in oil and gas extraction infrastructure.
  - **Social capital**, which could not be valued for this analysis and therefore does not factor into the assessment of overall comprehensive wealth, appears to be stable, but not growing, based on a series of non-monetary indicators (see Table 13 on page 79 and indicators SC1 to SC9 beginning on page 135).

- Over the same period, real per capita consumption in Canada grew relatively robustly (1.36 per cent annually). The gap between the relatively slow growth in comprehensive wealth and the relatively fast growth in consumption is a potential concern. Consumption growth that is more rapid than growth in comprehensive wealth can be sustainable in the long run only under certain circumstances. One of those is when productivity gains account for the difference. Canadian productivity growth from 1980 to 2013 was, however, too small (0.11 per cent annually) to explain

[36] All wealth values in this study are expressed in real (chained 2007 dollar) terms per capita to account for the effects of growth in prices and population over time. For ease of reading, the modifiers "real" and "per capita" are not always used when values are reported. When they are not, the reader should take for granted that the figures are in real per capita terms unless otherwise indicated.

the observed trends. Productivity growth closer to 1.2 per cent annually would have been needed to explain the gap between growth in consumption and growth in comprehensive wealth.

- In the absence of adequate productivity growth, a plausible explanation for the divergence between growth in consumption and comprehensive wealth is that Canadian investment was inadequate to allow comprehensive wealth to keep pace with consumption. In other words, the country may have invested too little (or not invested in the right places) for comprehensive wealth to grow robustly over the period. This could be because too much income was used to support current consumption and not enough set aside for investment or because the investments that were made did not create new wealth fast enough, or both.
- To the extent that the divergence between growth in consumption and comprehensive wealth was the result of relatively too much consumption and too little investment, the trend in natural capital is of particular concern, as it has been a traditional engine of consumption. As noted above, the value of Canada's market natural capital fell substantially in real per capita terms between 1980 and 2013. More up-to-date (but less detailed) data show that the value of market natural capital fell much further since 2013 due to the drop in global oil prices. By the end of 2015, the total nominal value of Canada's market natural capital was 75 per cent lower than at the beginning of 2014. Unless oil prices recover, this loss in wealth may not be recovered. On top of this decline in market natural capital, a variety of non-monetary indicators of ecosystems and climate-related variables all point toward declines in non-market natural capital as well.
- It is also worrisome that the trend in human capital—the largest component of comprehensive wealth by far—was flat over the time period covered, especially since a much greater percentage of Canadians graduated with some kind of formal educational certificate in 2013 than in 1980. Evidence shows as well that other developed countries were able to increase human capital during this period. The reasons for the lack of growth in Canadian human capital are complex, and further research is needed to understand them. Part of the explanation lies in the aging of Canada's workforce, since older workers have fewer years of work left and, by definition, lower levels of human capital. There is likely much more to it than this though. It may be that increased levels of education are needed just to maintain a given level of human capital today. Or it may be that Canada has not been investing in areas of education that are translating into increased human capital. Unfortunately, the available evidence on the level of investment in education in Canada is conflicting (see the discussion of the Education Spending Index – Indicator HC2). Again, further research is called for.
- Produced capital was the bright spot in comprehensive wealth over the period, growing at a robust 1.68 per cent annually. Here too, though, there may be concerns regarding long-term sustainability. For one, Canada's produced capital is tightly coupled with its declining natural capital and has become more so over time. In 1980, the oil and gas extraction industry accounted for about 9 per cent of the stock of produced capital in the business sector. By 2013, the share of this industry alone had risen to about 28 per cent. Over the period, investment in oil and gas extraction infrastructure accounted for 33 per cent of all growth in real business sector-produced capital. The other engine of produced capital growth over the period was housing. Other things being equal, a growing housing stock is positive for well-being and sustainability. However, the degree to which it—along with oil and gas extraction infrastructure—accounted for overall growth in produced capital is worrisome from an economic diversification perspective. When housing and oil and gas extraction infrastructure are removed, growth in produced capital was a more modest 0.89 per cent over the period.

Table 8. Summary of findings

Indicator	Per capita level in 1980	Per capita level in 2013	Annual growth rate 1980–2013
	Chained 2007 dollars		
Comprehensive Wealth Index	$592,000	$631,000	0.19%
Produced Capital Index	$58,100	$100,700	1.68%
Market Natural Capital Index	$39,800	$29,200	-0.93%
Non-Market Natural Capital Index			Unknown, but available non-monetary indicators suggest a decline
Human Capital Index	$500,000	$500,000	0%
Social Capital Index	n/a	n/a	Unknown, but available non-monetary indicators suggest stability
Consumption	$24,300	$37,500	1.36%

Source: Current study.

The above discussion points to potential concerns regarding Canada's capacity to sustain growing per capita consumption and, therefore, well-being in the longer term. To the extent that consumption growth has been supported in recent decades by the drawdown of natural capital, the downward trend in Canada's natural capital and its tight coupling with much of Canada's produced capital represents a risk. Human capital, the largest component of the nation's wealth, did not grow at all between 1980 and 2013, suggesting that investments in education and training have not been significant enough and/or fully effective. Social capital does not appear to be growing based on available non-monetary data.

Though this analysis is one of the first efforts at measuring comprehensive wealth in Canada, there is good reason to believe that the findings are robust. They are based on the best data available from Statistics Canada and, in a few cases, other reliable sources.[39] The methods used are well established and will be familiar to those accustomed to working with national economic, environmental or social statistics. Though still new to many people, the concept of comprehensive wealth dates back at least to the 1990s and thinking about the individual elements of it (produced, natural, human and social capital) dates back much further than that.[40] Finally, as the comparison in Section 6.7 below shows, the findings of other analyses of comprehensive wealth in Canada are largely consistent with those here. The findings are consistent as well with the conclusion of the federal government's Economic Advisory Council that per capita GDP growth could fall from its historic level of about 1.9 per cent annually to 0.8 per cent in the coming decades if policy changes to address the challenges associated with demographic shifts (such as aging of the workforce) are not implemented (Advisory Council on Economic Growth, 2016a).

At the same time, the analysis must be considered a work in progress. The findings are not the final word on the evolution of comprehensive wealth, as further development is needed in some of the concepts, methods and data used to compile them (see Text Box 7 on the need for a degree of caution in interpreting the value of human capital in particular). For this reason, one of the suggested actions in Section 7 is to carry out more research into comprehensive wealth and its measurement.

[39] Global Forest Watch Canada was the main source of data used to compile the ecosystem indicators (NC2 to NC5). In addition, data from the OECD were used for several indicators of human and social capital.

[40] Thinking about wealth dates back most famously to Adam Smith and his 18th century work on the wealth of nations. More recently, the late Canadian economist Anthony Scott had already characterized the environment in natural capital terms by the 1950s (Scott, 1956). Work on measuring human capital began seriously in the 1960s (Schultz 1960, 1961). Social capital, though somewhat newer, has been an area of active research since at least the mid-1980s (Bourdieu, 1986).

It is possible that further research would reveal no cause for concern about the sustainability of development in Canada. After all, Canadians have been enjoying relatively rapidly growing real per capita consumption from a more slowly growing comprehensive wealth base since at least 1980. Perhaps they can continue to do so into the future without difficulty and a simple explanation exists for the gap between consumption growth and growth in comprehensive wealth found here.

At the same time, as noted, there is reason to consider the findings sound. At the very least, discussion as to whether the findings suggest the need for policy action to enhance growth in comprehensive wealth or simply the need for further research is justified.

Even if further research were to find no threat to overall sustainability, the trends revealed here in the individual components of comprehensive wealth may well warrant action. The decline in the value of market natural capital and the downward trends in the indicators of non-market natural capital, in particular, are cause for concern even if they do not present a threat to overall sustainability. So too is the fact that human capital—the largest component of the comprehensive wealth portfolio—did not grow at all between 1980 and 2013, especially when other countries have done better. Similarly, the fact that investment in produced capital has been highly concentrated in housing and oil and gas extraction infrastructure amplifies recent concerns about the diversification of the economy.[41] Understanding the reasons for these trends and their implications, if any, for well-being in Canada are issues of importance to the nation.

The discussion now turns to the results of the analysis in more detail, beginning with the trend in overall comprehensive wealth.

Text Box 7. The quality of Statistics Canada's human capital data

Unlike the Statistics Canada data on produced, natural and social capital used in this report, the only published data available on human capital from Statistics Canada are not "official statistics" but the results of research studies. (It is worth noting that the same would be true in any country, as human capital is not yet released as an official statistic anywhere). For this reason, some caution is called for in interpreting the trend in the value of human capital. Given that human capital accounts for the majority of comprehensive wealth in Canada (as elsewhere), this caution is also called for in interpreting the trend in overall comprehensive wealth.

Though not official statistics, there is good reason to trust Statistics Canada's estimates of the value of human capital. The agency's quality standards are applied to research studies as much as to official statistics and research results can, therefore, be assumed to be as accurate as possible given the quality of the underlying data and the state of development of the concepts and methods applied.

In the case of the valuation of human capital, the concepts and methods used by Statistics Canada—based on the lifetime-income approach of Jorgenson and Fraumeni (1989 and 1992)—are well established and have been used to estimate the value of human capital in at least 17 other middle and high-income countries. The lifetime-income approach is one of two approaches to the measurement of human capital recently recommended by the Task Force on Measuring Human Capital of the UN Economic Commission for Europe (2016). [42]

The data required to implement the lifetime-income approach include wage rates, rates of employment by sex, age, educational attainment levels, years of schooling and population survival rates. Statistics Canada, as an advanced statistical agency, has access to good data in all of these areas.

See next page

[41] See, for example, Milner, 2016.

[42] The other approach, known as the cost-based approach, focuses on measuring investments in education (Schultz, 1960, 1961; Kendrick, 1976). See Text Box 6 for an explanation why the lifetime-income approach is preferred to the cost-based approach in this report.

Text Box 7. Continued

In addition to data, assumptions about the rate of future income growth and a discount rate are required to implement the lifetime-income approach. Like all assumptions, the choices about these are somewhat arbitrary, though there is theoretical and empirical reasoning that can be used to guide them. In the case of the discount rate, Statistics Canada used the weighted average return to debt and equity in the Canadian economy (5.1 per cent). The growth in real income was assumed to be equal to historical labour productivity growth in the Canadian business sector (1.7 per cent). Both of these rates can be considered to be on the conservative side. It is important to note that while the assumptions regarding these rates will affect the estimated level of human capital they have no impact on its *rate of growth*.

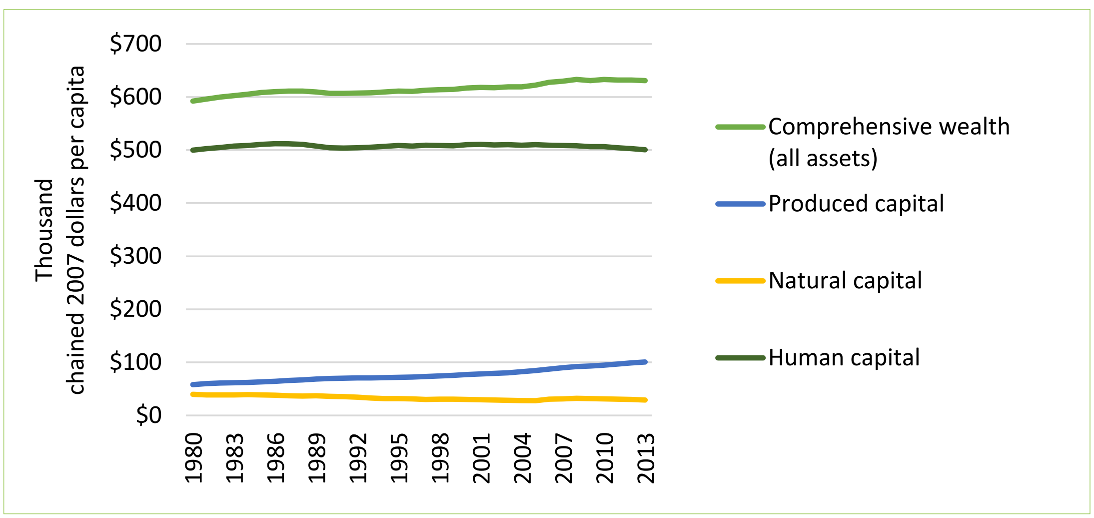
Thus, though there is reason to believe that the data on human capital used in this study may be of slightly lower quality than Statistics Canada's data on produced, natural and social capital, there is also reason to believe that these data remain of high quality. Their use in the analysis is, therefore, reason for some caution in interpreting the results but not reason to disregard them.

6.2 Trends in Overall Comprehensive Wealth

The most complete measure of wealth that could be compiled for this analysis[43]—what is called here the Comprehensive Wealth Index[44]—grew 6.6 per cent between 1980 and 2013. In 1980, the Comprehensive Wealth Index stood at $592,000 per Canadian (chained 2007 dollars). By 2013, it had risen to $631,000, for an annual average growth rate of 0.19 per cent (Figure 4).

Looking at the individual components of the index, growth in human capital—the largest of Canada's assets—was flat over the period. Natural capital declined significantly (0.93 per cent annually) while produced capital increased significantly (1.68 per cent annually). These results are based on the best available data from Statistics Canada. Details of the trends in each of the components of the index are provided further below. Table 9 shows the average composition of comprehensive wealth from 1980 to 2013.

Figure 4. Comprehensive Wealth Index, 1980–2013



Source: Current study.

[43] Ideally, it would have been possible to include social capital in the Comprehensive Wealth Index in addition to produced, natural and human capital. This was not possible, however, because the concepts, methods and data required to put a monetary value on social capital do not exist. What effect the exclusion of social capital from the Comprehensive Wealth Index has on the analysis here is impossible to say. What can be said is that the various non-monetary indicators of social capital (starting on page 134) point to stability, but not growth, in the various elements of social capital. This suggests that the conclusions of this report would not be much different had it been possible to include social capital in the Comprehensive Wealth Index.

[44] The Comprehensive Wealth Index measures the aggregate per capita real (that is, inflation adjusted) value of produced, natural and human capital. See Indicator CW1 for more detailed results. Further methodological details are provided in Annex 2.

In contrast to the trend in the Comprehensive Wealth Index, real consumption per capita[45] grew at an annual average real rate of 1.36 per cent. In other words, while the average Canadian's consumption grew substantially in real terms between 1980 and 2013, the asset base on which that consumption relied grew considerably less.

Table 9. Average composition of comprehensive wealth, 1980–2013

	Average share in comprehensive wealth, 1980-2013
Produced capital	15
Natural capital	5
Human capital	80

Source: Current study.

Note: Shares are based on nominal asset values

As noted above, the divergence between growth in consumption and growth in comprehensive wealth is a potential concern. Consumption growth that is not accompanied by growth in underlying assets is a sign that consumption—and the well-being that rests upon it—may be unsustainable in the long run. Economic theory (Hamilton & Clemens, 1999; Dasgupta & Mäler, 2000; Stiglitz et al., 2009; World Bank, 2011; UNU–IHDP & UNEP, 2012; Dasgupta, 2014) suggests that the Comprehensive Wealth Index is a nearly ideal indicator of sustainability. If real per capita comprehensive wealth it is growing over time, development (that is, increases in well-being) is likely on a sustainable path and the future can be reasonably expected to be as well or better off than the present. On the other hand, a declining Comprehensive Wealth Index is a strong indicator that development is unsustainable.

It must be noted that Canada's Comprehensive Wealth Index did not decline over the period considered here. But neither did it grow robustly (to recall, the index grew 0.19 per cent annually from 1980 to 2013). In and of itself, this relatively slow growth is not a concern. So long as the index is growing, it points toward sustainability.

However, as mentioned, the relatively slow growth in comprehensive wealth in comparison to the relatively fast growth in real per capita consumption (1.36 per cent) points to a potential concern. Drawing rapidly increasing income from a more slowly growing asset base can only be accomplished under certain conditions, some of which are not sustainable in the long run.

[45] Consumption as measured here includes all spending on market goods and services that are consumed within a given year by households, governments and non-profit organizations in the economy. It covers most household spending (other than purchases of property) plus government and non-profit organizations' spending on current goods and services (see here for Statistics Canada's formal definition). It is a useful measure of the level of current well-being generated by market production, though it does not include consumption of non-market goods and services. Thus, the figures reflect a narrower form of consumption than the broad form defined in Text Box 1. The estimates of consumption used here are based on final consumption expenditure as measured in Statistics Canada's System of National Accounts (see *Gross Domestic Product, Expenditure-based*, CANSIM Table 380-0064).

A sustainable way of growing income faster than the asset base is through productivity increases. Consumption can rise at a rate greater than growth in the asset base if gains in productivity (that is, the amount of consumption that can be derived from a given quantity of capital inputs) are significant enough over time. However, Canada's productivity track record over the period in question here was relatively weak. From 1980 to 2013, Statistics Canada's broadest measure of productivity[46] grew at an annual average rate of 0.11 per cent, slightly slower than the Comprehensive Wealth Index itself. Productivity growth of this level would not explain Canada's robust growth in consumption in the face of the slower growth in its asset base. For that to have been the case, productivity growth would have had to have been 1.17 per cent annually (the difference between the 1.36 per cent annual growth in real per capita consumption and the 0.19 per cent growth in the Comprehensive Wealth Index).

If productivity gains do not explain Canada's much faster growth in real per capita consumption than in real per capita comprehensive wealth, what could? A plausible—and worrisome—explanation is underinvestment in the nation's asset base (see Text Box 8 for possible statistical source of error).

There are two choices when it comes to using the income generated by the economy. One option is to save and invest it in new assets (new factories, newly discovered mineral deposits, better educated workers and so on) in order to grow the future productive base of the economy—in other words, to invest in increasing comprehensive wealth. The other option is to spend the income on current consumption, which benefits primarily those alive today. Canada's record of slow growth in comprehensive wealth coupled with relatively rapid consumption growth would make sense if there had been too little savings and investment in recent decades in comparison with growth in consumption.

It is important to note that Canada has invested in comprehensive wealth. As the analysis here shows, real per capita comprehensive wealth did increase in Canada over the period 1980 to 2013, albeit relatively slowly. This could not have happened without substantial investment in the nation's asset base. What may well have happened, however, is that the rate of investment growth in real per capita terms has not kept pace with the rate of real per capita income growth, meaning that over time the portion of income that has been saved and invested relative to the portion that has been consumed has been falling.

Coupled with too little investment, it is possible as well that the investments that have been made have not been as effective as they could have been at increasing comprehensive wealth. This may be so particularly in the case of human capital, where education and training are important forms of investment. The fact that real per capita human capital is flat over the study period raises the possibility that Canada has either underinvested in education or not invested in the right forms of education to increase human capital, or both.

[46] Statistics Canada, *Multi-factor productivity* (CANSIM Table 383-0021).

Text Box 8. Possible statistical sources of error

As noted earlier, further development may be needed in some of the concepts, methods and data used to compile the results in this study. Therefore, it cannot be ruled out that comprehensive wealth may have grown faster than the analysis here suggests due to statistical sources of error. The most likely source of error would be the Statistics Canada human capital estimates used in this analysis, which, as noted in Text Box 7, are based on the results of research studies and are not "official statistics." It is possible that these estimates are incorrect, and actual growth in human capital was more robust than estimated and/or that the actual level of human capital was lower than estimated. If true, either of these could erase some of the divergence between growth in consumption and growth in comprehensive wealth. As argued in Text Box 6 and Text Box 7, however, there is good reason to believe that Statistics Canada's estimates of human capital are sound, both conceptually and empirically. The odds of them explaining much of the discrepancy seem low.

Another possible statistical explanation for the results of this analysis is that productivity is currently measured too narrowly by Statistics Canada. Statistics Canada's broadest measure of productivity— what is known as multi-factor productivity or MFP—considers only the efficiency with which human capital[47] and produced capital are employed in creating income. The exclusion of natural capital from MFP may mean that productivity growth is underestimated (Brandt et al., 2013, 2014; Sustainable Prosperity, 2015). If true, this could explain part of the gap between the relatively strong growth in real per capita consumption and relatively weak growth in comprehensive wealth found in this analysis.[48] Again, though, it seems unlikely that productivity growth is so dramatically underestimated currently that it could explain the divergence between consumption growth and growth in comprehensive wealth found here.

Yet another possibility is that social capital, which could not be included in the Comprehensive Wealth Index because the concepts, methods and data required to value it are not available, explains the "missing investment" in Canada's asset base. However, based on the non-monetary indicators of social capital compiled for this study, the evidence points to stable, but not increasing, social capital in Canada. Social capital would have to be growing strongly in Canada to explain the difference between growth in consumption and growth in comprehensive wealth (see Section 6.6 for further discussion of the trends in social capital).

Determining exactly what explains the divergence between growth consumption and comprehensive wealth would require analysis beyond that which was possible for this report. Given the importance of ensuring the sustainability of Canada's development, it is clearly analysis that deserves to be undertaken. This point is taken up further in Section 7.

If, in fact, the divergence between growth in comprehensive wealth and consumption were to turn out to be related to underinvestment and/or unproductive investment, the question arises whether this is a concern for long-term sustainability of development. If Canada has been able to sustain robust growth in real per capita income in the face of slower growth in real per capita comprehensive wealth over more than three decades, can it not continue to do so into the future? Given the relatively weak overall growth in comprehensive wealth—and especially what has been happening to the nation's natural capital base—the answer could well be "no."

As already noted above (and discussed in more detail below in Section 6.4), the trend in real per capita natural capital from 1980 to 2013 is downward. This means that Canada has been exploiting its natural capital considerably faster than it has been replacing it. To the extent that this drawdown of natural capital has served as an engine fuelling consumption growth, the downward trend in natural capital is a concern. Clearly, the drawdown of natural capital cannot continue forever. At some point, simple physical depletion of stocks puts an end to further opportunities to exploit them. Beyond physical depletion,

[47] Strictly speaking, it is not human capital that is included directly in the measurement of MFP but hours worked, which can be taken as a proxy for human capital.

[48] It is worth noting that Sustainable Prosperity, an environment-economy think tank located at the University of Ottawa, is currently conducting a multi-year study of this issue.

there is also the possibility of "monetary" depletion of natural capital. Since Canada sells many of its natural resources on international markets, the value of much of the nation's natural capital rests on demand and prices in international markets. If demand and/or prices for resources fall, Canada's natural capital can be depleted in monetary terms even if there remains plenty in physical terms. Resources that are valuable assets when prices and demand are high can become "stranded" (that is, left in place with little or no value) if prices/demand fall significantly enough.

The concern for Canada here is twofold. One issue is that a number of Canada's natural assets have experienced substantial physical depletion over the past decades (see the discussion of Indicator NC1 – Natural Capital Index for details). Unless new reserves of these assets are found, their contribution to national income will fall at some point in the future.[49] The other is the current trend in global fossil fuel prices and demand. The recent fall in oil prices—coupled with slowing growth in global demand for fossil fuels, increased foreign production of fuels from new sources like shale gas and the growth of renewable energy—underscores the uncertain conditions for Canada's oil and gas assets. It is noteworthy, then, that the value of these assets has dropped dramatically since the final year of this analysis, 2013.[50] Statistics Canada estimates that the total nominal value[51] of mineral, fossil fuel and timber assets declined by $712 billion, or 75 per cent, from the first quarter of 2014 to the fourth quarter of 2015.[52] If oil prices do not recover, this value could drop even further in the future and the losses could be permanent.

To summarize, based on the best evidence available it is possible that Canada is not developing as it should in order to ensure long-term well-being for its citizens. Real consumption per capita has been growing faster than real per capita comprehensive wealth, suggesting the country may have been underinvesting (or unproductively investing) in its asset base. To the extent that natural capital, which is being drawn down rapidly, has been an engine in fuelling the growth in consumption, sustainability could be at risk if the value of natural capital is further eroded. Current trends in oil prices are not favourable in this regard. If these trends continue, Canada's ability to ensure sustained growth in consumption—and, therefore, well-being—into the future may be at risk. The more detailed discussions of the trends in produced, natural and human capital that come next provide additional evidence to support this concern.

[49] Reserves of lead, molybdenum, nickel, silver, zinc and iron were all less than half of their 1980 size by 2012. Of course, there may be possibilities to increase exploration in order to identify new reserves to offset the physical depletion of these assets. It is reasonable to assume, however, that reserves would not have declined by so much over such a long period if new reserves were easily found.

[50] Data beyond 2013 could not be incorporated in the full analysis prepared for this report because of missing details for some assets.

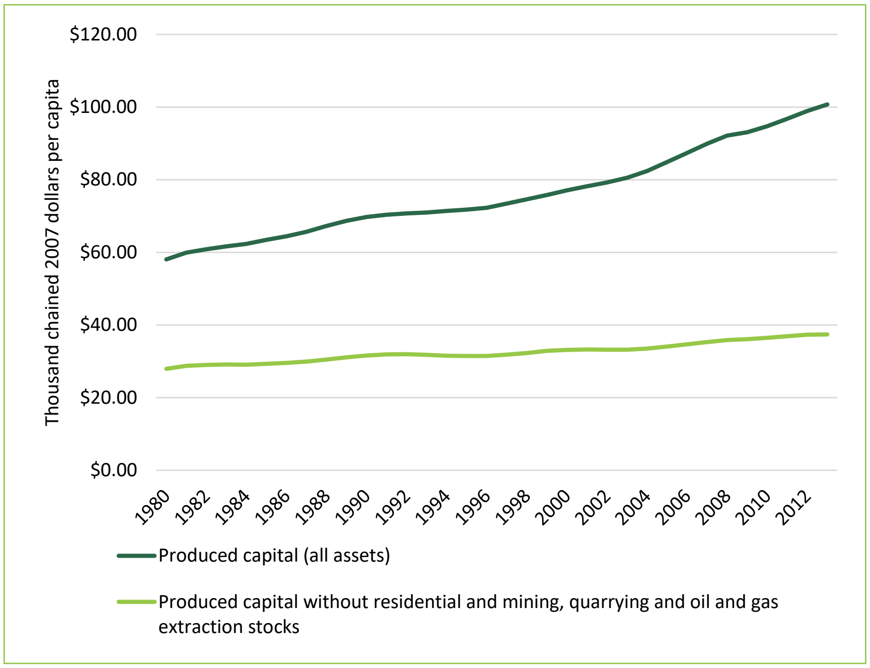
[51] Nominal values, as opposed to real values, are not adjusted for inflation.

[52] Statistics Canada, *National Balance Sheet Accounts*, CANSIM Table 378-0121.

6.3 Trends in Produced Capital

The overall trend in produced capital (houses, commercial buildings, machinery, roadways, oil wells, pipelines, etc.) from 1980 to 2013 is positive (Figure 5). Canada's Produced Capital Index (see Indicator PC1 for details) grew at an average annual rate of 1.68 per cent over the period, somewhat faster than the rate of growth of real per capita consumption (1.36 per cent). While this trend is positive in terms of ensuring the sustainability of Canada's development, a closer look at what drove growth in the Produced Capital Index reveals some structural realities that may be cause for concern.

Figure 5. Produced Capital Index, Canada, 1980–2013



Source: Current study.

The majority of the growth in the Produced Capital Index is explained by what happened in two areas of the economy: housing and the oil and gas extraction industry. The combined share of residential buildings and oil and gas extraction infrastructure in the nominal value of produced capital in 2013 was 60 per cent; in 1980 it was 45 per cent. In contrast, the manufacturing industries' share of the total dropped from 8 per cent to 3 per cent over the same period.[53]

If the value of the housing stock and oil and gas extraction infrastructure is removed, the Produced Capital Index grew at a more modest 0.89 per cent annually between 1980 and 2013. In absolute terms, with housing and oil and gas included, real produced capital increased by about $42,700 per person (chained 2007 dollars) over the period. When these two are taken out of the analysis, the absolute increase in drops to $9,500 per person.

A growing real housing stock per capita is, other things equal, a positive development for well-being. Canadians obviously gain much from living in good-quality houses with modern amenities that can by passed from one generation to the next. Houses are, however, an arguably less significant contributor to the productive base of the economy than are other types of assets. The concern is not so much whether houses contribute to the productive base, though, but more about the degree to which investment

[53] Statistics Canada, *Flows and Stocks of Fixed Non-residential Capital, by industry and asset*, CANSIM Table 031-0005 and *Flows and Stocks of Fixed Residential Capital*, CANSIM Table 031-0008.

in housing may be crowding out other investments in produced capital and what this means for the diversity of Canada's economy.

The strong growth in oil and gas extraction assets is also positive in terms of ensuring sustainability, other things equal. But, as with housing, other things may not be equal. The oil and gas extraction industry, and the subsoil resource extraction industry more broadly, is obviously tightly coupled with Canada's natural capital base. The analysis here (see the discussion earlier and in next sub-section) shows that the overall value of Canada's market natural capital shrank considerably in real per capita terms between 1980 and 2013 and has fallen even more since 2013 due to the drop in global oil prices. If oil prices do not recover, the possibility that some of the produced capital Canada has invested in the oil and gas extraction industry loses value (or becomes "stranded") along with oil and gas assets is real.

In this regard, it is worth noting that investment in oil and gas extraction assets has been driven in particular by investment in the oil sands.[54] Until recently, the value of the oil sands asset was growing rapidly. In nominal terms, the oil sands' asset value grew by 411 per cent from 2000 to 2008, when it alone was worth $476.7 billion.[55] The recent drop in oil prices wiped out much of this wealth. In the final quarter of 2015, the total nominal value of *all* of Canada's market natural capital (including the oil sands) was estimated to be $232.3 billion, less than half of what the oil sands alone had been worth in 2008.[56]

These numbers put in perspective the sustainability risk associated with the evolution of produced capital in Canada. One of two main drivers of produced capital growth in the last three and half decades, the oil and gas extraction industry, is tightly coupled with a natural asset that has fallen substantially in value. If oil prices recover in the future, the value of the oil sand asset will likely recover too. But if they do not—a plausible scenario given current global trends—the loss in the value of the oil sands asset may eventually be accompanied by losses in the value of the complementary oil and gas extraction assets. Given the fact that produced capital is the only one of the three components of comprehensive wealth that grew between 1980 and 2013 and that much of this growth was due to growth in oil and gas extraction assets, further losses in the value of Canada's natural capital clearly represent a potential concern for sustainability. The next sub-section discusses this in more detail.

6.4 Trends in Natural Capital

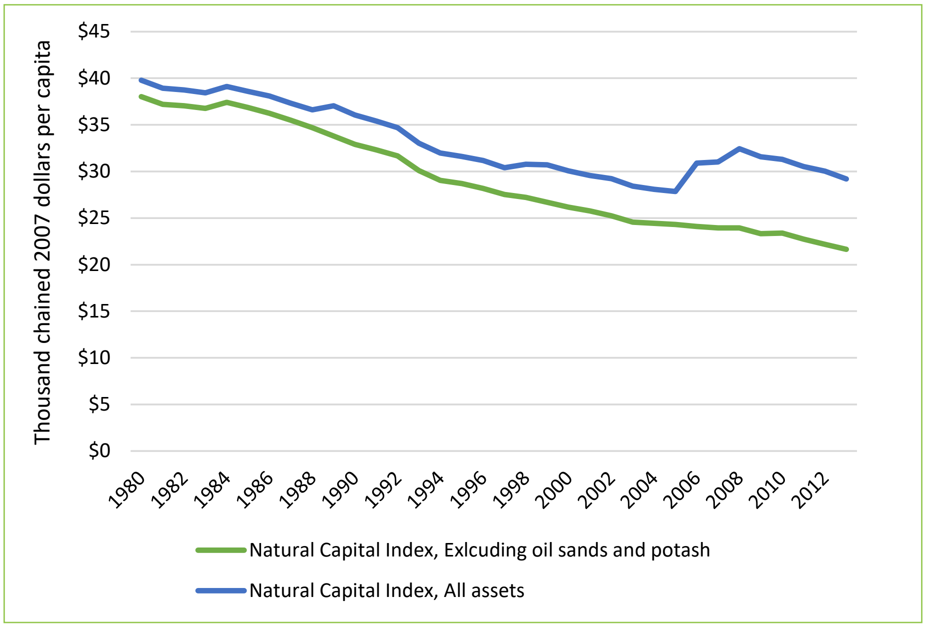
Canada's Market Natural Capital Index (Indicator NC1) fell at an average annual rate of 0.93 per cent from 1980 to 2013 (Figure 6) as Canadians physically drew down their stocks of natural capital and falling resource prices lowered asset values. Each Canadian started out in 1980 with $39.8 thousand (chained 2007 dollars) of natural capital. By 2013, this had dropped to $29.2 thousand, a loss of more than 25 per cent in less than a generation and a half. This decline was more significant if two of Canada's most valuable natural assets—the oils sands and potash—are taken out of the analysis. In that case, the decline in the index was 43 per cent over the period. This shows that, like produced capital (see the previous sub-section), the trend in Canada's natural capital is influenced by relatively few assets.

[54] It is not possible to precisely quantify the portion of the growth in oil and gas extraction assets that is due to the oil sands because of the confidentiality of Statistics Canada's capital stock data for the oil sands industry.

[55] Statistics Canada, *Value of Selected Natural Resource Reserves*, CANSIM Table 153-0121.

[56] Statistics Canada, *National Balance Sheet Accounts*, CANSIM Table 378-0121.

Figure 6. Market Natural Capital Index, Canada – 1980–2013



Source: Current study.

It is worth noting again that these results do not reflect the oil price drop in 2015, which eliminated hundreds of billions of dollars more from the value of Canada's oil and gas reserves after 2013.[57] As discussed just above, Statistics Canada estimates that the nominal value of mineral, fossil fuel and timber assets declined by $712 billion (75 per cent) from the first quarter of 2014 to the fourth quarter of 2015. Most of this decline was attributable to the impact of falling oil prices on the value of the oil sands asset.[58] This means that the Market Natural Capital Index will fall further in the period after 2013 once the detailed data required for its calculation become available. If oil prices do not recover, this drop could be permanent, wiping out a large share of Canada's market natural capital wealth.

It is also important to note that the trend in the Market Natural Capital Index considers changes in only some market natural capital stocks: minerals, fossil fuels, agricultural land and commercial timber. Changes in other forms of market natural capital—including commercial fish stocks; the water in hydroelectric and irrigation reservoirs; aquifers used to supply drinking water; and wildlife stocks used for hunting and fishing—cannot be included in the index because Statistics Canada does not yet compile the data needed to value them. The index also excludes Canada's non-market natural assets (non-commercial forests, wetlands and other ecosystems), none of which can be valued today due to gaps in concepts, methods and data. This does not, however, mean that nothing can be said about the trends in these other assets.

[57] It is not possible to calculate the Market Natural Capital Index up to 2015 because some of the data required to estimate the real value of all market natural capital assets for that year are not yet available. Statistics Canada does, however, provide an estimate of the aggregate value of minerals, fossil fuels and timber in nominal terms that is available on a timelier basis as part of the quarterly National Balance Sheet.

[58] It is not possible to precisely quantify the share of the decline due to oil prices because Statistics Canada's quarterly time series on natural resource wealth in the National Balance Sheet Accounts does not break down wealth by type of natural resource. It is worth mentioning that this quarterly natural resource wealth time series is a recent innovation of Statistics Canada, making it the first statistical office in the world to publish official estimates of sectored (that is, split between businesses, governments and households) natural resource wealth on a quarterly basis.

The series of ecosystem indicators (indicators NC2 to NC5) show declines in the area of key ecosystems. Other things equal, these declines imply reductions in the flow of many ecosystem goods and services. To the extent that Canadians benefit from the consumption of these flows, such reductions will reduce well-being.

The series of climate-related indicators (indicators NC6 to NC11) show trends consistent with the predicted impacts of climate change on Canada. While not proof that climate change is currently impacting well-being, these trends are of concern because climate change may impact the future ability of ecosystems to produce goods and services. It may decrease the value of other assets as well. For example, if extreme precipitation events increase in frequency, the value of produced capital (buildings, roads, powerlines, etc.) could be negatively impacted. Human and social capital could likewise be impacted if extreme weather disrupts communities and people's ability to earn a living.[59]

The trends in these non-monetary indicators therefore suggest that the 25 per cent loss in the Market Natural Capital Index from 1980 to 2013 likely represents a lower bound on the overall loss in natural capital.

Another lens on natural capital is offered by the results of a **case study on "green growth"** indicators (starting on page 115) undertaken for this report. The case study provides evidence that the pressure on Canada's natural capital is being brought under control in some areas, but also that more could be done. Both greenhouse gas and water productivity[60] have increased in recent years, though Canada has not done as well as its peers. The country ranked 31st out of 34 OECD member states in terms of CO_2 productivity in 2013. When it comes to environmental innovation, Canada, once a global leader, stood well below the OECD average in 2013. A similar story is revealed in terms of environmental taxes; Canada ranked second last among OECD member states in 2013 in the collection of taxes designed to achieve environmental goals.

Given the above, the overall trend in natural capital is a source of concern. For a country as reliant on natural resources as Canada, the loss of a quarter of natural capital (and possibly more) in less than two generations is reason to question whether development is sustainable, at least from an environmental standpoint. Only if the loss in natural capital were fully compensated by equal or greater growth in other forms of capital could well-being be sustained under these circumstances.[61] The analysis here suggests that this compensation did take place between 1980 and 2013, though just barely (recall that the overall Comprehensive Wealth Index grew at 0.19 per cent annually over the period) and not without some worrying structural aspects (the high concentration of produced capital growth in the areas of housing and oil and gas extraction). Moreover, the situation with respect to natural capital has deteriorated further since 2013 as a result of falling oil prices.

[59] According to the Intact Centre for Climate Change Adaptation at the University of Waterloo, Canada is not well prepared to deal with increased flooding that is expected to result from climate change. Overall, the degree of preparedness of provincial/territorial governments (other than NWT and Nunavut) to deal with current and expected future flooding was given a "C" grade (Feltmate & Moudrak, 2016).

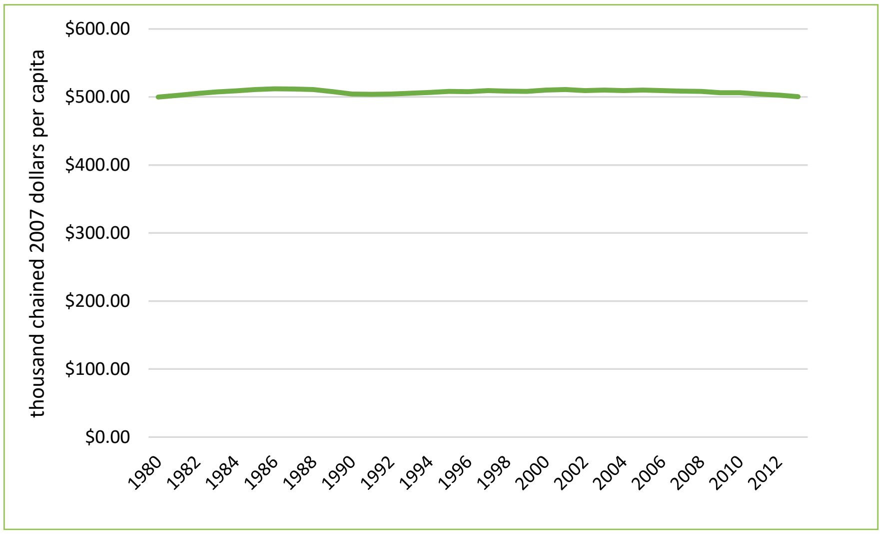
[60] Productivity in this case refers to the income (measured in inflation-adjusted terms) generated per unit of water consumed or greenhouse gases emitted.

[61] This assumes that none of the natural capital lost is of the critical variety. See the discussion on page 11 for a definition of critical capital.

6.5 Trends in Human Capital

Human capital represents the greatest share of comprehensive wealth in Canada (80 per cent on average—see Table 9), as it does in most industrialized countries. The Human Capital Index compiled for this report (see Indicator HC1) shows that human capital was essentially flat over the period 1980 to 2013 (Figure 7).

Figure 7. Human Capital Index, Canada, 1980–2013



Source: Current study.

This is despite the fact that more Canadians graduated in 2013 with some kind of formal educational certificate than in 1980 (see Indicator NC3). Other countries have done better than Canada in this regard, with several succeeding in growing real per capita human capital over similar time periods (Text Box 9).

The reasons for the lack of growth in the Human Capital Index are complex. One simple factor at play, however, is the aging of the population. As the average Canadian worker gets older, his/her remaining years in the work force drops. Fewer years left to work translates into less lifetime income and, other things equal, less human capital.[62]

Another factor is the degree to which Canada invests in the creation of human capital through formal education and on-the-job training. Assessing the level of this investment is, it turns out, harder than it might seem.

According to the Educational Spending Index (Indicator HC2) compiled for this report, overall public and private spending on education and training fell substantially from 1980 to 2013 (Figure 2). Real education expenditures per pupil started the time period at about $45,600 and ended it at $31,300, an annual average decrease of 1.14 per cent. The majority of the decline in spending took place during the early 1990s, a period of government cost cutting across the country. Total expenditures were more or less stable after 1995. When the split between elementary/secondary and post-secondary spending is considered, all of the decline in total spending was due to declines in post-secondary spending in the early 1990s. Elementary/secondary spending was up in real per-pupil terms over the time period (1.72 per cent annually) while post-secondary spending per pupil declined at an annual average rate of 2.23 per cent.

[62] The estimates of human capital used in the report are drawn from a Statistics Canada research study (Gu & Wong, 2010) that uses the lifetime-income approach (Jorgenson & Fraumeni, 1989 and 1992) to estimate human capital. The methodology underlying the life-time income approach is such that as the average age of the working population increases, human capital decreases, other things equal.

It must be noted, however, that other sources suggest different trends in educational investment, though differences in concepts, time series and units of measure between the sources prevent direct comparisons.

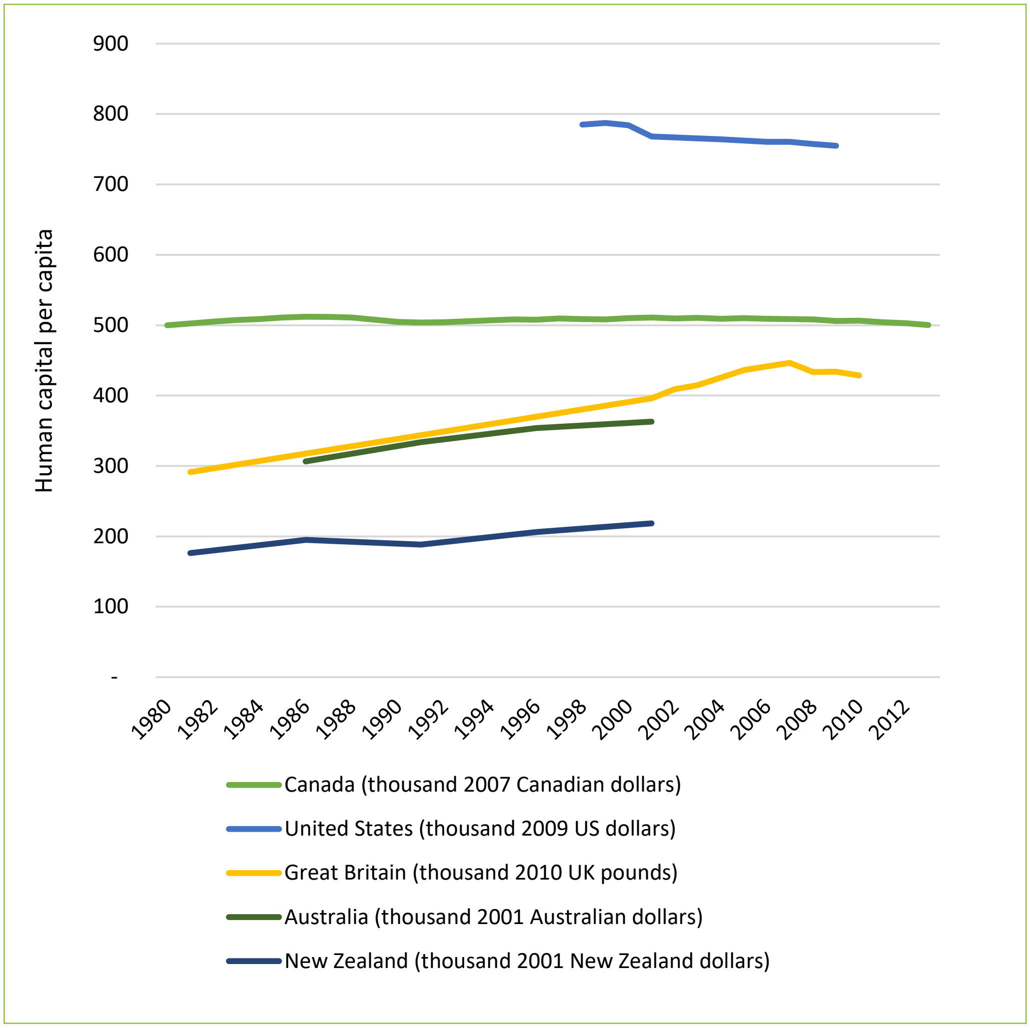
A Statistics Canada research paper on the value of output in the education sector (Gu & Wong, 2012) found that real per-pupil educational investment grew overall between 1976 and 2005 at an annual rate of 0.48 per cent compared with the 1.14 per cent annual decline in the Educational Spending Index found here for the period 1980–2013.

Another source is Statistics Canada's national accounts. Dividing the official estimate of real output the education industry from the national accounts[63] by student enrolment data from Statistics Canada suggests that output per pupil grew at an annual rate of 1.66 per cent between 1997 and 2013.

Given the variations in the data regarding educational spending, the exact trend is difficult to discern. Whatever the trend in spending, however, it seems that it was sufficient only to ensure stable but not growing real human capital per capita between 1980 and 2013. As discussed earlier (see page 34), this may be because increasing educational spending is necessary just to maintain a given level of human capital in today's economy. It could also be that the quality of education has declined over time, so that individuals are better *qualified* but are not necessarily better *educated* than in the past. It is also possible that Canadians truly are better educated than in the past but that for reasons having nothing to do with education this did not translate into increased human capital in recent decades. Further research would be needed to determine if any of these factors—or some other—explains the lack of growth in real per capita human capital.

[63] CANSIM Table 379-0031, Gross Domestic Product (GDP) at Basic Prices.

Text Box 9. **Human Capital in other countries**

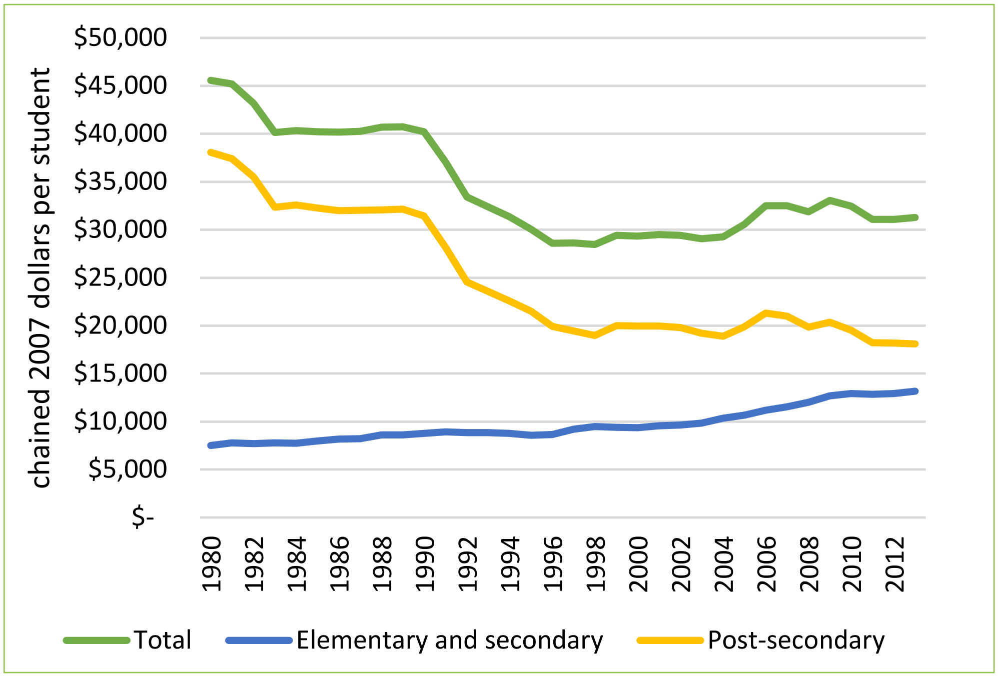


Sources: Canada (Gu, personal communication); United States (Christian, 2011); United Kingdom (Office for National Statistics, 2011); Australia (Wei, 2008); New Zealand (Le et al., 2006).

Note: Data for Australia and New Zealand are available for 1981, 1986, 1991, 1996 and 2001 only. Missing years have been filled in using linear interpolation.

Relatively few countries make estimates of human capital. Those with estimates covering more or less the time period considered in this study and also based on the lifetime-income approach are presented in the chart above. As can be seen, real human capital per capita increased in Great Britain, Australia and New Zealand over the time periods measured. Canada's trend, as already discussed, was flat from 1980 to 2013. Only the United States (which had the shortest time series of the sample) fared worse than Canada in terms of growth in human capital.

Figure 8. Educational Spending Index, Canada, 1980–2013



Source: Current study.

6.6 Trends in Social Capital

Social capital, the remaining component of comprehensive wealth, is more difficult to assess. The concepts, methods and data necessary to value social capital do not exist, so no Social Capital Index can be compiled, and social capital does not figure in the overall Comprehensive Wealth Index compiled here. However, a variety of non-monetary indicators have been compiled (starting on page 134).

Various indicators of **civic engagement** show different trends. Only Diversity in Social Networks (Indicator SC3) rose steadily between 2003 and 2013. Participation in Group Activities (Indicator SC1) rose slightly from 2003 to 2008 but then remained steady until 2013. Volunteering rates (Indicator SC2) rose slightly from 2004 to 2010 and then fell again 2013. The share of people feeling that they had some degree of Control Over Public Decisions (Indicator SC4) increased substantially between 1993 and 2000 but then remained more or less stable until 2011. Finally, Voter Turnout (Indicator SC5) in federal elections trended generally downward from 1979 to 2007 but rose again in the last two federal elections, though not quite back to its 1979 level.

Likewise, the various indicators of **trust and cooperative norms** showed different trends. Only Trust in Institutions (Indicator SC9), measured as confidence in the federal government, showed a general upward trend (though it varied considerably between 1993 and 2011). The broadest indicator, Generalized Trust (Indicator SC 6), showed essentially no change between 2003 and 2013. Trust in Neighbours (Indicator SC7) was similarly unchanged from 2003 to 2013. Trust that a Lost Wallet Will Be Returned (Indicator SC8) was also unchanged between 2003 and 2008.

Overall, these indicators paint a picture of stability, but not growth, in social capital. It must be noted, however, that the available time series are shorter than for the other forms of capital and there is no way to look at social capital per capita.

In spite of the available evidence pointing toward stability in social capital, it remains possible that the "missing investment" explaining how real per capita consumption grew faster than growth in real per capita comprehensive wealth is, in fact, to be found in social capital. Perhaps levels of civic engagement and trust actually increased over the time period (possible during the 1980s and 1990s when data are generally unavailable), making for a more "efficient" society that is better able to translate a given amount of produced, natural and human capital into well-being. If this is the case, the growth in the Comprehensive Wealth Index estimated for this report may be too low. Whether this is the case or not could only be determined with further detailed analysis.

6.7 Comparison with Other Studies

As noted earlier, this study is one of only a few analyses of comprehensive wealth ever undertaken for Canada. The others are the wealth component of the Index of Economic Well-Being compiled by the Ottawa-based Centre for the Study of Living Standards (Osberg & Sharpe, 2011), the two global reports measuring "inclusive" wealth[64] prepared by UNEP (UNU–IHDP & UNEP, 2012, 2014) and the work of the World Bank on measuring "the wealth of nations" (World Bank, 2006, 2011). The results here are compared with Osberg and Sharpe and the 2014 UNEP report below.[65] As will be seen, though the reports are not directly comparable in all ways, the other studies tend to corroborate the findings here.

6.7.1 Comparison with Osberg and Sharpe

The analysis here differs from that by Osberg and Sharpe in several ways. First, and most importantly, Osberg and Sharpe take a cost-based approach to the measurement of human capital rather than the lifetime-income-based approach used in this analysis (see Section 4.2.2. for a discussion of the two approaches to measuring human capital). As will be seen, this results in quite different conclusions regarding the level and the rate of growth of human capital. Second, Osberg and Sharpe include a few additional components in their analysis that are not included here.[66] Third, they restrict themselves to monetary measures whereas both monetary and non-monetary measures are used here; among other things, this permits the analysis here to delve more deeply into natural capital and, especially, social capital. Finally, Osberg and Sharpe combine their estimates of comprehensive wealth with estimates of a variety of other economic variables into an overall Index of Economic Well-Being. It is the trend in the overall index that is the main feature of their analysis (though they of course discuss the trends in each of the components of their comprehensive wealth index). This contrasts with the focus here, which is entirely on the trend in comprehensive wealth.

Osberg and Sharpe's analysis covers nearly the same time period as the analysis here (1981–2014 versus 1980–2013), so comparison of the results is not hampered by different analytical periods. As noted above, Osberg and Sharpe restrict themselves to monetary measures, so only the overall Comprehensive Wealth Index and the three sub-indexes for produced, natural and human capital compiled here can be compared. No comparison with the non-monetary indicators of ecosystems, climate and social capital compiled here is possible.

[64] "Inclusive wealth" is a synonym for comprehensive wealth.

[65] No comparison is made with the work of the World Bank because it does not include direct estimates of human capital and is, therefore, less directly comparable with the results here.

[66] Osberg and Sharpe include their own estimates of the value of "research and development" capital and of the real value of Canada's international investment position (net foreign financial assets). In addition, they make a downward adjustment to wealth for the social cost of greenhouse gas emissions. All these additional elements are small and do not greatly affect the comparability of Osberg and Sharpe's estimates with those here.

Overall, Osberg and Sharpe find that real comprehensive wealth per capita grew at an annual rate of 1.21 per cent between 1981 and 2013. This is considerably higher than the 0.18 per cent annual growth in this study's Comprehensive Wealth Index for the same time period and much closer to the 1.36 per cent annual growth in real per capita consumption over the period.

While at first glance this may appear to be an important difference, in fact it is almost entirely due to Osberg and Sharpe's use of a different method for estimating human capital. As noted above, they use a human capital measure based on the cost-based approach, while the analysis here uses one from Statistics Canada based on the lifetime-income approach. While both measures have their place in the analysis of human capital, the view here is that the lifetime-income-based approach is more appropriate to the analysis of the long-term prospects for sustaining development (see Text Box 6 for further explanation). If the lifetime-income-based estimates of human capital used in this analysis are substituted into Osberg and Sharpe's analysis, their estimate of the annual growth in real per capita comprehensive wealth from 1981 to 2013 falls to 0.20 per cent, almost identical to the figure of 0.18 per cent here.

With regard to the estimated level of real per capita comprehensive wealth, Osberg and Sharpe's results are, not surprisingly, different from those here. They estimate real per capita comprehensive wealth in 2013 to have been about $267,000 (2007 constant dollars) compared with about $613,000 (2007 chained dollars) here. Again, this difference is almost entirely due to their choice of human capital measure, which is considerably lower than the one here.

Looking at the components of comprehensive wealth in more detail, Osberg and Sharpe find that real **produced capital** per capita grew at an annual average rate of 1.55 per cent from 1981 to 2013, almost identical to the figure of 1.59 per cent for the Produced Capital Index over the same period based on the analysis here.[67] Their estimated level of real per capita produced capital in 2013 ($101,000 in 2007 constant dollars) is essentially identical to that here ($101,000 in 2007 chained dollars).

They find that real **natural capital** per capita declined at a rate of 0.88 per cent annually, again almost identical to the figure of 0.90 per cent for the Natural Capital Index here over the period 1981 to 2013.[68] Their estimated level of real per capita natural capital in 2013 ($19,100 in 2007 constant dollars) is close to that here ($29,200 in 2007 chained dollars). The difference is accounted for by the fact that the estimates here include the value of agricultural land whereas Osberg and Sharpe's do not.

In terms of **human capital**, they find an annual average growth rate in real per capita terms of 1.16 per cent compared with 0.01 per cent for the Human Capital Index here. As just discussed, this difference is due entirely to Osberg and Sharpe's use of a cost-based estimate of human capital rather than Statistics Canada's lifetime-income-based estimate. Their estimated level of real per capita human capital in 2013 ($154,000 in 2007 constant dollars) is, as expected,[69]considerably below that here ($500,000 in 2007 chained dollars).

Any remaining differences between Osberg and Sharpe's results and those here are based on their inclusion of small additional estimates for "research and development" capital, an estimate of Canada's international investment position in real terms and an adjustment for the social cost of greenhouse gas emissions.

[67] The small difference is accounted for by the fact that Osberg and Sharpe use Statistics Canada's produced capital data measured in so-called "constant 2007 dollars" whereas the data used here are measured in "chained 2007 dollars." The view taken here is that the latter are more appropriate.

[68] The small difference is accounted for by differences in the scope of the measures and different methods for aggregating across different types of natural capital.

[69] As explained in Text Box 6, cost-based measures of human capital result in lower estimates than income-based estimates.

Overall, Osberg and Sharpe's findings largely confirm the results of the analysis here. With the exception of their choice of a different—and arguably less appropriate—method for estimating human capital, they come to essentially the same overall conclusion as here: real per capita comprehensive wealth grew at about 0.2 per cent annually over the past few decades if a lifetime-income-based approach is used to measure human capital.

6.7.2 Comparison With UNEP's Global Inclusive Wealth Report

Comparing the results here with those from UNEP's 2014 global inclusive wealth report (UNU–IHDP & UNEP, 2014) is slightly less meaningful because UNEP measures comprehensive wealth in U.S. rather than Canadian dollars and because it uses methods that are adapted to the production of comparable estimates across 140 countries with widely varying data availability and quality. The difference in currency units is not that important, since it is mainly the growth rate rather than the level of comprehensive that is of interest here.[70] UNEP's time series (1990–2010) is also shorter than the one here, though the two time periods do overlap, so meaningful comparisons are at least possible.

One distinct advantage of the UNEP report is that it provides consistent estimates of comprehensive wealth for 140 countries, so it is possible to compare Canada's performance with its peers on the basis of UNEP's methods and data sources. This is done at the end of this sub-section.

Like Osberg and Sharpe, UNEP focuses only on monetary measures of comprehensive wealth, so only the overall Comprehensive Wealth Index and the three sub-indexes for produced, natural and human capital here can be compared. No comparison with the non-monetary indicators of ecosystems, climate and social capital compiled here is possible.

Overall, UNEP finds that Canadian real per capita comprehensive wealth (measured in constant 2005 U.S. dollars) grew at an annual average rate of 0.28 per cent from 1990 to 2010. The equivalent figure based on the Comprehensive Wealth Index compiled for this analysis (measured in chained 2007 Canadian dollars) is 0.21 per cent. As noted, direct comparison of these growth rates is not recommended due to the different methods, data and currency units used in the two studies. Nonetheless, the fact that the two growth rates are similar provides some evidence to support the results here.

Unlike Osberg and Sharpe, UNEP uses a variant of the lifetime-income approach to measure human capital that is much like the approach used by Statistics Canada to compile the estimates used here. This helps explains why UNEP's overall growth rate is similar to the one here while Osberg and Sharpe's is quite different.

With regard to the estimated level of real per capita comprehensive wealth, the results from UNEP's analysis are quite close to those here (taking the differences in the currency units into consideration). UNEP estimates Canada's real per capita comprehensive wealth in 2010 to have been about $503,000 (constant 2005 U.S. dollars). The equivalent figure here is $633,000 (chained 2007 Canadian dollars).

Looking at the components of comprehensive wealth, UNEP finds that real per capita **produced capital** in Canada grew at an annual average rate of 2.3 per cent from 1990 to 2010 using their methods and global data measured in constant 2005 U.S. dollars. The equivalent figure based on the Produced Capital Index compiled for this analysis using Statistics Canada's methods and data in chained 2007 Canadian dollars is 1.55 per cent. With regard to the level of real produced capital per capita, the results of the two studies are relatively close; UNEP's estimate for Canada in 2010 is about $108,000 (constant 2005 U.S. dollars), while the figure here is about $95,000 (chained 2007 Canadian dollars).

[70] Depending on how currency conversion was carried out by UNEP, which is not fully clear from the report, variations in exchange rates over time could affect estimated growth rates to some extent.

With regard to **natural capital**, UNEP finds that Canadian real per capita natural capital in constant 2005 U.S. dollars declined at an annual average rate of 1.46 per cent from 1990 to 2010. The equivalent figure based on the Natural Capital Index compiled for this analysis using Statistics Canada's methods and data in chained 2007 Canadian dollars is a decline of 0.71 per cent annually (from 1990 to 2010). The estimated levels are in this case quite different. UNEP estimates that real per capita natural capital in 2010 was about $128,000 in constant 2005 U.S. dollars, while the figure here is about $31,000 in chained 2007 Canadian dollars. The major reason for the difference in level between the two estimates is the inclusion of the value of non-timber forest goods and services in the UNEP figure. UNEP estimates that non-timber forest goods and services alone were worth about $58,600 (constant 2005 U.S. dollars) in 2013.

Finally, with regard to **human capital**, UNEP finds that Canadian real per capita human capital grew in constant 2005 U.S. dollars at an annual average rate of 0.63 per cent from 1990 to 2010. The equivalent figure based on the Produced Capital Index compiled for this analysis using Statistics Canada methods and data in chained 2007 Canadian dollars is 0.02 per cent. UNEP's estimated level of real human capital per capita ($268,000 in constant 2005 U.S. dollars in 2010) is about two thirds of that here ($506,000 in chained 2007 Canadian dollars). These results are not surprising, given that UNEP uses a discount rate of 8.5 per cent in its lifetime-income present valuation calculation while Statistics Canada uses a rate of 5.1 per cent. [71]

To summarize, the broad trends in Canadian comprehensive wealth estimated by UNEP using globally available data and methods are similar, though not identical, to those compiled here using the best available data and methods from Statistics Canada. The overall growth rate and level of real per capita comprehensive wealth estimated by the two studies are very close, though there are differences in the estimates for the components of comprehensive wealth. These are likely due to the different methods and global data UNEP used in its study.

Arguably more interesting than the comparison between UNEP's results and those here is the comparison of UNEP's results for Canada with those for other countries. Table 1 presents UNEP's estimates of real per capita comprehensive wealth for Canada and selected high- and middle-income countries. As can be seen, Canada ranked quite highly in terms of the level of comprehensive wealth in 2010 (3rd of 23 countries) but much lower (19th) in terms of its growth between 1990 and 2010.

It is worth noting that the two countries that ranked ahead of Canada in terms of the level of comprehensive wealth (Norway and Australia) are also highly endowed with natural capital and also ranked relatively poorly in terms of the annual growth in comprehensive wealth between 1990 and 2010 (18th and 16th respectively). It would seem, then, that there is a correlation between being well endowed with natural capital but performing relatively poorly in terms of growing comprehensive wealth.[72]

Looking specifically at G7 nations,[73] Canada ranked first in terms of level of comprehensive wealth thanks to its vast reserves of natural capital. Compared with its G7 peers, Canada has nearly five times more natural capital in per capita terms than the next best endowed nation (the United States). This

[71] The use of a high discount rate affects UNEP's estimate in two ways. First, it results in a lower estimated level of human capital, meaning that any growth in human capital is from a lower starting point and will be proportionally larger as result. Second, the drag of Canada's ageing population on human capital growth (see the discussion on p. 61) is lessened, since income in distant years is greatly discounted. This brings the lifetime earnings of older and younger workers toward one another, making their relative shares in the labour market less important in determining the value of human capital.

[72] It should be noted that UNEP's estimates do not include the value of net foreign financial assets of nations. In the case of Norway, the country has amassed very significant net foreign financial assets in the form of a sovereign wealth fund created with rents from the extraction of North Sea oil. If these financial assets were included in the estimates for Norway, it would rank much higher in terms of the growth rate of comprehensive wealth between 1990 and 2010.

[73] The G7 members are Canada, France, Germany, Japan, Italy, the United Kingdom and the United States.

clearly puts the country in a position of strength.[74] At the same time—and consistent with the findings of this study—the UN ranked Canada last among G7 members in terms of *growth* in comprehensive wealth. In other words, other G7 countries are doing better than Canada at managing the growth of their comprehensive wealth portfolios. And they are catching up to Canada's level as a result. In 1990, the average per capita comprehensive wealth in other G7 countries was 72 per cent of Canada's; by 2010, this share had climbed to 83 per cent.

Table 10. UNEP estimated comprehensive wealth, Canada and selected countries, 1990 and 2010

Country	Real comprehensive wealth *per capita**			Annual growth rate - 1990-2010	
	1990	2010	Rank (2010)	Percent	Rank (2010)
Argentina	72,664	77,449	18	0.32	17
Australia	483,439	515,734	2	0.32	16
Brazil	82,498	84,330	16	0.11	21
Canada	475,846	502,972	3	0.28	19
China	16,216	23,834	21	1.94	2
Costa Rica	63,377	74,003	20	0.78	11
France	342,866	425,022	8	1.08	4
Germany	325,513	435,655	6	1.47	3
India	10,628	12,321	23	0.74	12
Indonesia	22,772	22,680	22	-0.02	22
Italy	276,943	324,712	11	0.8	10
Japan	361,234	432,236	7	0.9	6
Mexico	67,127	80,296	17	0.9	7
Netherlands	342,690	411,715	9	0.92	5
New Zealand	255,197	280,407	12	0.47	15
Norway	613,670	651,018	1	0.3	18
Russian Federation	132,450	136,156	15	0.14	20
Saudi Arabia	356,776	272,137	13	-1.34	23
South Korea	122,581	195,033	14	0.63	13
Sweden	407,954	462,462	5	2.35	1
Turkey	63,238	75,600	19	0.9	8
United Kingdom	345,487	409,074	10	0.85	9
United States	411,673	463,375	4	0.59	14

*All values expressed in thousand constant 2005 U.S. dollars.

[74] If Canada's levels of natural capital were similar to other G7 nations, it would fall somewhere near the bottom of the group in terms of its level of comprehensive wealth.

7 DISCUSSION OF FINDINGS AND SUGGESTED RESEARCH AGENDA

7.1 What Do the Findings Mean for Canada?

This report is largely about measuring comprehensive wealth rather than ways of creating and managing it. The goal is to highlight trends in Canada's comprehensive wealth portfolio using the best methods and data available in an effort to bring attention to an issue—wealth and its importance for the sustainability of development—that is not widely discussed in Canada. The hope is that doing so will promote discussion of the issue among Canadians and their leaders. Canada would be better positioned to guide its development if comprehensive wealth were among the measures routinely used to assess national progress.

Indeed, the need for Canada to measure and understand comprehensive wealth has never been greater. Canada's development model is based heavily on the exploitation of natural capital, and the country cannot sustain another 30 years of natural capital depletion. Short-term commodity price volatility and the longer-term global shift to a cleaner, knowledge-driven economy mean that future reliance on fossil fuels to underpin the country's growth is risky. The current debate about fossil fuel projects and pipelines needs, therefore, to include a vision of transformation toward a low-carbon economy. Given all this, it is surprising how little understood the role of natural capital within the overall economy is. Comprehensive wealth measurement promises to shed greater light on this role.

Inevitably, Canada will have to diversify its economy and focus on growing all components of the comprehensive wealth portfolio to ensure that its development remains sustainable. The range of possible actions to accomplish this is obviously broad and complex, touching upon aspects of tax, fiscal, industrial, trade, natural resource, climate, environmental, education and health policies to name just a few. Given this complexity, detailed policy suggestions are beyond the scope of this study. However, there are a few obvious areas in which actions will be necessary.

First, Canada must reverse the trend in its natural capital, both to ensure continued flows of resource commodities and to ensure the on-going provision of environmental benefits like clean air and water. Climate change represents a major threat to the latter, and more research is needed to understand its potential impacts on Canadians and their well-being.

Second, Canada must grow its human capital. Better education and training are key here, but so too are efforts to increase productivity. This is a particularly complex area and one where more data of the sort provided by comprehensive wealth would be very welcome.

Third, the country needs to diversify its produced capital so that housing and oil and gas infrastructure are less dominant in the overall mix. Investments in housing, while obviously important to well-being in many ways, can hamper it in the long term if they crowd out investments elsewhere in the economy or if housing values are diminished because of market corrections. The value of oil and gas extraction assets is tightly coupled with the value of Canada's fossil fuel assets, which have fallen rapidly in recent years and, as noted, face serious obstacles in the long term. Diversification of produced capital is needed to hedge against these risks. The recent recommendation from the federal government's Economic Advisory Council for significant and broad investment in the country's infrastructure is welcome in this regard: as the Council noted, "governments at all levels have not invested enough to support long-term economic growth" (Advisory Council on Economic Growth, 2016b, p. 4).

Finally, Canada needs to begin systematically measuring comprehensive wealth to track its success in making these and other necessary changes to ensure continued growth in the nation's wealth. As noted, Statistics Canada already keeps one of the most detailed sets of wealth figures in the world, so Canada is well placed to play a leadership role in this emerging area. To this end, the federal government should fund Statistics Canada to begin regular reporting of comprehensive wealth measures following the same cycle as GDP (see the next section for further research recommendations).

Simply publishing new measures of comprehensive wealth is, of course, not enough. Decision makers must at the same time increase their focus on comprehensive wealth, using the new measures both to guide and evaluate their efforts in ensuring its growth. Public and private efforts have long been focused on ensuring growth in GDP and the country has enjoyed much success in this regard. The question of whether the comprehensive wealth portfolio—which is, after all, the basis for GDP—is sustainable has received less attention.

7.2 Research Agenda

Despite its value as a measure of sustainable development, comprehensive wealth remains largely unstudied. As discussed earlier, this report is one of the only efforts ever made at measuring comprehensive wealth in Canada and one of the only such efforts anywhere in the world. The only component of comprehensive wealth thoroughly measured by Statistics Canada is produced capital. The agency does publish data on some types of natural capital but only in nominal dollars, which are not suitable for time-series analysis. Human and social capital are measured by Statistics Canada only in occasional research papers, with social capital only being measured using non-monetary indicators.

> **Research activity #1** – *The federal government should fund Statistics Canada to regularly publish comprehensive wealth measures. These should include timely and complete estimates of produced, financial, natural, human and social capital in monetary and non-monetary terms to be published alongside quarterly GDP. All of these measures should be compiled for Canada as a whole and for each province/territory, by sector of the economy and by income level (to reflect the distribution of wealth).*

Human capital accounts for about 80 per cent of comprehensive wealth in Canada. Given this large share, the fact that human capital did not grow between 1980 and 2013 is a particular concern. Canada is a wealthy, technologically advanced country competing in a global market where at least some peer countries have succeeded in increasing human capital in recent years. The starting point for addressing the challenge of growing human capital in Canada is more information, as understanding of it today is limited to a handful of research studies.

> **Research activity #2** – *Research is suggested to better understand the reasons for Canada's human capital performance. To facilitate this study, the federal government should, as a priority, fund Statistics Canada to elevate its research program on human capital to a fully-fledged set of official statistics. As part of this, the agency should be asked to produce official estimates of investment in education to replace the contradictory estimates that can be currently gleaned from education statistics and the national accounts.*

Social capital is the least understood and measured component of the comprehensive wealth portfolio. The fact that no valuation of social capital is possible means that the Comprehensive Wealth Index presented here is not truly comprehensive.

> **Research action #3** – *Research is suggested to better understand social capital and its relation to other forms of capital. In particular, research into possible means of valuing social capital to permit its inclusion in the Comprehensive Wealth Index would be beneficial.*

Next to human and social capital, research on natural capital is the most urgently needed. As noted earlier, the values of important natural assets—commercial fisheries, water and all ecosystems—are not currently measured by Statistics Canada. In measuring the value of these assets, the potential impact of climate change should be taken into consideration. Fish stocks, forests, agricultural land, lakes and rivers, wetlands, permafrost, glaciers and other natural assets are all at risk of disturbance from a changing climate. This has implications for water, food and timber supplies, tourism and recreation, flood protection, transportation, cultural and spiritual well-being and the well-being of non-human species. The impacts are not necessarily limited to natural capital either; produced capital, in particular, is tightly coupled with natural capital in Canada. Degradation of natural capital due to climate change may therefore lead to "knock-on" losses in other asset categories.

> **Research action #4** – *Research is needed to fill the gaps in Statistics Canada's measures of natural capital. In this, the possible impacts of climate change on Canada's natural capital should be considered. The research should also consider how changes to natural capital stocks as a result of climate change might affect the value of other capital stocks; for example, how the loss of timber stocks due to more severe pest infestations or forest fires might impact the value of produced, human and social capital.*

Beyond the need to regularly measure comprehensive wealth and its components, there is a need to review the way in which productivity is measured in Canada. Statistics Canada's broadest measure of productivity considers only the efficiency with which human capital and produced capital are employed in creating output. The exclusion of natural capital from this measure may mean that productivity growth is underestimated.

Research action #5 – *Statistics Canada should study the inclusion of natural capital as an explicit input in the calculation of multi-factor productivity. Most of the data required to do so already exist. The major gaps requiring filling in the short term are the value of commercial fish stocks and water resources (e.g., hydroelectric and irrigation reservoirs). The value of ecosystem services such as pollination of crops, surface water flow regulation and pollution absorption could be added in the longer term.*

Comprehensive Wealth

PART III:

COMPREHENSIVE WEALTH INDICATORS FOR CANADA

8 SUMMARY OF INDICATOR TRENDS

The third part of this report presents the individual comprehensive wealth indicators that are currently measurable in Canada. It begins with narrative and graphical summaries of the overall trends in the indicators for natural, human and social capital (no overview of the indicators of overall comprehensive wealth or produced capital is offered since just one indicator has been compiled for each of these).

This is followed by presentation of the indicators themselves in five sections, one each for overall comprehensive wealth (beginning on page 80); produced capital (page 84.); natural capital (page 87), including a case study on "green growth" indicators (page 115); human capital (page 123); and social capital (page 134).

The indicators are presented in individual discussions covering:

- the geographic scope of the indicator
- the time series for which the indicator has been compiled
- the frequency with which the indicator can be compiled
- a description of the indicator
- the relevance of the indicator to comprehensive wealth
- the methods and data sources (and their limitations) used to compile the indicator
- the statistical reliability of indicator,[75] and
- and an analysis of the trends in the indicator.

8.1 Natural Capital – Summary of Indicator Trends

Market Natural Capital: The trend in the Market Natural Capital Index (Indicator NC1) is downward. From 1980 to 2013, the index fell by 0.93 per cent annually on average. As a consequence, Canada has substantially less market natural capital per capita to draw upon today than it did a generation and a half ago. Along with population growth, the factors driving the decline are the physical depletion of assets (certain minerals and, to a lesser degree, commercial timber stocks) and declines in commodity prices (especially for forest products[76] and, recently, oil). Fossil fuel stocks, especially oil sands, were a bright spot in this picture until recently, with large physical growth in reserves and substantial price increases helping to buoy the Market Natural Capital Index beginning in the mid-2000s. The recent drop in oil prices has eliminated most of these gains, however, and it is expected the Market Natural Capital Index will decline further after 2013.

Ecosystems: The various ecosystem indicators all show negative trends (except for Surface Water – Indicator NC4, for which an assessment of change was not possible due to data gaps).

[75] Statistical reliability is a qualitative assessment made on the basis of the report's authors' knowledge of data quality and conceptual and methodological soundness. Indicators are rated as either "very reliable", "reliable" or "acceptable". Indicators are considered to be "very reliable" (Class 1) when they are characterized by source data that are mainly derived from highly reliable sources like Statistics Canada surveys or from other sources that are considered to be highly reliable and by concepts and methods that are based on accepted environmental, economic or statistical theory and do not require arbitrary or subjective decisions regarding important parameters. Indicators that meet all but one of the above criteria are deemed to be "reliable" (Class 2). Those that fail to meet two or more of the criteria are deemed to be "acceptable" (Class 3).

[76] Statistics Canada's price index for lumber and other wood products (CANSIM Table 379-0074) sat at about the same level in 2015 as it did in 1993 and was down by 14 per cent from its peak in 1999.

Forests (Indicator NC2) declined slightly in area between 2000 and 2011, mainly due to growing losses from pest infestations and fires. Despite Canada's size and the extent of our forests, about 40 per cent of forests were considered "developed" in 2011, i.e., found within 1 kilometre of a development feature such as a road, pipeline or town.

Wetlands (Indicator NC3) also declined in area in most parts of the country (other than the Maritimes and the North). These losses, while relatively small, came on top of significant declines in wetlands in earlier periods of the nation's development. Cumulatively, Canada has lost a large (but unknown) share of its original wetlands since European settlement. With most of the country's remaining wetlands found in northern regions, only about one fifth (21 per cent) were considered developed, so future threats from human development may be small.

Grasslands (Indicator NC5) also saw small declines in area from 2000 to 2011 that came on top of large historical losses. Unlike wetlands, however, remaining grasslands are significantly threatened by further development. An estimated 95 per cent of remaining grasslands in Alberta and Manitoba were considered developed in 2011. In Saskatchewan, the corresponding figure was about 77 per cent.

Though no assessment of the change in Surface Water (Indicator NC4) extent or quality was possible, data for 2011 indicate that about 40 per cent of surface water areas were developed in Newfoundland and Labrador, New Brunswick, Nova Scotia, PEI, Alberta and British Columbia. Nationally, 20 per cent of surface water areas were considered developed.

Climate: The various climate indicators all showed trends consistent with the most recent scientific assessment of climate change (Collins et al., 2013). Precipitation (Indicator NC6) generally increased in Canada between 1948 and 2014, with the greatest increases coming in the North. Though increased precipitation is not necessarily a threat to development,[77] the fact that the trend is consistent with climate change—which will likely have overall negative impacts on well-being in Canada and globally—leads to this trend being labelled negative.

Temperature (Indicator NC7) showed a trend similar to that of precipitation, with an overall increase nationally from 1948–2014 and the greatest increases coming in the North. Again, this trend is consistent with climate change predictions and is considered negative.

In spite of increased precipitation, annual average Snow Cover (Indicator NC8) declined across the country from 1972 to 2011. Similarly, the mass of selected Glaciers (Indicator NC9) in the Western Cordillera and High Arctic declined from 1960 to 2007 and the Extent of Sea Ice (Indicator NC11) declined from 1968 to 2010. Each of these trends is consistent with warming temperatures in the North and is considered negative here.

Finally, Water Yield (Indicator NC10)—an estimate of the annual renewal of Canada's freshwater resources—declined in the southern (most populated) part of the country from 1971 to 2004, another climate change-consistent and negative trend.[78]

The above trends are summarized graphically in Table 11.

Green growth case study: The indicators in the green growth case provide some evidence that the pressure on Canada's natural capital is being brought under control but also that more could be done. Both greenhouse gas and water productivity[79] have increased in recent years. Compared to its peers, however, Canada's economy remains relatively greenhouse gas-intensive. The country ranked 31st

[77] Agriculture and Agri-food Canada (n.d.) expects that increased precipitation will, for example, be a benefit for agriculture in Alberta.

[78] Water yield can be estimated only for the southern part of the country with existing data.

[79] Productivity in this case refers to the income (measured in inflation-adjusted terms) generated per unit of water consumed or greenhouse gases emitted.

out of 34 OECD member states in terms of CO2 productivity in 2013. When it comes to Environmental Innovation, Canada figured among the leaders in the 1990s in terms of the share of new technologies that were environmentally related. Its performance dropped off beginning in the 2000s, though, and the country stood well below the OECD average in 2013. In terms of environmental taxes, Canada did not fare well compared to its OECD peers. The country ranked second last among OECD member states in 2013, though its performance in this regard is likely to improve as more provinces move toward placing a price on carbon emissions.

Table 11. Trends in natural capital indicators

Theme	Indicator	Trend	
Market natural capital	*Market Natural Capital Index* (Indicator NC1)	*Market Natural Capital Index* (Indicator NC1)	↓
Ecosystems	*Forests* (Indicator NC2)	*Forests* (Indicator NC2)	↓
	Wetlands (Indicator NC3)	*Wetlands* (Indicator NC3)	↓
	Surface Water (Indicator NC4)	*Surface Water* (Indicator NC4)	No assessment of change possible
	Grasslands (Indicator NC5)	*Grasslands* (Indicator NC5)	↓
Climate	*Precipitation* (Indicator NC6)	*Precipitation* (Indicator NC6)	↓
	Temperature (Indicator NC7)	*Temperature* (Indicator NC7)	↓
	Snow Cover (Indicator NC8)	*Snow Cover* (Indicator NC8)	↓
	Glacier Mass (Indicator NC9)	*Glacier Mass* (Indicator NC9)	↓
	Water Yield (Indicator NC10)	*Water Yield* (Indicator NC10)	↓
	Sea Ice Extent (Indicator NC11)	*Sea Ice Extent* (Indicator NC11)	↓

8.2 Human Capital – Summary of Indicator Trends

Human Capital Index: The Human Capital Index (Indicator HC1), showed essentially no change between 1980 and 2013. Though this does not, strictly speaking, indicate an unsustainable trend with respect to human capital, when put in the broader context of overall comprehensive wealth, this trend is characterized as negative here.

Educational Inputs: According to the Educational Spending Index (Indicator HC2), real education expenditures per pupil started the time period at $45,600 and ended it at $31,300 (chained 2007 dollars), an annual average decrease of 1.14 per cent. The majority of the decrease in spending took during the early 1990s. All of it took place at the post-secondary level.

Though this trend can only be characterized as negative, other studies suggest the trend may not be as unfavourable as might be thought (see the discussion on page 127 for further details). For this reason, the trend is indicated as neutral here.

Educational outcomes: Educational Attainment (Indicator HC3) steadily rose in Canada from 1986 to 2011. In 1986, 47 per cent of the population age 15 and over had no formal educational certificate, diploma or degree and only 9 per cent had a university degree. By 2011, only 20 per cent had no formal certificate, diploma or degree, while 20 per cent had a university degree. It is not possible to assess the trend in Adult Skills (Indicator HC4) with existing data (which are available for 2012 only). All that can be said is that Canada scored just above the OECD average for literacy, slightly below the average for numeracy and above the average for problem solving.

The above trends are summarized graphically in Table 11.

Table 12. Trends in human capital indicators

Theme	Indicator	Trend
Human capital	*Human Capital Index*	↓
Educational inputs	*Educational Spending*	⇔
Educational outcomes	*Educational Attainment*	↑
	Adult Skills	No assessment of change possible

8.3 Social Capital – Summary of Indicator Trends

Civic engagement: The various indicators of civic engagement showed different trends. Participation in Group Activities (Indicator SC1) rose slightly from 61 per cent to 65 per cent of the population from 2003 to 2008 but then remained steady until 2013. The results were uneven across provinces, with group participation up significantly in some provinces from 2003 to 2013 and nearly unchanged in others. Volunteering rates (Indicator SC2) rose slightly from 2004 to 2010 (from 45 per cent to 47 per cent) and then fell again to 43.6 per cent in 2013. As with group participation, results varied significantly across provinces. Diversity in Social Networks (Indicator SC3) rose steadily between 2003 and 2013, with the share of people having contact with friends from visibly different ethnic groups increasing from 54 per cent to 59 per cent between 2003 and 2013. This trend was consistent across provinces. The share of people feeling that they had some degree of Control Over Public Decisions (Indicator SC4) increased substantially between 1993 (45.2 per cent) and 2000 (62 per cent) but then remained more or less stable until 2011. Finally, Voter Turnout (Indicator SC5) in federal elections trended generally downward from 1979 to 2007 but rose again in the last two federal elections. It stood at 68.3 per cent in the 2015 election, compared with 69.3 per cent in 1979.

Overall, of the civic engagement indicators only the indicator of diversity in social networks showed a strong and consistent upward trend over the period considered. Results for the other indicators were more ambiguous, with trends characterized by inconsistencies across time and regions.

Trust and cooperative norms: Again, the various indicators of trust and cooperative norms showed different trends. The broadest indicator, Generalized Trust (Indicator SC 6), showed essentially no change between 2003 and 2013. Results were uneven across provinces, with most provinces showing declines but a few with largely unchanged levels of trust. Trust in Neighbours (Indicator SC7) was similarly unchanged from 2003 to 2013; Trust in Strangers (Indicator SC7) increased slightly from 2.2 on a scale of 1 to 5 to 2.4. Trust in Neighbours and Trust in Strangers both dipped significantly in 2008 before recovering again in 2013. Trust that a Lost Wallet Will Be Returned (Indicator SC8) was unchanged between 2003 and 2008, showing varied results from province to province. Finally, Trust in Institutions (Indicator SC9), measured as confidence in the federal government, varied considerably from 1993 to 2011, though there was a general trend toward greater confidence; 31.1 per cent of people reported having some degree of confidence in the federal government in 1993, whereas 55.2 per cent had confidence in it in 2011.

Overall, none of the indicators of trust and cooperative norms showed a consistent upward trend over the period, with considerable inconsistencies in results across time and regions.

Although about half of the social capital indicators showed an upward trend over the period considered, for most the trend was tempered by inconsistencies across time and/or region. Only one of the nine indicators (Diversity in Social Networks) showed a strong upward trend that was consistent over time and region. For this reason, the conclusion here is that social capital was stable—but not growing—in Canada during the period studied.

The above trends are summarized graphically in Table 13.

Table 13. Trends in social capital indicators

Theme	Indicator	Trend	
Civic Engagement	*Participation in Group Activities*	• Participation in group activities rose slightly from 2003 to 2008 but then remained steady until 2013.	⇔
	Volunteering	• Volunteering rates rose slightly from 2004 to 2010 and then fell again in 2013.	⇔
	Diversity in Social Networks	• The share of people having contact with friends from visibly different ethnic groups increased steadily between 2003 and 2013.	↑
	Control over public decisions	• The share of people feeling that they had some degree of control over public decisions increased substantially between 1993 and 2000 but then remained more or less stable until 2011.	⇔
	Voter Turnout	• Voter turnout in federal elections trended generally downward from 1979 to 2007 but rose again in the last two federal elections though not to its 1979 level.	⇔
Trust and Cooperative Norms	*Generalized Trust*	• Generalized trust showed essentially no change between 2003 and 2013.	⇔
	Trust in Neighbours and Strangers	• Trust in neighbours was unchanged from 2003 to 2013, while trust in strangers increased slightly; both dipped significantly in 2008 before recovering again in 2013.	⇔
	Trust that a Lost Wallet Will Be Returned	• Trust that a lost wallet will be returned was unchanged between 2003 and 2008.	⇔
	Trust in Institutions	• Trust in institutions, measured as confidence in the federal government, varied considerably from 1993 to 2011, though there was a general trend toward greater confidence.	⇔

Comprehensive Wealth

OVERALL COMPREHENSIVE WEALTH

Indicator CW1 – Comprehensive Wealth Index

Theme: Overall Comprehensive Wealth

Geographic scope: Canada

Time series: 1980–2013

Frequency: Annual

Description: The Comprehensive Wealth Index measures the aggregate value of real (inflation-adjusted) per capita produced, natural and human capital (it is not possible at the moment to include social capital – see Limitations below). It is measured in chained 2007 dollars.

Relevance to comprehensive wealth: The Comprehensive Wealth Index is the broadest measure of comprehensive wealth available. By combining the values of produced, natural and human capital into a single index, it offers the possibility of readily monitoring and communicating the overall trend in comprehensive wealth, just as GDP does for the overall trend in income.

In theory, the Comprehensive Wealth Index is a nearly ideal indictor of the sustainability of well-being (Hamilton & Clemens, 1999; Dasgupta & Mäler, 2000; Stiglitz et al., 2009; World Bank, 2011; UNU–IHDP & UNEP, 2012; Dasgupta, 2014). This is because the assets measured by the index are the basis for producing all the "goods and services" that are "consumed" by individual Canadians. This consumption serves, in turn, as the basis for a great deal of well-being.[80] "Goods and services" and "consumption" are placed within quotation marks to indicate that the terms are used differently here from their everyday understanding. The "goods and services" produced by the assets comprising comprehensive wealth include the market goods and services that are traditionally associated with the term. They extend far beyond that, however, to include a wide range of goods and services produced and consumed outside of the market. These include tangible goods (such as subsistence food derived from the environment), that are very much like market goods, as well as services that contribute to market production but for which no payment is made (such as pollination of crops freely provided by wild insects). They also include services that contribute directly to well-being: recreational opportunities, provision of clean air and water, aesthetic enjoyment, cultural and spiritual experiences and a variety of human skills and abilities (parenting skills, for example).[81] The broad coverage of the Comprehensive Wealth Index in terms of well-being enhancing assets is what makes it such a valuable indicator of sustainability. If the real per capita value of comprehensive wealth is increasing over time, development (that is, increasing well-being) is likely sustainable. If it is falling over time, development is unambiguously unsustainable and well-being will fall at some point in the future.

Method of calculation and data sources: The Comprehensive Wealth Index is calculated as a quantity index of per capita produced, natural and human capital stocks.[82] Data were obtained from Statistics Canada and the index was compiled the authors of this report (Annex 2 provides details of the methods and data sources used in the compilation of the Comprehensive Wealth Index).

[80] Some well-being obviously comes from within individuals themselves (such as pure spirituality) and is not provided by the assets that are included in comprehensive wealth.

[81] In its ideal form the Comprehensive Wealth Index would include social capital and all of the well-being-enhancing "services" associated with civic engagement and trust; for example, security, a sense of belonging and support in times of need. With social capital included, the Comprehensive Wealth Index becomes a very inclusive measure of the basis of well-being.

[82] Specifically, the Comprehensive Wealth Index is a chained Törnqvist volume index with 2007 used as the base year to calculate annual levels ("chained dollar"quantities) of comprehensive wealth from 1980 to 2013.

Limitations: The major limitation of the Comprehensive Wealth Index is its exclusion of social capital, which cannot be included because the concepts, methods and data sources required to value it are not yet available. Also significant is the exclusion of a number of natural assets that cannot (or should not[83]) be valued: commercial fish stocks, lakes and rivers, groundwater, non-commercial forests, wetlands and other ecosystems.

Inclusion of commercial timber assets in the index required extension of the timber volume estimate from Statistics Canada's Physical Timber Stock Account[84], which has not been updated since 2003 (see Annex 3 for details).

Statistics Canada's human capital estimates are published by the agency only in research studies and not as official national statistics. As a result, they may be less reliable than the estimates of produced and natural capital, both of which are official statistics.

Finally, it is not possible to include the value of Canada's net foreign financial assets (the International Investment Position) in the index because Statistics Canada measures the value of these assets in nominal terms only. See Text Box 3 for further discussion of financial assets and the measurement of comprehensive wealth.

Reliability: The Comprehensive Wealth Index is considered reliable rather than very reliable only because the estimates of human capital are based on research results rather than official statistics.[85]

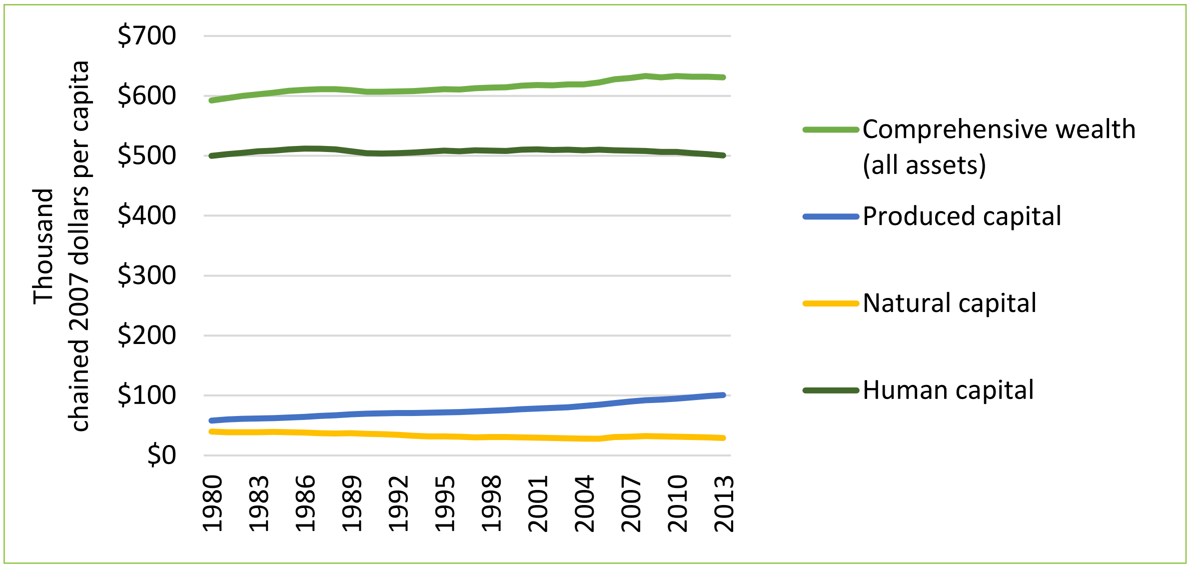
[83] Some of these can be considered "critical" natural capital and are not amenable to valuation or inclusion in the Comprehensive Wealth Index. See the discussion of critical natural capital in Section 3.1 for further details.

[84] Statistics Canada, *Timber Assets* (Volume), CANSIM Table 153-0030.

[85] See Footnote 6 for details of the reliability scale used in this report.

Analysis: Analysis: The Comprehensive Wealth Index grew by 6.6 per cent between 1980 and 2013. In 1980, the Comprehensive Wealth Index's value stood at $592,000 per Canadian (chained 2007 dollars). By 2013, it had risen to $631,000, for an annual average growth rate of 0.19 per cent (Figure 9).

Figure 9. Comprehensive Wealth Index, 1980–2013



Source: Current study (see Annex 2 for details of the compilation methodology).

Looking at the components of the index, **produced capital** increased at an annual average rate of 1.68 per cent annually over the period. **Natural capital** moved in the opposite direction, falling at an average annual rate of 0.93 per cent over the period. **Human capital**, which makes up by far the largest share of the index, was essentially unchanged between 1980 and 2013.[86]

[86] Note that the nature of chained indexes is such that the sum of the components does not necessarily equal the value of the overall index. The chained Törnqvist index is better than others in this regard, which is why it has been applied here.

Comprehensive Wealth

PRODUCED CAPITAL

Indicator PC1 – Produced Capital Index

Theme: Produced Capital

Geographic scope: Canada

Time series: 1980–2013

Frequency: Annual

Description: The Produced Capital Index measures the aggregate value of real (inflation-adjusted) per capita produced capital (residential buildings; non-residential buildings; roads, dams and other infrastructure; machinery and equipment; and intangible assets such as patents).

Relevance to comprehensive wealth: Produced capital is one of the four components of comprehensive wealth and a main factor of production in the business sector (along with human capital and natural capital). It is a key part of the productive base upon which market output is created and therefore plays a key role in the provision of well-being-enhancing market goods and services.

Method of calculation and data sources: The index is created by combining Statistics Canada's estimates of real non-residential[87] and residential[88] capital stocks (divided by population[89] to convert them to a per capita basis) into an annual volume index for 1980 to 2013.[90] It is measured in chained 2007 dollars.

Limitations: The Produced Capital Index has no notable limitations.

Reliability: The Produced Capital Index is considered very reliable.[91]

Analysis: The Produced Capital Index grew at an average annual rate of 1.68 per cent between 1980 and 2013 (Figure 1). The majority of the growth in the Produced Capital Index is explained by what happened in two areas of the economy: residential buildings and the oil and gas industry.[92] If the values of the housing stock and oil and gas extraction assets are removed from the analysis, produced capital grew at a more modest 0.89 per cent on average between 1980 and 2013.

In absolute terms, with housing and oil and gas included, produced capital increased by about $42,700 per person (chained 2007 dollars) over the period. When housing and oil and gas extraction assets are taken out of the analysis, the absolute increase drops to $9,500 per person and the overall level available per person drops significantly.

[87] Statistics Canada, *Flows and Stocks of Fixed Residential Capital, by Industry and Asset,* CANSIM Table 031-0005.

[88] Statistics Canada, *Flows and Stocks of Fixed Residential Capital*, CANSIM Table 031-0008.

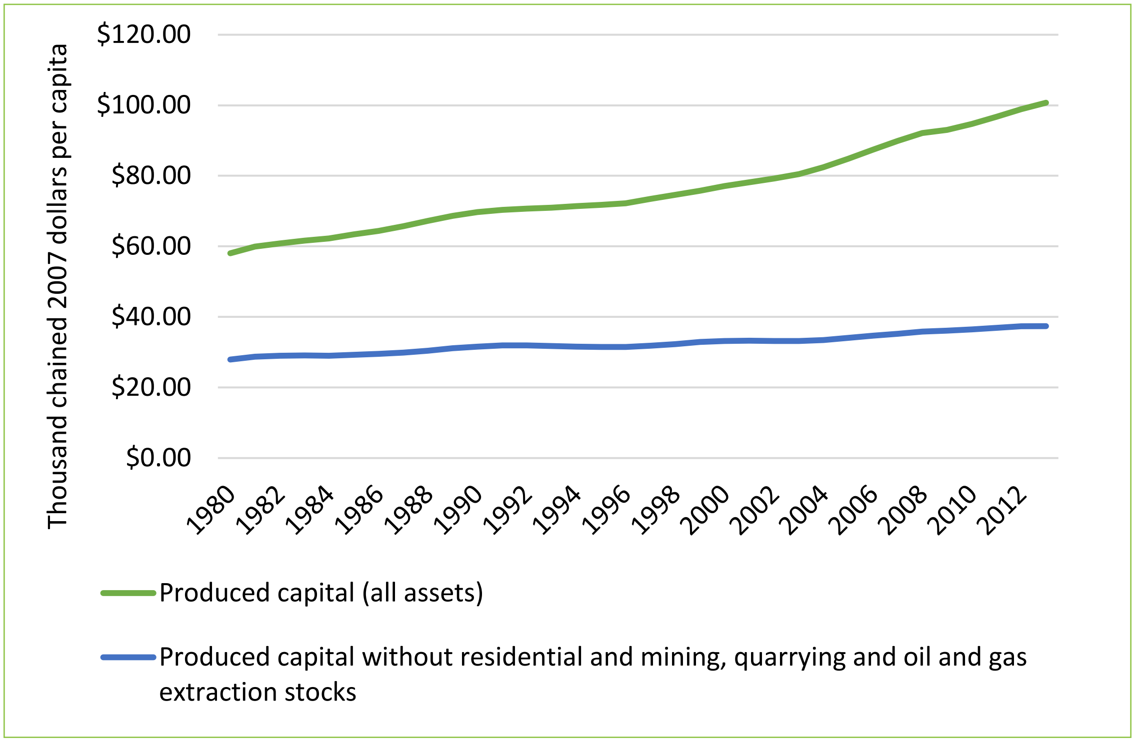
[89] Statistics Canada, *Estimates of population for July 1*, CANSIM Table 051-0001.

[90] Specifically, the Produced Capital Index is a chained Törnqvist volume index with 2007 used as the base year to calculate annual levels ("chained dollar" quantities) from 1980 to 2013. See Annex 2 for further details.

[91] See Footnote 6 for details of the reliability scale used in this report.

[92] Strictly speaking, the industry in question is the mining, quarrying and oil and gas extraction Industry. The majority of capital growth in this industry is, however, related to increased investment in just the oil and gas extraction sub-industry.

Figure 10. Produced Capital Index, 1980–2013



Source: Current study.

Comprehensive Wealth

NATURAL CAPITAL AND GREEN GROWTH CASE STUDY

Indicator NC1 – Market Natural Capital Index

Theme: Natural Capital – *Market natural capital*

Geographic Scope: National

Time series: 1980–2013

Frequency: Annual

Description: The Market Natural Capital Index measures the aggregate value of real (inflation-adjusted) per capita market natural capital (commercial timber stocks, productive fossil fuel reserves, productive mineral reserves and agricultural land). It is measured in chained 2007 dollars.

Relevance to comprehensive wealth: Natural capital is one of the four components of comprehensive wealth and a main factor of production in the business sector (along with human capital and produced capital). It is a key part of the productive base upon which market output is created and therefore plays a key role in the provision of well-being enhancing market goods and services.

The Market Natural Capital Index is essential for overcoming one of the key challenges in measuring comprehensive wealth: the fact that natural assets are generally measured in physical units and that different units are used for different assets. Potash, for example, is measured in tonnes where crude oil is measured in cubic metres. As a result, their quantities cannot simply be summed, unlike produced and human capital, for which quantities are measured in dollars. Overall sustainability is difficult to assess in physical terms. For example, if the quantity of potash declines while the quantity of crude bitumen increases, is the country more or less sustainable? An aggregate index allows for the total natural asset base to be assessed and integrated with similar measures of produced and human capital to assess comprehensive wealth.

Method of calculation and data sources: The index is created by combining a Statistics Canada quantity index of fossil fuels, minerals and agricultural land[93] with estimates of commercial timber volumes compiled by the authors[94] into an annual quantity index for 1980 to 2013.[95]

Limitations: A few important market natural resources (primarily commercial fish stocks and water in hydroelectric, drinking and irrigation reservoirs) are not included in the Market Natural Capital Index due to gaps in data and methods. As a result, the value of market natural capital is somewhat underestimated by the index. There are also non-market natural assets that contribute indirectly to market production (such as forest-based insects that provide pollination services freely to farmers and aquatic ecosystems that regulate water quality and prevent floods) that could be valued and combined into a separate index of non-market natural capital.

[93] This index is an update of the one that appeared in a 2007 Statistics Canada article on natural resource wealth (Islam, 2007). The index was updated by Statistics Canada at the request of the authors of this report (Islam, personal communication).

[94] Until 2003, Statistics Canada made annual estimates of the volume of commercial timber assets in its *Physical Timber Stock Account*. Following the loss of the main data source, this account was suspended. The authors of this study extended this time series to 2013 for the purposes of compiling the Market Natural Capital Index. See Annex 3 for further details.

[95] Specifically, the Market Natural Capital Index is a chained Törnqvist quantity index with 2007 used as the base year to calculate annual levels ("chained dollar" quantities) from 1980 to 2013. See Annex 2 for further details.

Reliability: The Market Natural Capital Index is considered very reliable, with the exception of the extended estimates of commercial timber volumes compiled by the authors of this study, which can be considered only acceptable. Since timber assets make up a relatively small share of the overall index and most of the timber asset data come from an official Statistics Canada source, the index's overall reliability is rated as very reliable.[96]

Analysis: The Market Natural Capital Index fell at an average annual rate of 0.93 per cent from 1980 to 2013 indicating that Canadians drew down their stocks of natural capital substantially over the period (Figure 2). Each Canadian started out in 1980 with $39,800 thousand (chained 2007 dollars) of natural capital. By 2013, this had dropped to $29,200, a loss of more than 25 per cent.

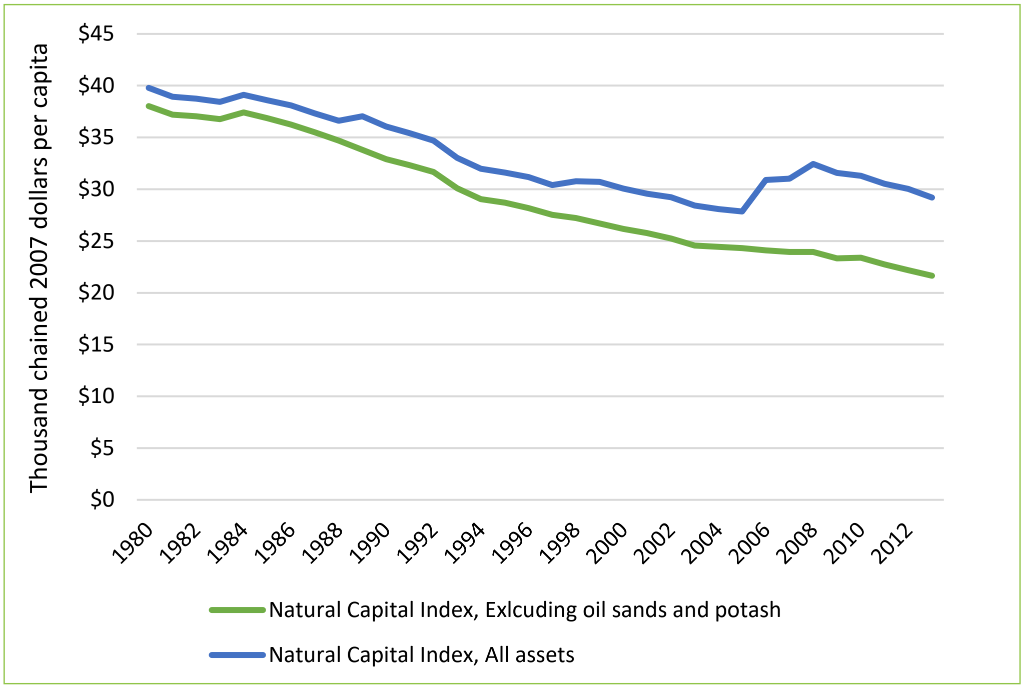
The figures in Table 14, which show the share of the 1980 physical quantities of various natural assets still remaining in 2012 (the last year for which data for all are available), help explain the trend in the Market Natural Capital Index. Of the 16 assets shown, only four expanded in absolute physical quantity between 1980 and 2012. The remaining assets all fell in size (some, like lead, silver, zinc and iron, very substantially) providing considerable downward momentum to the Market Natural Capital Index.[97]

Two of the assets that increased in size, crude bitumen (oil sands) and potash, are particularly important in Canada, as the reserves are very large and valuable. As can be seen in Figure 2, they did much to keep the value of the Market Natural Capital Index from falling even more than it did. Excluding them from the index (lower line in Figure 2), causes it to fall by 43 per cent instead of 25 per cent between 1980 and 2013.

[96] See Footnote 6 for details of the reliability scale used in this report.

[97] It is important to understand that the Market Natural Capital Index is influenced by both the physical size and value of the underlying assets, so that assets—like the oil sands—that are both very valuable and changed greatly in physical size over the period have more influence on the index's movement than those that are less valuable and changed less.

Figure 11. Market Natural Capital Index, Canada, 1980–2013



Source: Current study.

Table 14. Index of physical natural assets, 2012 (1980=100)

Recoverable uranium reserves	94.4
Proven and probable copper reserves	61.6
Proven and probable gold reserves from gold mines	260.0
Proven and probable lead reserves	1.3
Proven and probable molybdenum reserves	46.5
Proven and probable nickel reserves	32.7
Proven and probable silver reserves	16.6
Proven and probable zinc reserves	15.0
Established crude bitumen reserves	1,230.9
Established crude oil reserves	68.4
Established natural gas reserves	80.4
Established reserves of natural gas liquids	52.8
Established sulphur reserves	120.5
Proven and probable iron reserves	21.2
Proven and probable potash reserves	430.8
Commercial timber volume	86.4

Source: Authors' calculations based on Statistics Canada, *Selected Natural Resource Reserves*, CANSIM Table 153-0122.

Indicator NC2 – Forests[98]

Theme: Natural Capital – *Ecosystems*

Geographic Scope: National by province and territory

Time Series: 2000 and 2011

Frequency: Intermittent

Description: This indicator presents changes in the area of Canada's forest ecosystems at the level of provinces/territories between 2000 and 2011 and an assessment of the quality-adjusted extent of forest ecosystems in 2011 taking into consideration pressures on forest ecosystems as a result of cumulative human development of the landscape (roads, buildings, infrastructure and inhabited areas).

Relevance to comprehensive wealth: Canada has more than 3.4 million square kilometres of forest cover, amounting to about 38 per cent of its land area. Forests provide ecosystem goods services such as timber, water purification, climate stabilization and recreational/cultural experiences that contribute very significantly to Canada's wealth. They are also important habitat for various wildlife species.

Method of calculation and data sources: The estimates of forest ecosystem extent are derived from the *Land Cover Time Series* (LCTS) spatial dataset compiled by the Canada Centre for Remote Sensing (2012). This is the most current, publicly available land-cover dataset that provides complete coverage of Canada. To determine the impact of cumulative human development on forests, a spatial dataset of human land use was created by Global Forest Watch Canada (GFWC). This dataset was intersected with the LCTS to determine where forests are "developed" (that is, under pressure from immediately surrounding human land uses) and "undeveloped" (that is, far enough from any human land use to be considered free from direct human influence). Forest is considered "developed" if it is within 1 kilometre of a linear feature like a road or a pipeline or within 10 kilometres of other types of human land uses (for example, mines, dams or inhabited areas).

Limitations: This indicator has no major limitations aside from the irregularity of the underlying data required for its compilation.

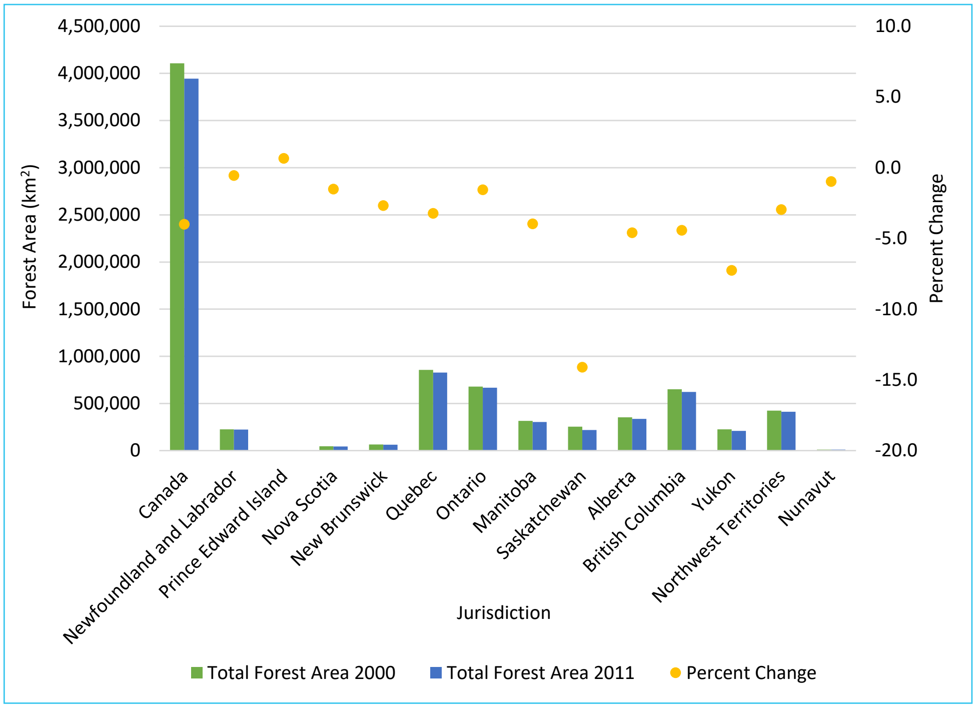
Reliability: Forests is considered reliable.[99]

Analysis: The area of forest ecosystems declined by 164,170 km^2 between 2000 and 2011 (Figure12). The most significant changes occurred in Saskatchewan, with a decrease of over 14 per cent in forest area, and the Yukon, where forest area decreased by 7 per cent. The area of land classified as "post-disturbance" (that is, burned forests and shrubland/low vegetation cover) increased from 642,650 km2 to 811,480 km^2 over the period, indicating that most of the forest loss was due to fire or pest infestations.

[98] Further details on the methods used in the compilation of the ecosystem indicators are available in Annex 5.

[99] See Footnote 6 for details of the reliability scale used in this report.

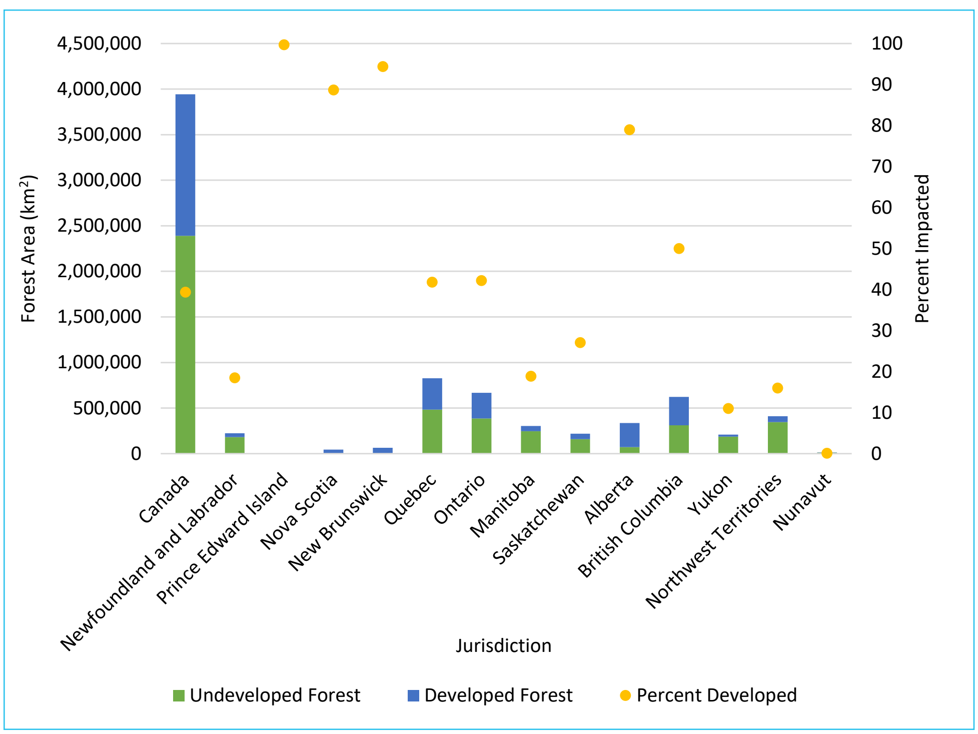
Figure 12. Forest ecosystem area and percentage change, by province/territory, 2000–2011



Source: Global Forest Watch Canada

Despite the immense area of forests in Canada, cumulative human development exerted a significant impact on the quality of forest ecosystems in 2011. Over 1.5 million km^2, or 39 per cent, of all forests were found within 1 kilometre of a linear development feature such as a road or a pipeline or within 10 kilometres of a mine, dam, inhabitation or other human land use (Figure 13). The Maritime provinces, Alberta and British Columbia all had greater than 50 per cent developed forests.

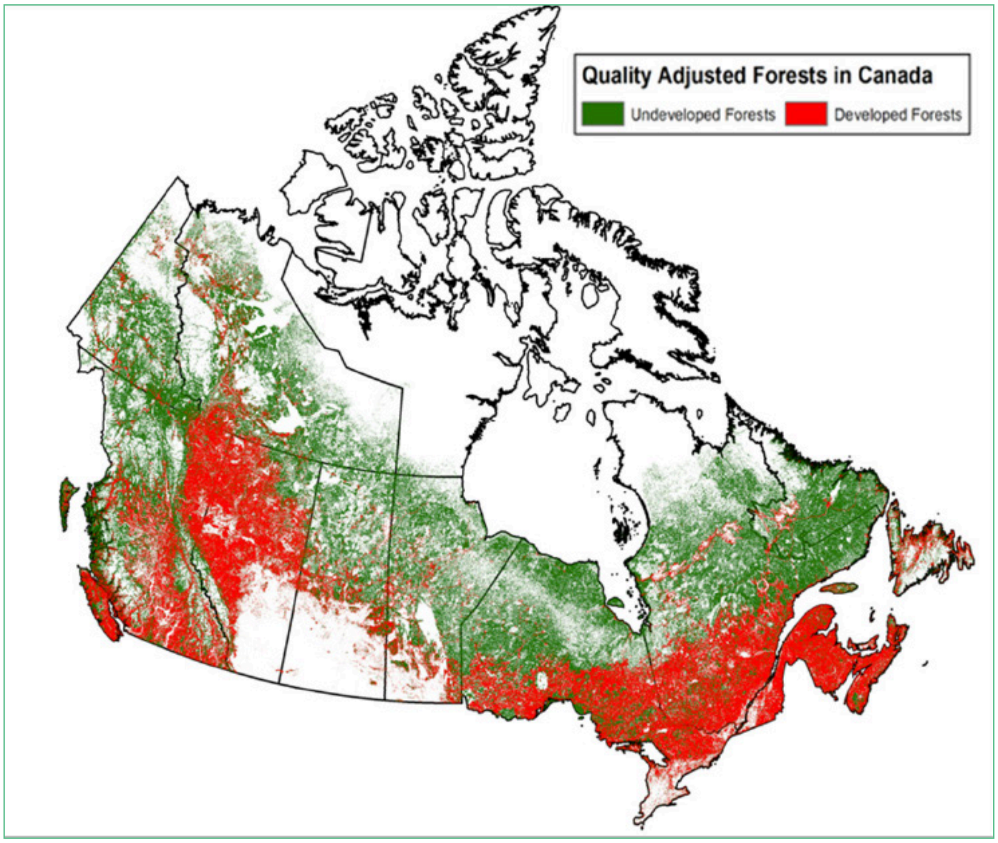
Figure 13. Quality-adjusted forest ecosystem extent, by province/territory, 2011



Source: Global Forest Watch Canada

Unsurprisingly, the least impacted (i.e., or most intact) forest ecosystems were those found in the northern portions of Canada (Map 1).

Map 1. **Quality-adjusted forest ecosystems, 2011**



Source: Global Forest Watch Canada

Indicator NC3 – Wetlands[100]

Theme: Natural Capital – *Ecosystems*

Geographic Scope: National by province and territory

Time Series: 2000 and 2011

Frequency: Intermittent

Description: This indicator presents changes in the area of Canada's wetland ecosystems at the level of provinces/territories between 2000 and 2011 and an assessment of the quality-adjusted extent of wetland ecosystems in 2011 taking into consideration pressure on wetlands as a result of cumulative human development of the landscape (roads, buildings, infrastructure and inhabited areas).

Relevance to comprehensive wealth: Wetlands cover 14 per cent of Canada's landmass. They provide essential ecosystem services such as flood regulation, water purification, carbon storage and recreational opportunities but are rapidly changing. Saskatchewan, for example, may have lost as much as 70 per cent of its wetlands since European settlement.

Method of calculation and data sources: The estimates of wetland ecosystem extent are derived from the *Land Cover Time Series* (LCTS) spatial dataset compiled by the Canada Centre for Remote Sensing (2012). This is the most current, publicly available land-cover dataset that provides complete coverage of Canada. To determine the impact of cumulative human development on wetlands, a spatial dataset of human land use was created by Global Forest Watch Canada (GFWC). This dataset was intersected with the LCTS to determine where wetlands are "developed" (that is, under pressure from immediately surrounding human land uses) and "undeveloped" (that is, far enough from any human land use to be considered free from direct human influence). Wetlands are considered "developed" if they are within 1 kilometre of a linear feature like a road or a pipeline or within 10 kilometres of other types of human land uses (for example, mines, dams or inhabited areas).

Limitations: This indicator has no major limitations aside from the irregularity of the underlying data required for its compilation.

Reliability: Wetlands is considered reliable.[101]

Analysis: Nationally, wetland area decreased by 3 per cent from 411,653 km2 in 2000 to 399,893 km^2 in 2011. Wetlands declined in area in most provinces, the exceptions being the Maritime provinces, the Yukon and Nunavut. The largest decreases in absolute terms were in Manitoba, with a loss of 2,888 km^2 (3 per cent), followed by Quebec (2,173 km^2; 6 per cent), Alberta (1,898 km^2; 5 per cent), Saskatchewan (1,809 km^2; 9 per cent) and Ontario (1,607 km^2; 1 per cent) (Figure 14).

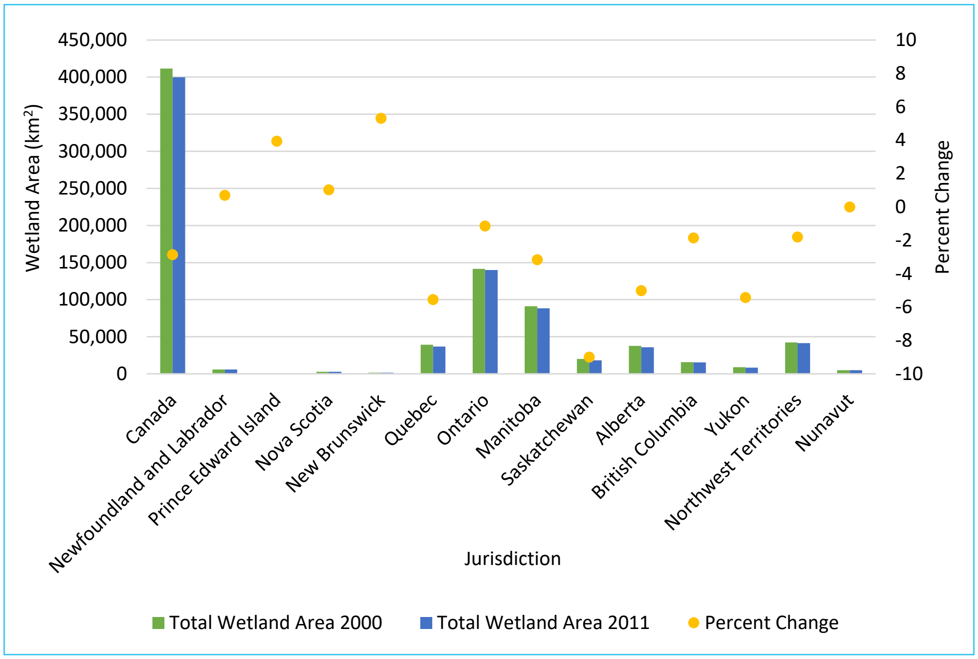
Cumulative human development exerted considerable pressure on wetlands in 2011 (Figure 15 and Map 2). Nationally, 21 per cent of all wetlands (over 85,000 km2) were found within 1 kilometre of a linear development feature such as a road or a pipeline or within 10 kilometres of a mine, dam, inhabitation or other human land use. Regionally, levels of wetland development were especially high in the Maritimes, where over 90 per cent of wetlands could be considered developed.

[100] Further details on the methods used in the compilation of the ecosystem indicators are available in Annex 5.

[101] See Footnote 6 for details of the reliability scale used in this report.

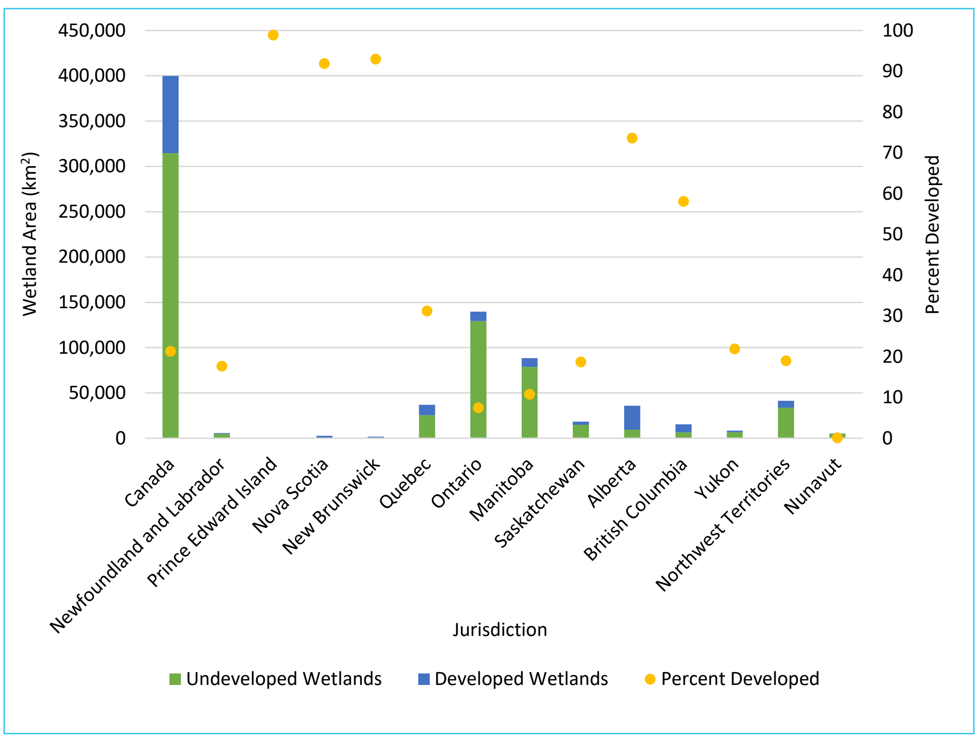
Ontario had the largest extent of wetlands in 2011 (129,840 km^2, mostly in the northern part of the province), most of which was undeveloped. Manitoba had the second greatest area (88,366 km^2), of which almost 11 per cent was affected by cumulative development.

Figure 14. Wetland ecosystem extent and percent change, by province/territory, 2000-2011



Source: Global Forest Watch Canada

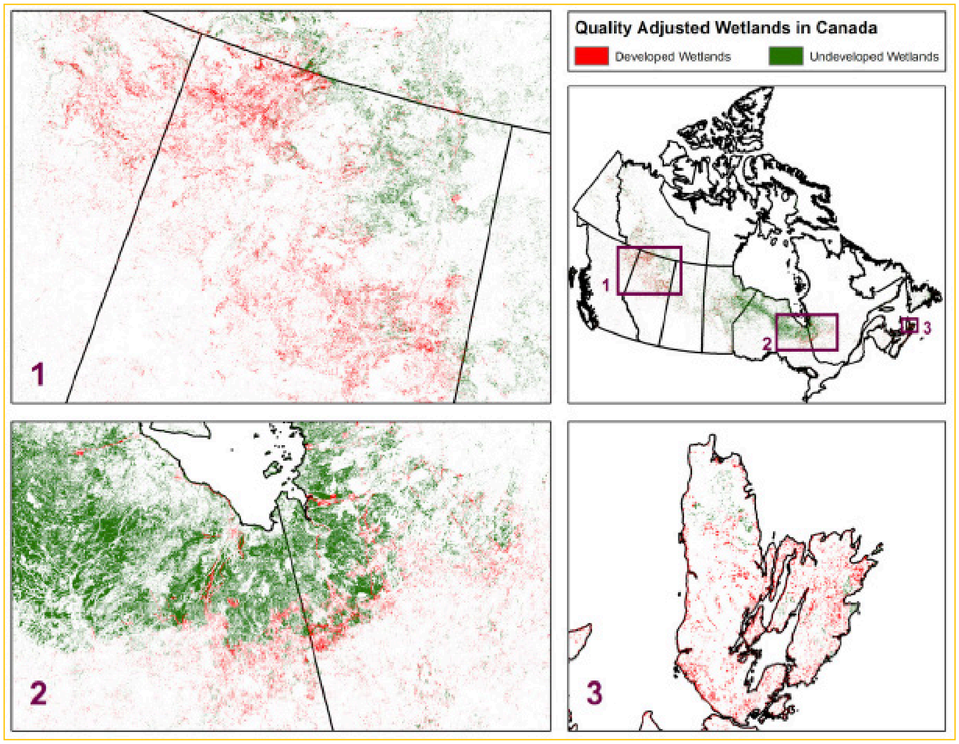
Figure 15. Quality-adjusted wetland ecosystem extent, by province/territory, 2011



Source: Global Forest Watch Canada

Alberta was unique in a number of regards. It was the only province that had a large absolute area of wetlands (35,940 km^2), a high level of development (74 per cent), and a high absolute loss (1,900 km^2). It was also the only province in which northern wetlands were highly developed. All of this reflects the impact of the dense network of linear development features (such as roads, pipelines and seismic lines) in the northern part of the province.

Map 2. **Quality-adjusted wetland ecosystems, selected regions, 2011**



Source: Global Forest Watch Canada

Indicator NC4 – Surface Freshwater[102]

Theme: Natural Capital – *Ecosystems*

Geographic Scope: National by province and territory

Time Series: 2011

Frequency: Intermittent

Description: This indicator presents an assessment of the quality-adjusted extent of surface freshwater ecosystems in 2011 taking into consideration pressure on lakes and rivers as a result of cumulative human development of the landscape (roads, buildings, infrastructure and inhabited areas).

Relevance to comprehensive wealth: Canada has 8,500 named rivers and more lake area than any other country in the world. These lakes and rivers are the source of many ecosystem goods and services that contribute greatly to comprehensive wealth: fresh water for drinking, industrial use and hydropower production; fish for subsistence and recreation; flood control; and cultural benefits.

Method of calculation and data sources: To determine the impact of cumulative human development on lakes and rivers, a spatial dataset of human land use was created by Global Forest Watch Canada (GFWC). This dataset was intersected with the hydrographic boundaries to determine where lakes and rivers are “developed” (that is, under pressure from immediately surrounding human land uses) and “undeveloped” (that is, far enough from any human land use to be considered free from direct human influence). Lakes and rivers are considered “developed” if they are within 1 kilometre of a linear feature like a road or a pipeline or within 10 kilometres of other types of human land uses (for example, mines, dams or inhabited areas).

Limitations: This indicator has no major limitations aside from the irregularity of the underlying data required for its compilation.

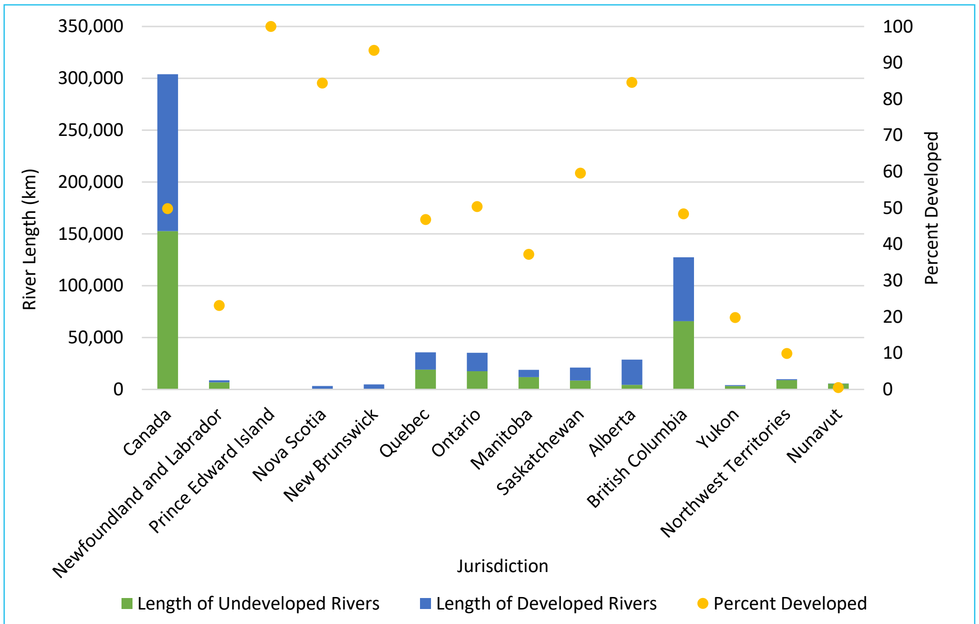
Reliability: Surface Freshwater is considered reliable.[103]

Analysis: In terms of cumulative development, rivers in the Maritimes and Alberta were the most highly developed in 2011. Over 80 per cent of rivers (by length) were developed in these regions (Figure 16).

[102] Further details on the methods used in the compilation of the ecosystem indicators are available in Annex 5.

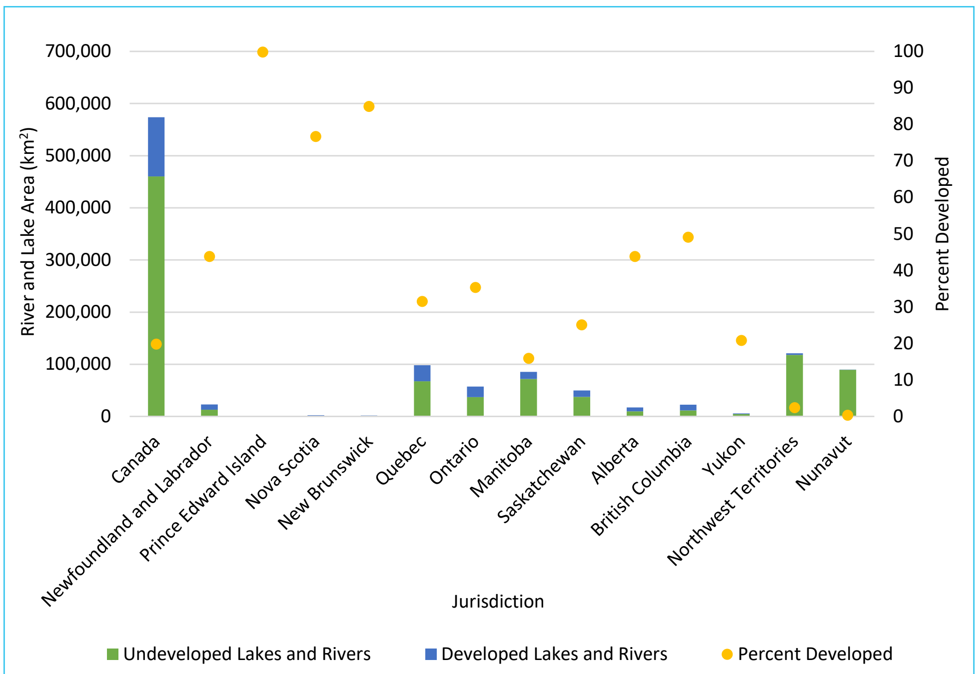
[103] See Footnote 6 on for details of the reliability scale used in this report.

Figure 16. Quality-adjusted river length, provinces and territories, 2011



Source: Global Forest Watch Canada

Figure 17. Quality-adjusted surface water extent, provinces and territories, 2011



Source: Global Forest Watch Canada

Development of overall surface water area (Figure 17) was greatest in the Maritimes (over 70 per cent). It was also high in Alberta, British Columbia and Newfoundland and Labrador.

Indicator NC5 – Grasslands[104]

Theme: *Natural Capital* – Ecosystems

Geographic Scope: National by province and territory

Time Series: 2000 and 2011

Frequency: Intermittent

Description: This indicator presents changes in the extent of Canada's grassland ecosystems at the level of provinces/territories between 2000 and 2011, and an assessment of the quality-adjusted extent of grassland ecosystems in 2011 taking into consideration pressure on grasslands as a result of cumulative human development of the landscape (roads, buildings, infrastructure and inhabited areas).

Relevance to comprehensive wealth: Grasslands are the ecosystems are under the greatest pressure from development in Canada. Their extent has diminished considerably since European settlement, with 70 per cent of prairie grasslands (Federal, Provincial and Territorial Governments of Canada, 2010) and 97 per cent of southern Ontario grasslands (Ontario Tallgrass Prairie and Savanna Association, 2004) having disappeared in the past two hundred years. They cover only 0.5 per cent of Canada today and the vast majority of those remaining are impacted by development. They contribute to wealth through the provision of important cultural and recreational benefits, genetic diversity and increasingly rare habitat for plants and wildlife.

Method of calculation and data sources: The estimates of grassland ecosystem extent are derived from the *Land Cover Time Series* (LCTS) spatial dataset compiled by the Canada Centre for Remote Sensing (2012). This is the most current, publicly available land-cover dataset that provides complete coverage of Canada. To determine the impact of cumulative human development on grasslands, a spatial dataset of human land use was created by Global Forest Watch Canada (GFWC). This dataset was intersected with the LCTS to determine where grasslands are "developed" (that is, under pressure from immediately surrounding human land uses) and "undeveloped" (that is, far enough from any human land use to be considered free from direct human influence). Grasslands are considered "developed" if they are within 1 kilometre of a linear feature like a road or a pipeline or within 10 kilometres of other types of human land uses (for example, mines, dams or inhabited areas).

Limitations: This indicator has no major limitations aside from the irregularity of the underlying data required for its compilation.

Reliability: Grasslands is considered reliable.[105]

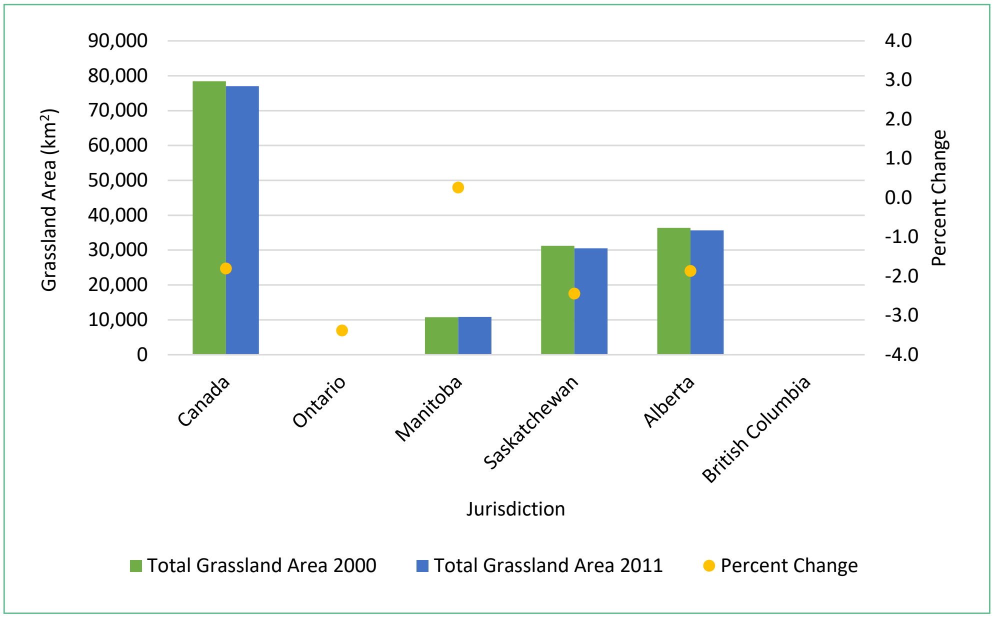
Analysis: Between 2000 and 2011, Canada lost 1,410 km^2 of its remaining grasslands (2 per cent). Alberta, Manitoba, Saskatchewan, British Columbia and Ontario are the only provinces where grassland ecosystems are found, with the vast majority located in Alberta, Saskatchewan and Manitoba. The greatest decrease was in Saskatchewan, which lost 764 km^2 over the period (Figure 18).

Cumulative human development exerted very significant pressure on the grassland ecosystems in 2011. Grasslands in both Alberta and Manitoba were nearly 95 per cent developed and those in Saskatchewan were over 77 per cent developed (Figure 19 and Map 3).

104 Further details on the methods used in the compilation of the ecosystem indicators are available in Annex 5.

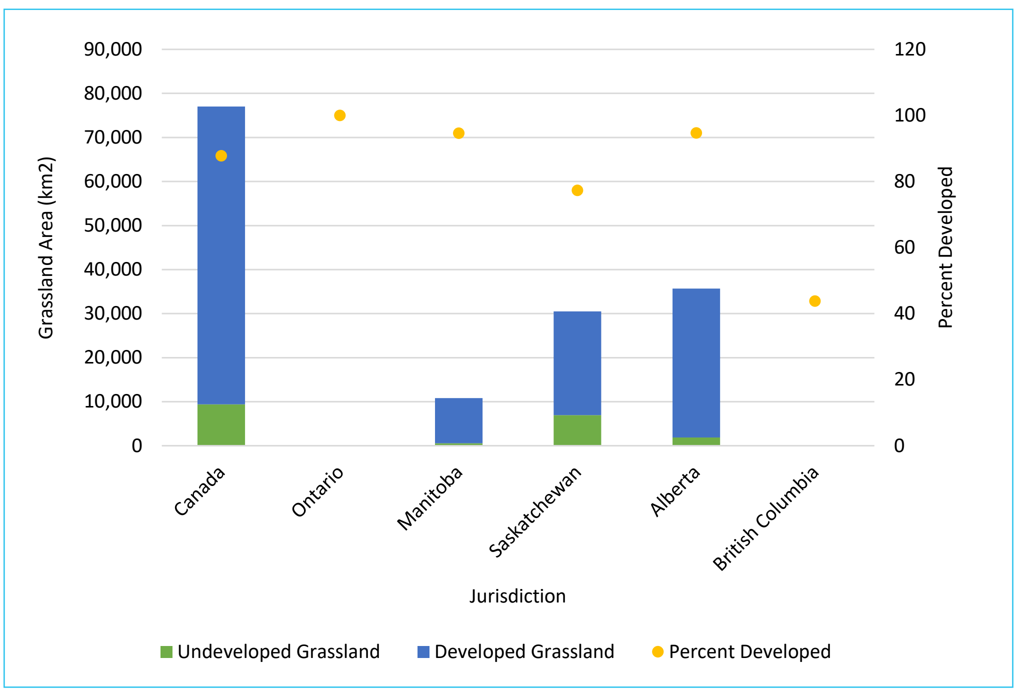
105 See Footnote 6 for details of the reliability scale used in this report.

Figure 18. Grassland ecosystem extent and percent change, Canada and provinces, 2000–2011



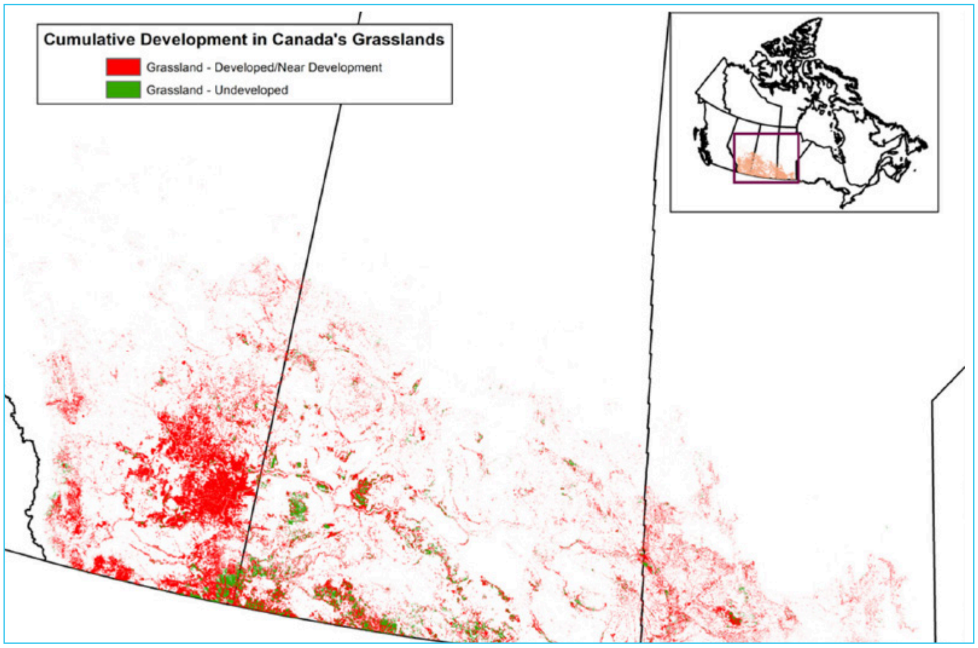
Source: Global Forest Watch Canada

Figure 19. Quality-adjusted grassland ecosystem extent, Canada and provinces, 2011



Source: Global Forest Watch Canada

Map 3. **Quality-adjusted grassland ecosystems, southern Prairies, 2011**



Source: Global Forest Watch Canada

Indicator NC6 – Precipitation

Theme: Natural Capital – *Climate*

Geographic scope: National, regional

Time series: 1948 to 2014

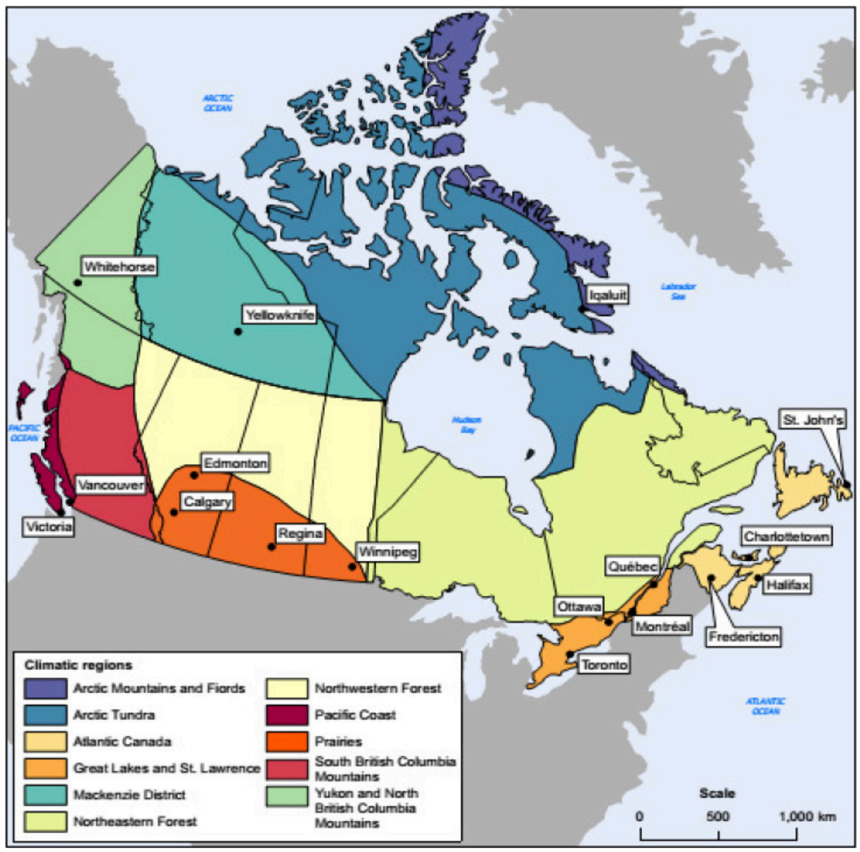
Frequency: Annual

Description: This indicator presents an annual time series of precipitation departures from normal over the period 1948 to 2014 for 11 climatic regions and at the national level. The 11 climatic regions are presented in Figure 20. Climatic Regions of Canada (Environment Canada, 2015). These same climatic regions are used in Indicator NC7 – *Temperature*. The indicator presents the annual departure from the precipitation "normal" for the period 1961 to 1990. [106]

Relevance to comprehensive wealth: Precipitation is an important indicator of climatic conditions and is considered an essential climate variable by the World Meteorological Organization-Global Climate Observing System. The United Nations Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC) also use precipitation in their work.

Changing precipitation patterns affect water levels and can change the timing of peak stream flows. Increased precipitation can result in increased flooding and soil loss. Decreased precipitation can threaten drinking water supply and result in droughts. Changes in precipitation have a particularly large impact on agricultural land and productivity, as both droughts and flooding result in crop losses.

Figure 20. Climatic Regions of Canada



Source: Fritzsche, 2011a

Method of calculation and data sources: The indicator is based on a method developed by Statistics Canada (Fritzsche, 2011a). Precipitation departure data are taken from the *Climate Trends and Variations Bulletin* produced by Environment Canada, which is, in turn, based on the Adjusted and Homogenized Canadian Climate Database (AHCCD). The AHCCD combines data from 470 stations across the country. Precipitation departures are calculated by subtracting the normal value for 1961 to 1990 from the annual value at each station. Values from the stations are interpolated to evenly spaced 50 km grid boxes, which are then averaged within each climatic region and the country as a whole (Environment Canada, n.d.).

[106] A precipitation normal is defined as the average annual precipitation over a given 30-year period for a given region.

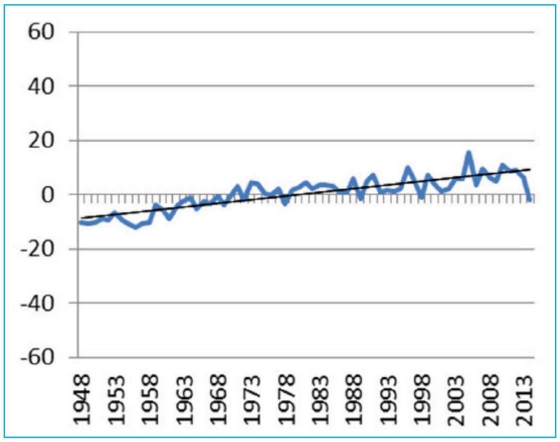
Limitations: As the data are presented as percentage departures from normal, they must be interpreted carefully. The same percentage departure in different climatic regions can represent a very different absolute change in precipitation, particularly in the North, where there are lower levels of precipitation.

Precipitation varies significantly annually. As a result, trends in precipitation are sensitive to start and end periods of analysis.

Reliability: Precipitation is considered very reliable.[107]

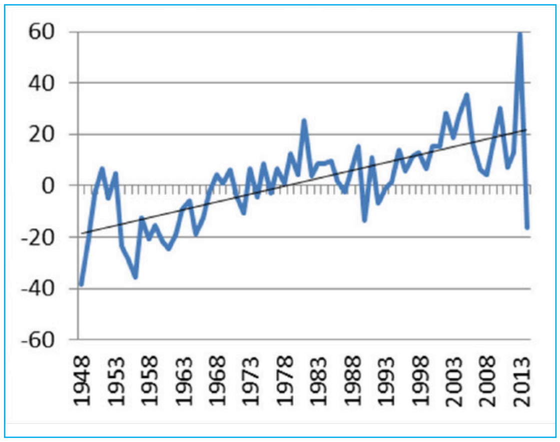
Analysis: There has been an upward trend in precipitation at the national level, although there is a high degree of variability year to year (Figure 21). Compared to the 1961 to 1990 average, there has been a shift from drier to wetter between 1948 and 2014, with the trend increasing 18 per cent over that period. The wettest year took place in 2005, at 15.6 per cent above average. The driest year was 1956, at 12.2 per cent below average. The precipitation departure was 2.2 per cent below average in 2014.

Figure 21. Precipitation departure from 1961–1990 normal (percent), Canada, 1948–2014



Source: Fritzsche, 2011a

Figure 22. Precipitation departure from 1961–1990 normal (percent), Arctic Mountains and Fiords region, 1948-2014



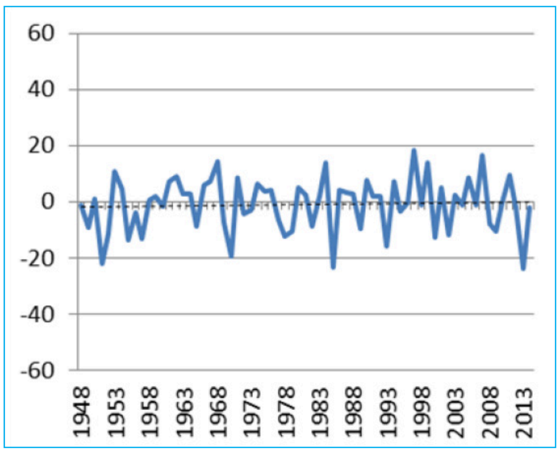
Source: Fritzsche, 2011a

The majority of Canada's climatic regions show an upward trend in precipitation departures from 1948 to 2014. This is particularly true in the northern regions of the country. The greatest increase was in the Arctic Mountains and Fiords region, where the trend increased by 40 per cent from 1948 to 2014 (Figure 22).

Not all regions showed significant trends, particularly the Pacific Coast (Figure 23).

No climatic region in Canada showed a downward trend in precipitation departure from normal.

Figure 23. Precipitation departure from 1961–1990 normal (percent), Pacific Coast region, 1948–2014



Source: Fritzsche, 2011a

[107] See Footnote 6 for details of the reliability scale used in this report.

Indicator NC7 –Temperature

Theme: Natural Capital – *Climate*

Geographic scope: National, regional

Time series: 1948 to 2014

Frequency: Annual

Description: This indicator presents an annual time series of temperature departures from normal over the period 1948 to 2014 for 11 climatic regions and at the national level. The 11 climatic regions are presented in Figure 20 on Figure 20. Climatic Regions of Canada (Environmet Canada, 2015). These same climatic regions are used in Indicator NC6 – Precipitation. The indicator presents the annual departure from the temperature "normal" for the period 1961 to 1990.[108]

Relevance to comprehensive wealth: Surface air temperature is an important indicator of climatic conditions and is considered an essential climate variable by the World Meteorological Organization-Global Climate Observing System. The United Nations Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC) also use surface air temperature in their work.

Air temperature is a primary important indicator of global climate change. Changes in climate and temperature have a long-term impact on stocks of natural capital including the value and productivity of agricultural land, the extent of forest and timber stocks, the functioning of ecosystems and the availability of ecosystem services.

Method of calculation and data sources: The indicator is based on a method developed by Statistics Canada (Fritzsche, 2011a). Precipitation departure data are taken from the *Climate Trends and Variations Bulletin* produced by Environment Canada, which is, in turn, based on the *Adjusted and Homogenized Canadian Climate Database* (AHCCD). The AHCCD combines data from 470 stations across the country. Precipitation departures are calculated by subtracting the normal value for 1961 to 1990 from the annual value at each station. Values from the stations are interpolated to evenly spaced 50 km grid boxes, which are then averaged within each climatic region and the country as a whole (Environment Canada, n.d.).

Limitations: Average temperatures undergo substantial fluctuations year to year, and over decades. As a result, trends based on short time periods are more sensitive to beginning and end dates, which may be affected by phenomena such as El Niño (IPCC, 2014).

Reliability: Temperature is considered very reliable.[109]

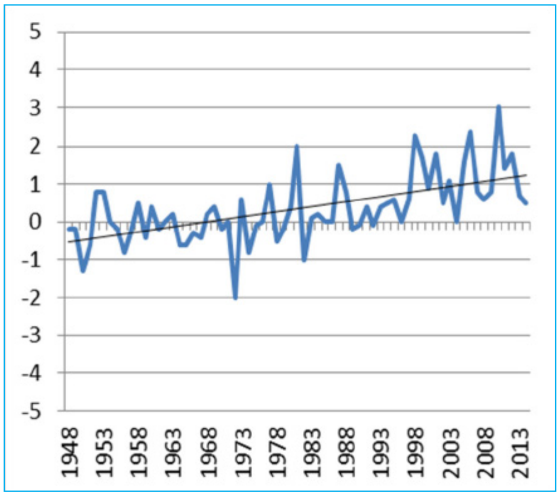
Analysis: Though there was a high degree of variability year to year, a clear upward trend in temperature can be seen at the national level from 1948 to 2014. Compared to the 1961–1990 normal, the trend in average temperatures across the country increased by 1.8 degrees Celsius (Figure 24). The warmest year was 2010 (3 degrees Celsius above the normal) and the coldest year was 1972 (2 degrees Celsius below the normal). The temperature departure was 0.5 degrees Celsius above average in 2014.

[108] A temperature normal is defined as the average annual temperature over a given 30-year period for a given region.

[109] See Footnote 6 for details of the reliability scale used in this report.

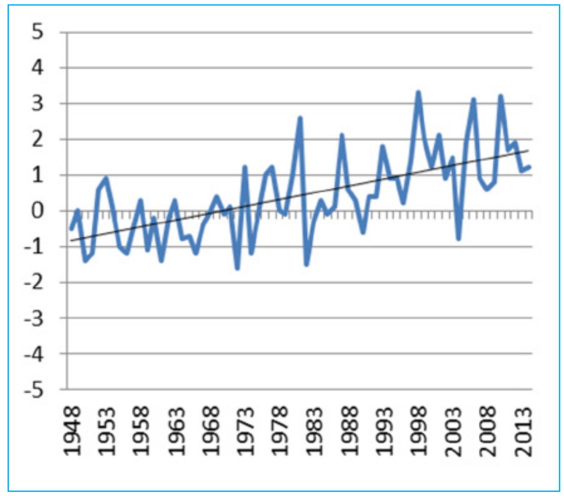
All climatic regions in Canada showed an upward trend, with the largest increase happening in the North. The trend in the Mackenzie District increased 2.5 degrees Celsius over the period (Figure 25). The smallest increase took place in Atlantic Canada, where the trend increased 0.9 degrees Celsius (Figure 26).

Figure 24. Temperature departure from 1961–1990 normal (degrees Celsius), Canada, 1948–2014



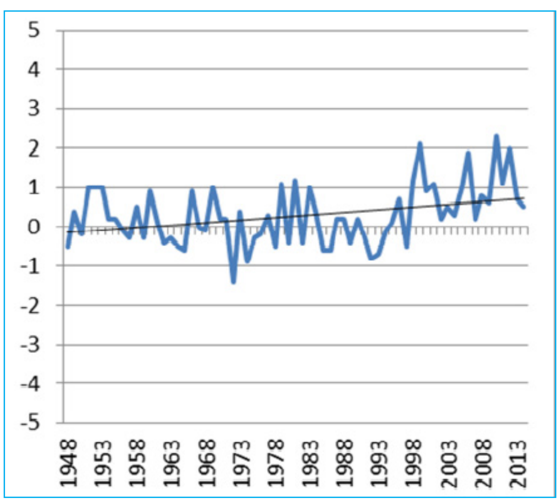
Source: Fritzsche, 2011a

Figure 25. Temperature departure from 1961–1990 normal (degrees Celsius), Mackenzie District, 1948–2014



Source: Fritzsche, 2011a

Figure 26. Temperature departure from 1961–1990 normal (degrees Celsius), Atlantic Canada, 1948–2014



Source: Fritzsche, 2011a

Indicator NC8 – Snow Cover

Theme: Natural Capital – *Climate*

Geographic scope: National

Time series: 1972 to 2010

Frequency: Annual

Description: This indicator presents an annual series of estimates of the average area covered by snow at the national level from 1972 to 2010. Snow cover extent is examined annually and for the months of October and November—the period that marks the onset and expansion of snow cover for much of Canada—and April, May and June—the spring snow melt period.

Relevance to comprehensive wealth: Snow cover is an important indicator of climatic conditions and is considered an essential climate variable by the World Meteorological Organization-Global Climate Observing System. The United Nations Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC) also use snow cover extent in their work.

Method of calculation and data sources: Data for snow cover were derived from the National Oceanic and Atmospheric Administration's Climate Data Record Northern Hemisphere gridded weekly snow chart dataset. These data are based on analysis of satellite imagery. The data were collected and analyzed by Statistics Canada (Henry, 2012).

Limitations: As with precipitation (Indicator NC6) and temperature (Indicator NC7), the extent of snow cover is highly variable from year to year. As a result, trends in snow cover are sensitive to start and end dates.

Snow cover data have not been updated since 2010.

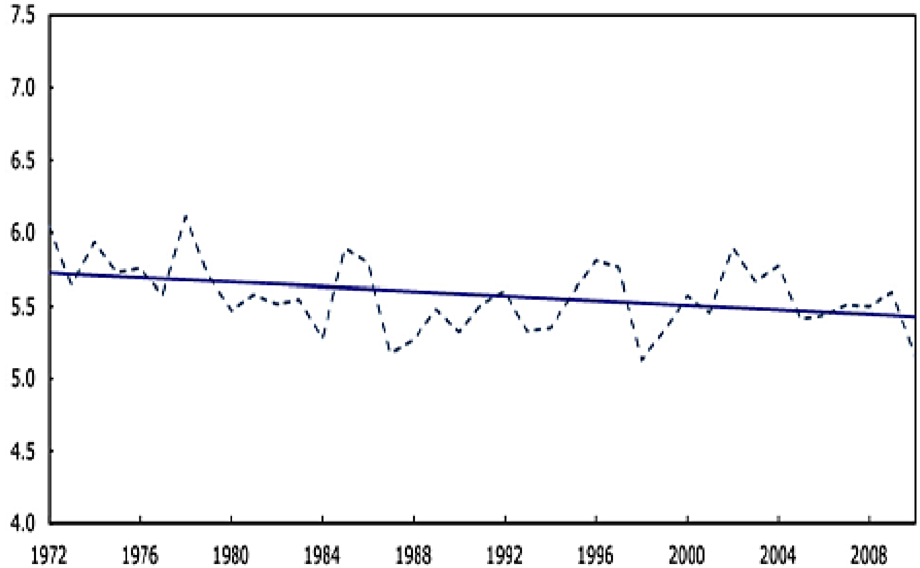
Reliability: Snow Cover is considered very reliable.[110]

Analysis: Though precipitation overall increased in recent decades (Indicator NC6), particularly in the North where snow cover is more persistent, this increase did not result in greater snow cover extent. The average annual snow-covered area in Canada fell by 5.1 per cent between 1972 and 2010 (Figure 27). The minimum extent of snow cover was about 5.2 million square kilometres and the maximum was about 6.2 million square kilometres. The fact that snow cover extent declined at the same time as precipitation increased is consistent with the increased temperatures witnessed over the period (Indicator NC7).

Snow cover extent during the fall onset period did not change significantly over the time period, with average extent in the months of October and November showing no upward or downward trend. However, snow cover extent during the period of the spring melt showed a significant downward decline (Figure 28).

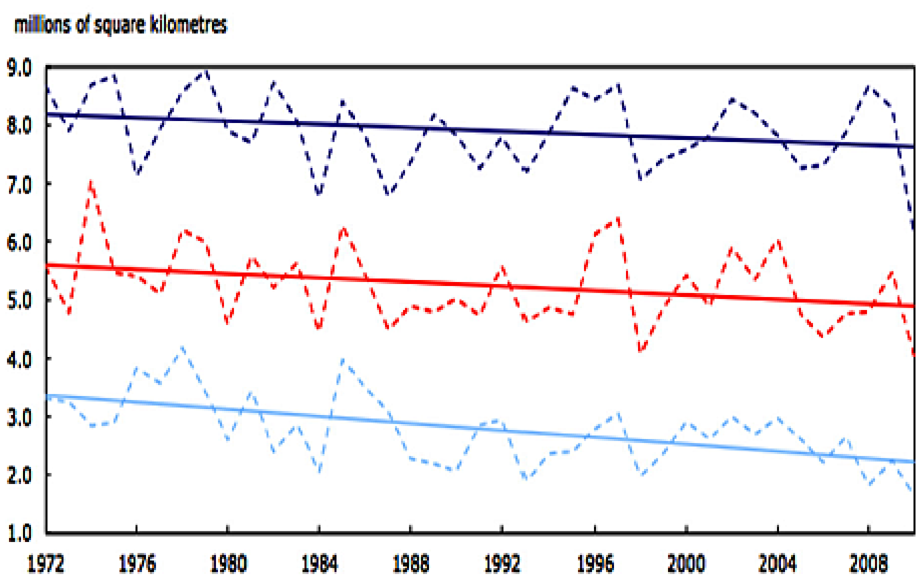
[110] See Footnote 6 for details of the reliability scale used in this report.

Figure 27. Trend in average annual snow cover, Canada (million square kilometres), 1972–2010



Source: Henry, 2012

Figure 28. Trend in average snow cover during the melt period, Canada (million square kilometres), 1972–2010



Source: Henry, 2012

Indicator NC9 – Glacier Mass

Theme: Natural Capital – *Climate*

Geographic Scope: Regional

Time series: 1960 to 2007

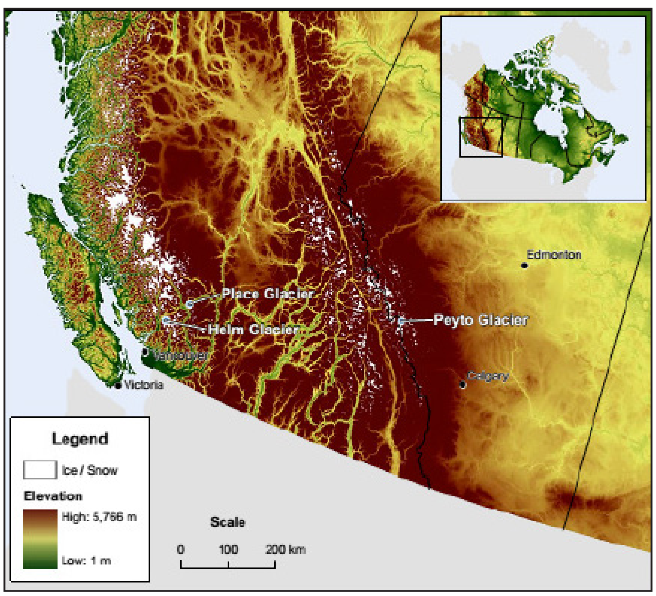
Frequency: Annual

Description: This indicator presents changes to the cumulative mass balance of six glaciers in Western Canada over the period of 1960 to 2007. Glacier mass increases through the accumulation of snow and ice throughout the winter. Mass decreases due to melting, evaporation, calving (breaking off of icebergs) and sublimation in the spring and summer.

Glacier mass balance measures the net result of mass increase and decrease over the course of a year. If a glacier gains more mass than it loses in a year, it has a positive mass balance. Cumulative mass balance sums mass balance over time, indicating the trend in glacier mass.

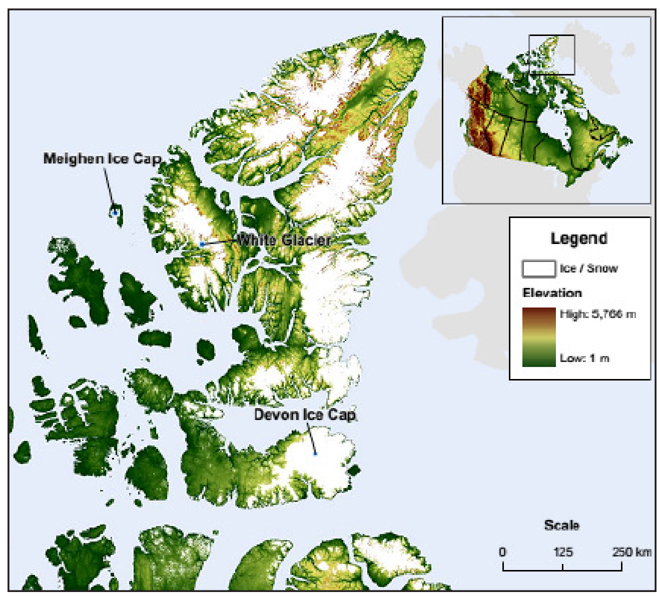
Cumulative mass balance is measured for six glaciers in two regions. The Helm, Peyto and Place glaciers are located in the Western Cordillera (Figure 29). The Devon Ice Cap, Meighen Ice Cap and White Glacier are located in the High Arctic (Figure 30).

Figure 29. Western Cordillera glaciers



Source: Fritzsche, 2010.

Figure 30. High Arctic glaciers



Source: Fritzsche, 2010.

Relevance to comprehensive wealth: Glacier mass balance is an important indicator of climatic conditions and is considered an essential climate variable by the World Meteorological Organization-Global Climate Observing System.

Glacier mass loss is expected to be a primary cause of climate change-related sea level rise, which threatens coastal cities and resources (IPCC, 2014). Glaciers are also an important source of fresh water during the summer months in parts of the country, particularly the Rocky Mountains and Prairies. Loss of glacier mass threatens water yield in these areas (Indicator NC10).

Method of calculation and data sources: The data for glacier mass balance are derived from the Climate Change Geoscience Program at Natural Resources Canada's Earth Science Sector. Monitoring of glaciers in Canada is undertaken by a number of government departments and universities. Data for each glacier varies in duration. The data were collected and analyzed by Statistics Canada (Fritzsche, 2010).

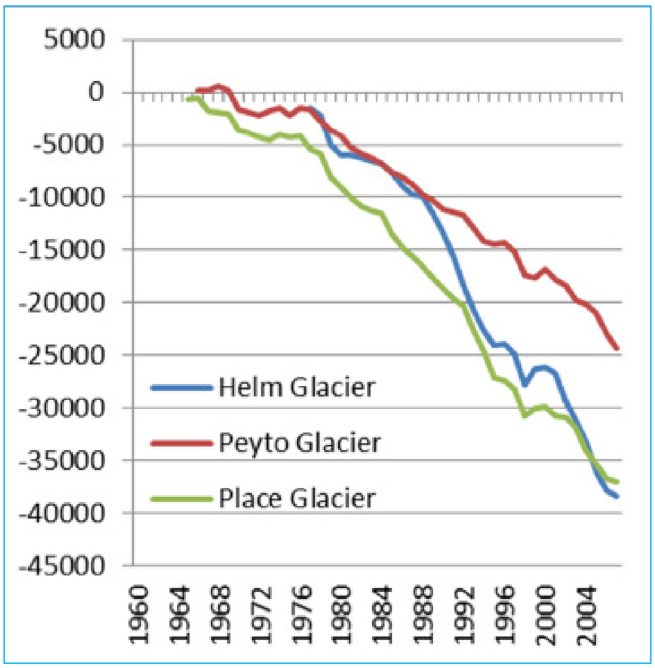
Limitations: While the six glaciers analyzed for this indicator are intended to be representative, they represent only a small portion of the total glacier coverage in Canada.

The data are updated intermittently.

Reliability: Glacier Mass is considered reliable.[111]

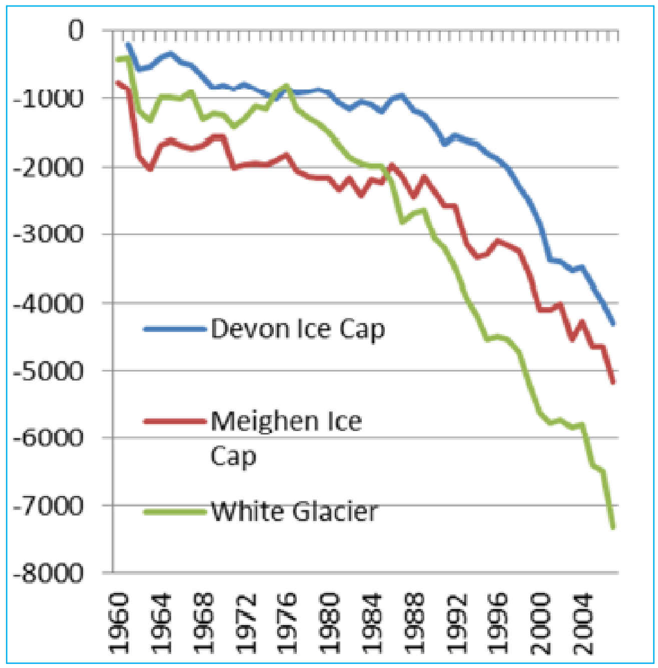
Analysis: All six glaciers experienced mass losses from 1960 to 2007. Those in the Western Cordillera (Figure 31) experienced a significantly higher rate of loss than those in the High Arctic (Figure 32).

Figure 31. Glacier cumulative mass balance, Western Cordillera (equivalent millimetres of water), 1960–2010



Source: Fritzsche, 2010.

Figure 32. Glacier cumulative mass balance, High Arctic (equivalent millimetres of water), 1960–2010



Source: Fritzsche, 2010.

[111] See Footnote 6 for details of the reliability scale used in this report.

Indicator NC10 – Water Yield

Theme: Natural Capital – *Climate*

Geographic scope: National, regional

Time series: 1971 to 2004[112]

Frequency: Annual

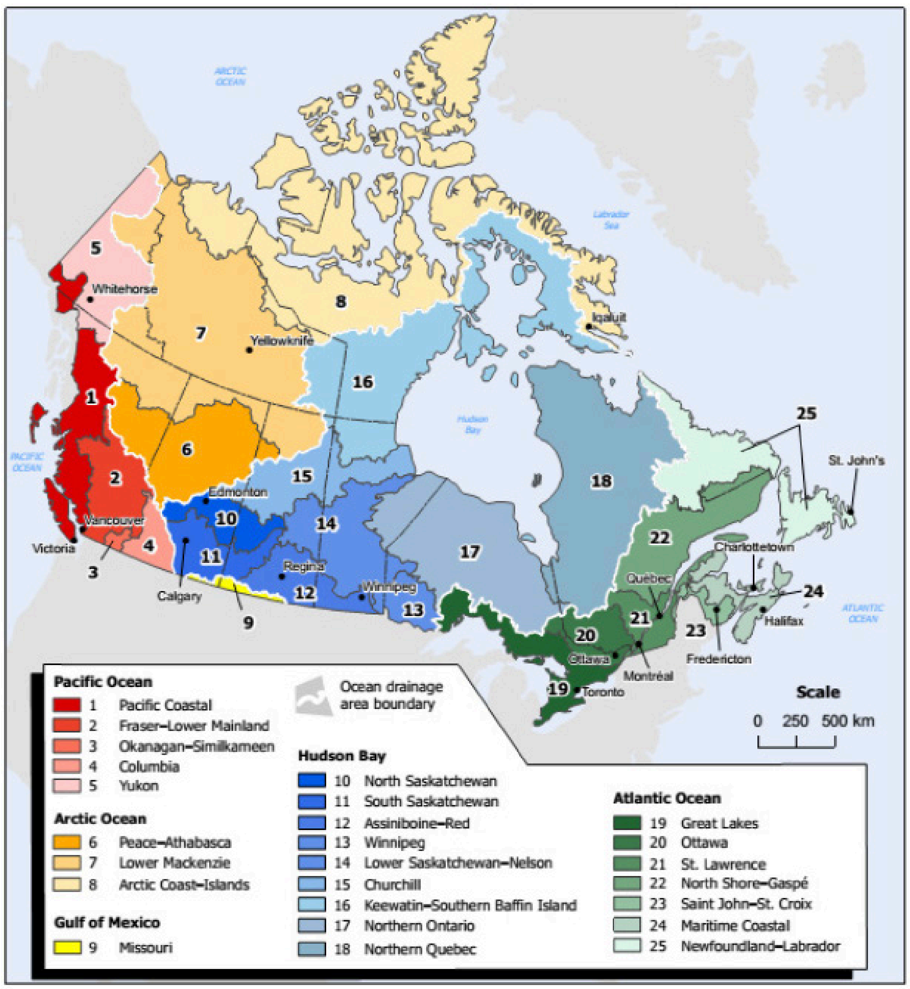
Description: This indicator presents estimates of water yield for Canada for the country as a whole and 25 drainage areas (Figure 33) from 1971 to 2004. Water yield is a measure of water renewal derived by monitoring flows of surface water in Canada's rivers and streams. Surface flows are a combination of flows originating from groundwater, precipitation and melting snow and ice (Bemrose, Kemp, Henry, & Soulard, 2009).

Relevance to comprehensive wealth: For water use to be sustainable, consumption of water from surface and groundwater must not exceed the amount of water returned to the environment by natural sources. Estimates of water yield provide an approximation of water renewal.

Estimates of water yield at the national level are important for understanding sustainability, but water yield varies considerably between regions. Regional water use needs to be assessed accordingly.

Measuring water yield is important not only because consumption patterns change, but also because renewal patterns are changing. Precipitation, snow cover and glacier mass all impact water yield (see indicators NC6, NC8 and NC9).

Figure 33. Drainage areas of Canada



Source: Fritzsche, 2011a

[112] Beginning in 2016, Statistics Canada will compile this indicator on an annual basis.

Method of calculation and data sources: The indicator is based on a method developed at Statistics Canada (Bemrose et al., 2009). Water yield is estimated using a database of natural streamflow observations from the HYDAT database operated by Environment Canada. Streamflow values are converted to runoff depths and spatially interpolated to account for areas without direct measurement. The spatial estimates are scaled to create a national estimate of water yield as a 30-year average.

Limitations: Water yield is not a perfect measure of water renewability because some surface flow originates from non-renewable sources, specifically from the melting of glaciers that are declining in mass over time (Indicator NC9).

Reliability: Water Yield is considered reliable.[113]

Analysis: The average annual water yield in Canada from 1971 to 2004 was 3,472.3 cubic kilometres (Table 15). However, water yield is not eveyounly distributed across the country. The Pacific Coastal drainage area had the highest average annual yield. The Prairies had the lowest yields, with the Missouri drainage area in Southern Alberta and Saskatchewan having the lowest average annual yield.

Table 15. Average annual water yield 1971–2004, selected drainage areas

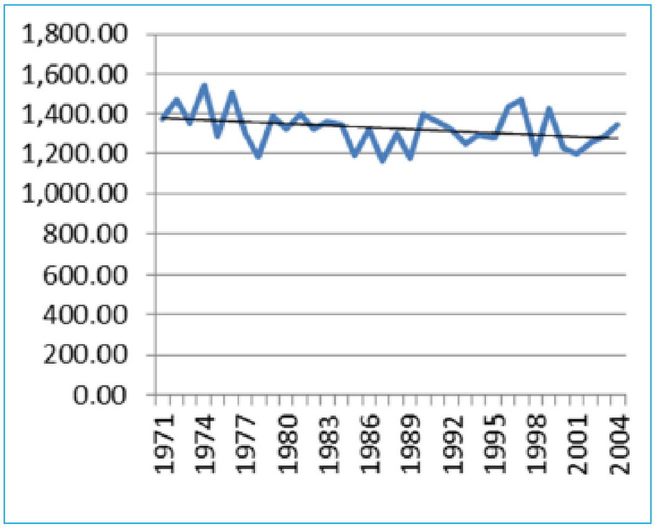
Drainage area	Volume (km^3)	Volume per unit area (m^3 per m^2)
Canada	3,472.3	0.348
Pacific Coastal	513.7	1.536
Okanagan-Similkameen	4.2	0.270
Missouri	0.5	0.019
Assiniboine-Red	6.9	0.036
Northern Quebec	516.3	0.549
Ottawa	62.6	0.428
St. Lawrence	71.3	0.600
Newfoundland-Labrador	325.4	0.856

Source: Statistics Canada, 2010.

113 See Footnote 6 for details of the reliability scale used in this report.

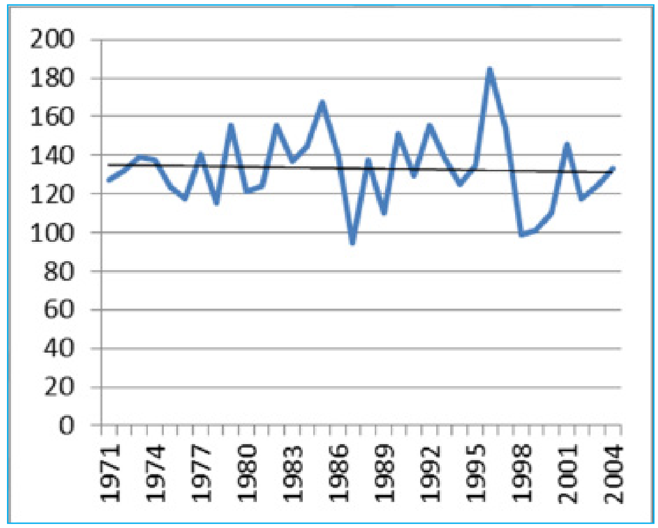
The southern portion of the country accounts for only 38 per cent of the total water yield even though the vast majority of the country's population lives there. Water yield in the south declined by about 102 km^3, or 7 per cent, between 1971 and 2004 (Figure 34). Average annual water yield, Southern Canada (cubic kilometres) – 1971–2004). The trend in the most densely populated drainage area in Canada—the Great Lakes—was also slightly downward (Figure 35).

Figure 34. Average annual water yield, Southern Canada (cubic kilometres), 1971–2004



Source: Statistics Canada, 2010

Figure 35. Average annual water yield, Great Lakes drainage area (cubic kilometres), 1971–2004



Source: Statistics Canada, 2010

Indicator NC11 – Sea Ice Extent 118

Theme: Natural Capital – *Climate*

Geographic scope: National

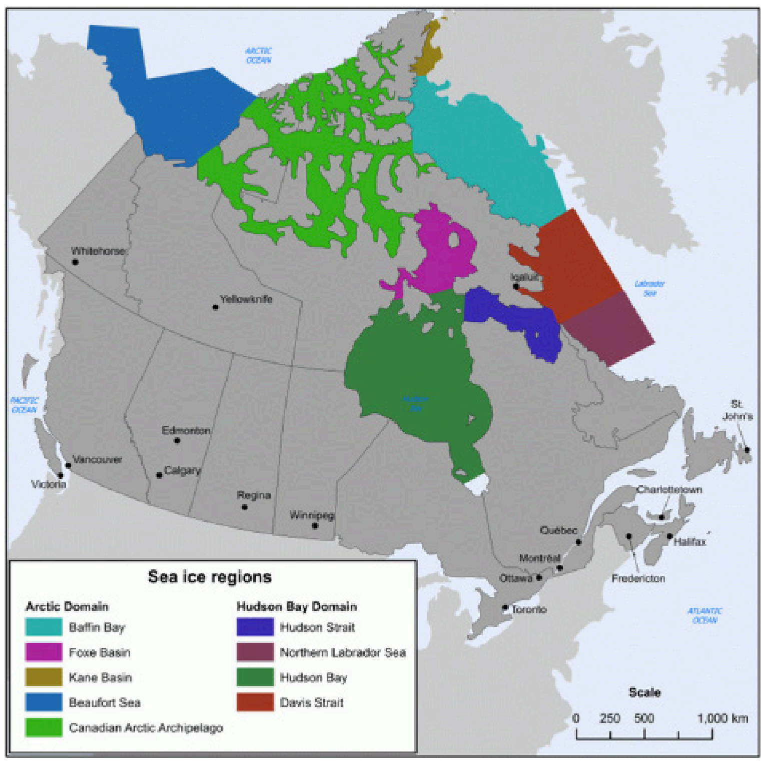
Time series: 1968 to 2010

Frequency: Annual

Description: This indicator presents data on the average area covered by sea ice during the summer. Total ice cover is the area covered by all sea ice. Multi-year ice cover is the area covered by ice that has persisted for at least one summer. The trend for total ice cover is presented for nine sea ice regions and three shipping route regions. The trend for multi-year ice cover is presented for five sea ice regions and two shipping route regions. The average area covered by sea ice is expressed in square kilometres—the rate of change is expressed as the absolute change in sea ice coverage per decade and as a percentage relative to the first year of the time series (1968). The rate of change is based on the overall decline in the linear trend.

The nine sea ice regions are spread across two domains (Figure 36). The Southern Beaufort Sea, Kane, Canadian Arctic Archipelago, Foxe and Baffin Bay regions are in the Arctic domain. The Northern Labrador Sea, Davis Strait, Hudson Strait and Hudson Bay regions are in the Hudson Bay domain.

Figure 36. Sea ice regions



Source: Henry, 2011.

Relevance to comprehensive wealth: Sea ice extent is an important indicator of climatic conditions and is considered an essential climate variable by the World Meteorological Organization-Global Climate Observing System. The United Nations Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC) also use sea ice extent in their work (Henry, 2011).

Sea ice covers a substantial part of the Earth's surface and plays a major role in global climate regulation. Snow-covered sea ice is relatively reflective, reflecting sun light and the heat it contains back into space. Dark ocean water, on the other hand, absorbs much more of the sun's incoming energy. Reduced summer sea ice may therefore contribute to global warming (Natural Resources Canada, n.d.a).

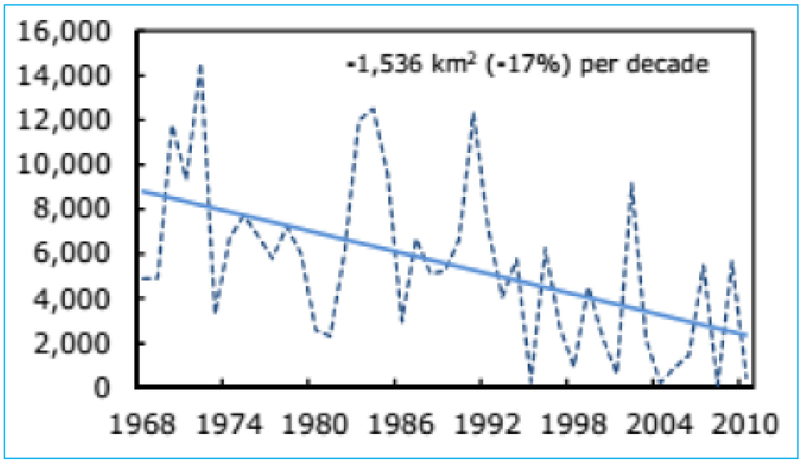
Method of calculation and data sources: Data for this indicator were derived from weekly sea ice charts produced by the Canadian Ice Service, using a combination of aerial surveys, surface observations, airborne and ship reports and satellite data. The data were compiled into a time series by the Climate Processes Section of the Climate Research Division at Environment Canada (Henry, 2011).

Limitations: This indicator has no major limitations aside from the irregularity of its updating. The underlying sea ice extent data required for its compilation are compiled regularly by the Canadian Ice Centre, but the trend analysis by Statistics Canada has not been updated since 2011.

Reliability: Sea Ice Extent is considered very reliable.[114]

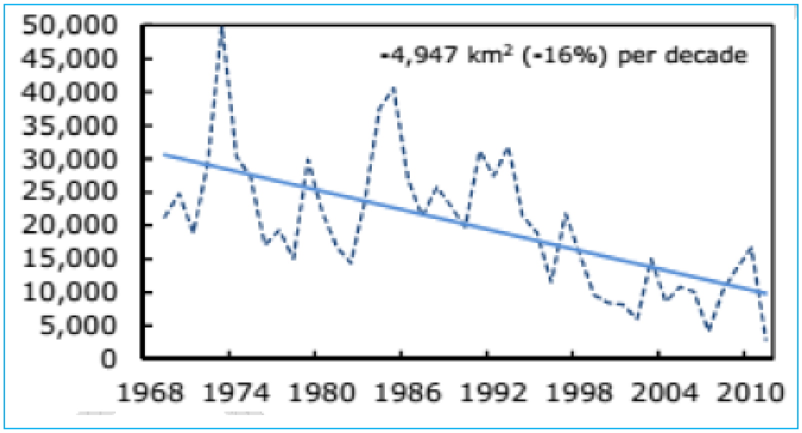
Analysis: The annual average extent of total sea ice declined in all regions between 1968 and 2010, with regions in the Hudson Bay domain seeing the greatest declines. There was no clear trend in multi-year ice coverage. The Northern Labrador Sea and the Hudson Strait regions experienced the greatest declines, at 17 per cent per decade (Figure 37) and 16 per cent per decade (Figure 38) respectively.

Figure 37. Average area of total sea ice during summer, Northern Labrador Sea (square kilometres), 1968–2010



Source: Henry, 2011.

Figure 38. Average area of total sea ice during summer, Hudson Strait (square kilometres), 1968–2010



Source: Henry, 2011.

While the regions of the Arctic domain experienced smaller relative changes in total sea ice coverage, they had larger absolute changes. The Southern Beaufort Sea experienced the largest absolute change per decade between 1968 and 2010, at a loss of almost 25,000 km^2 per decade.[115]

[114] See Footnote 6 for details of the reliability scale used in this report.

[115] According to the United States National Snow and Ice Data Center (2016), 2016 set new record lows for arctic sea ice extent during the months of January, February, April and May. May 2016's average sea ice extent was 580,000 km^2 below the previous record low for the month set in 2004 and 1.39 million km^2 below the 1981 to 2010 long-term average.

Green Growth Case Study

This report is largely about assessing the status of the capital *stocks* that contribute to comprehensive wealth in Canada. However, these stocks are just part of the portrait. Changes over time in the stocks are the result of *flows* to and from them, e.g., the flow of timber out of forests and the flow of education and skills training into human capital. Understanding comprehensive wealth is, then, as much about measuring flows as it is about measuring stocks. An assessment of all the flows related to comprehensive wealth would have made this report unmanageable in size and scope, so it has not been undertaken. As an example of what such an assessment might provide, this case study considers some of the flows relevant to natural capital.

Specifically, the case study looks at the degree to which Canada makes effective use of its natural capital. Three dimensions are considered: the income Canada succeeds in generating per unit of natural capital used; the degree to which the management of natural capital drives innovation and the use of fiscal measures to help preserve natural capital.

Maintaining natural capital over time is vital for both current and future well-being. Excessive use of the goods and services natural capital provides depletes individual natural assets, possibly reducing comprehensive wealth and threatening the sustainability of well-being. Finding means to effectively use the goods and services offered by natural capital is essential to ensuring sustainability. Moreover, it represents an opportunity to generate sustainable economic growth through the development of new, resource-efficient technologies.

Measuring how effectively Canada uses its natural capital requires indicators beyond those presented in the preceding pages. The OECD "green growth framework" provides a useful starting point for finding flow indicators (OECD, 2011b). Green growth "is about fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies" (OECD, 2011b, p. 9). Measuring green growth for Canada can help shed light on how our economy uses natural capital, where that use can be made more productive, and where opportunities to create more sustainable growth might lie.

The OECD's framework includes indicators in four categories:

- **Environmental and resource productivity** – These indicators measure the effectiveness of natural capital use by considering the economic output (GDP) produced per unit of a given natural capital input (for example, GDP per unit of energy consumed).
- **Maintaining the natural asset base** – these indicators measure the value and quality of natural assets themselves (they are very similar to the natural capital indicators presented here).
- **Environmental quality of life** – These indicators measure the degree to which environmental degradation directly affects quality of life.
- **Economic opportunities and environmental policy** – These indicators measure the extent to which environmental protection can be harnessed as a source of growth, competitiveness, trade and jobs.

For the purposes of this case study, four indicators from the first and fourth categories have been chosen:

1. **Greenhouse gas productivity** – This indicator measures the income (GDP) generated per unit of greenhouse gas emissions. It is a measure of the effectiveness of Canada's use of the climate's weather regulation service.

2. **Water productivity** – This indicator measures the income (GDP) created per unit of water consumed. It is a measure of the effectiveness of Canada's use of the stock of water found in groundwater and surface water assets.
3. **Environmental innovation** – This indicator measures the number of new technologies (patents) Canada produces that are related to environmental protection. It is a measure of the degree to which the Canadian economy profits from the need to find more effective ways of using natural capital.
4. **Environmental taxes** – This indicator measures the revenue earned by the federal/provincial/territorial governments from taxes intended to reduce reliance on natural capital. It is a measure of the extent to which Canadian governments are making use of fiscal policy measures to meet environmental goals. Fiscal policy measures are of interest because they can, in some cases, reduce the economic cost of achieving environmental goals in comparison to regulatory approaches.

Findings

Overall, the results of the case study suggest that Canada is making somewhat more effective use of its natural capital over time, and is taking some measures to ensure environmental protection and economic development are jointly pursued. At the same time, it is clear that more could be done, especially in comparison to our international peers.

The two productivity indicators both show improvements at the level of the total economy, meaning that Canada is generally deriving more income from natural capital inputs over time. While this is encouraging, some sectors are clearly lagging in Canada, and other countries have generally done better. The mining, quarrying and oil and gas extraction sector has moved opposite to other major sectors, witnessing a decline in both its greenhouse gas emission and water productivity between 1997 and 2013. In 2013, the OECD ranked Canada only 31st out of 34 member states in terms of carbon dioxide productivity.116 Changes to productivity can result from several effects, including substitution between natural capital and other inputs and changes in the composition of economic output (for example, an increasing emphasis on services versus manufactured goods). It was not possible to distinguish the effects of these effects on Canada's natural capital productivity performance here. Further analysis would be useful in this regard.

Canada fared somewhat better in regard to environmental innovation. Between 1990 and 2012, environmental technologies developed in Canada held constant as a share of all technologies developed and increased slightly in per capita terms. On average, OECD countries did better though, with environmental technologies increasing considerably both as a share of all technological development and per capita. Still, Canada's performance was good enough for it to rank, respectively, 24th and 17th in terms of these indicators.[117]

In terms of the use of taxes to achieve environment goals, Canada again fared poorly in comparison to its OECD peers. Of 24 member states for which data were available in 2013, Canada ranked second last, just ahead of the United States, in terms of environmentally related taxes as a share of total national tax revenue.[118]

[116] The OECD only measures productivity for energy-related carbon dioxide emissions and not for other greenhouse gases.

[117] OECD.stat, *Green Growth Indicators*, *Development of environment-related technologies*.

[118] OECD.stat, *Green Growth Indicators, Environmentally related taxes, of total tax revenue*.

Selected Green Growth Indicators for Canada

1. Greenhouse Gas Productivity

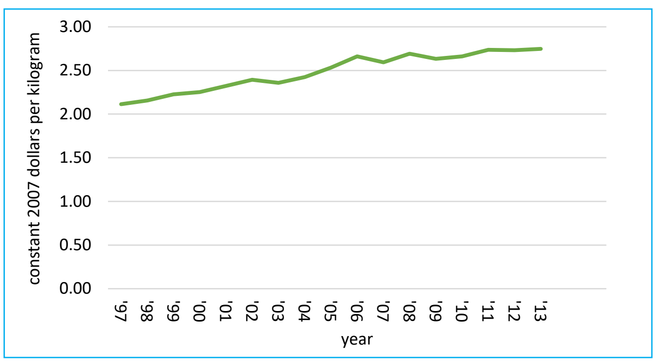
Greenhouse gas emissions[119] per dollar of GDP[120] trended downward in the economy overall between 1997 and 2013 (Figure 39). In 1997, overall greenhouse gas productivity was about 2.11 constant 2007 dollars per kilogram of greenhouse gas emissions. By, 2013, this figure had risen to 2.75 constant 2007 dollars per kilogram, an average annual improvement of 1.8 per cent.

Looked at in more detail, it is clear that some sectors performed better than others. The mining, quarrying and oil and gas extraction industries were notable for being the only major sector of the economy to show a decline in greenhouse gas productivity over the period (Figure 40). On average, the productivity of these industries fell by 2.1 per cent annually. This is particularly worrying given that this sector is the largest contributor to emissions in the business sector.

The utilities industry fared much better (Figure 41). Their greenhouse gas productivity grew from 0.30 to 0.43 constant 2007 dollars per kilogram of emissions over the period; an annual average growth rate of 2.4 per cent.

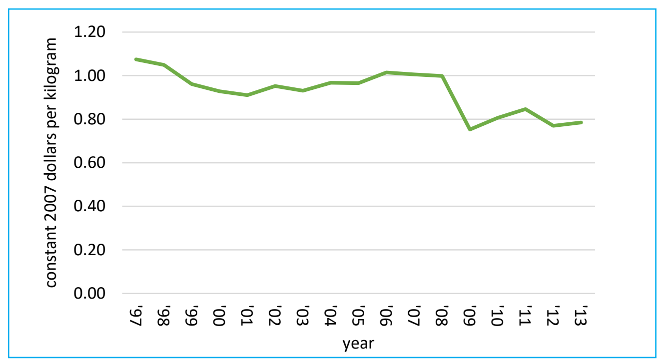
The manufacturing industries began and ended the period with essentially unchanged greenhouse gas productivity, even though they had improved their record considerably during the 2000s (Figure 42).

Figure 39. **Greenhouse gas productivity, Total economy, 1997–2013**



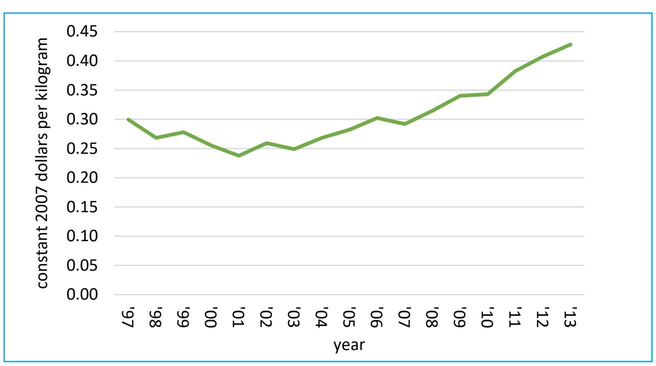
Source: Current study.

Figure 40. **Greenhouse gas productivity, Mining, Quarrying and Oil and Gas Extraction, 1997–2013**



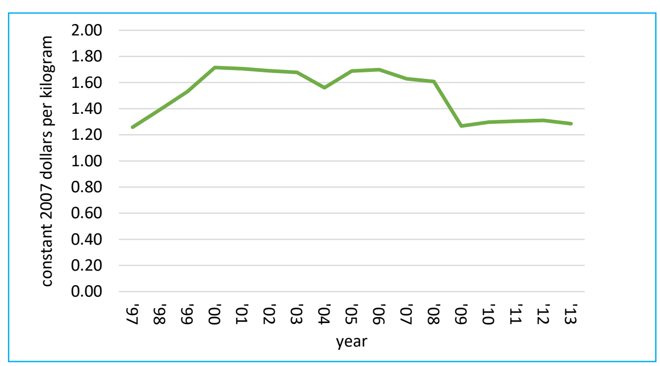
Source: Current study.

Figure 41. **Greenhouse gas productivity, Utilities, 1997–2013**



Source: Current study.

Figure 42. **Greenhouse gas productivity, Manufacturing, 1997–2013**



Source: Current study.

[119] Carbon dioxide, methane and nitrous oxide emissions expressed as equivalent carbon dioxide emissions.

[120] Statistics Canada, *Physical Flow Account for Greenhouse Gas Emissions,* CANSIM Table 153-0114 and Gross Domestic Product at Basic Prices, CANSIM Table 379-0031.

While Canada's greenhouse gas productivity has improved since 1997, a comparison with our international peers shows that the country has not done as well as it might have. Canada lags in terms of CO_2 productivity compared with other OECD member states. It ranked just 31st of 34 member states in 2013 (Table 16).[121]

Table 16. CO_2 productivity, OECD member states, 2013

Rank	OECD Member State	GDP per unit of energy-related CO_2 emissions (USD per kilogram)
1	Sweden	9.27
2	Switzerland	8.2
3	Norway	6.93
4	France	6.5
5	Iceland	5.98
6	Ireland	5.31
7	Spain	5.16
8	United Kingdom	5.01
9	Portugal	4.96
10	Austria	4.86
11	Italy	4.81
12	Denmark	4.77
13	Hungary	4.46
14	Belgium	4.25
15	Netherlands	4.16
16	New Zealand	3.91
17	Germany	3.88
18	Luxembourg	3.83
19	Turkey	3.73
20	Slovak Republic	3.66
21	Finland	3.56
22	Mexico	3.53
23	Chile	3.52
24	Slovenia	3.52
25	Israel	3.49
26	Japan	3.3
27	Greece	3.25
28	United States	2.8
29	Korea	2.72
30	Czech Republic	2.55
31	Canada	2.47
32	Poland	2.45
33	Australia	2.3
34	Estonia	1.34

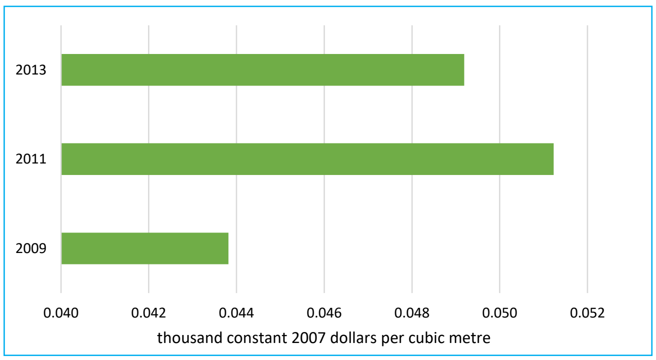
Source: OECD.stat, *Green Growth Indicators*, Production-based CO_2 Productivity and Energy Productivity

[121] OECD.stat, *Green Growth Indicators*, Production-based CO_2 Productivity and Energy Productivity. Note that the OECD green growth indicator database does not include an indicator of water productivity.

2. Water Productivity

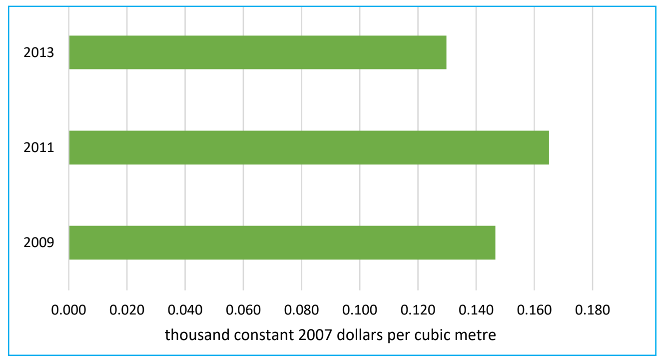
Water productivity in the economy as a whole increased from 440 constant 2007 dollars per cubic metre in 2009 to 490 constant 2007 dollars per cubic metre in 2013, an average annual increase of 2.9 per cent (Figure 43).[122] As in the case of greenhouse gases, the mining, quarrying and oil and gas extraction sector stood out for moving in opposition to the economy as a whole. Its water productivity fell from 147 constant 2007 dollars per cubic metre in 2009 to 130 constant 2007 dollars per cubic metre in 2013 (Figure 44). It was the only major water-using sector of the economy to see a decline over the period. The utilities sector, which is the largest single water-using sector, saw its water productivity increase by 2.5 per cent annually on average over the period (Figure 45). For the manufacturing sector, the average annual increase was 2.9 per cent (Figure 46).

Figure 43. Water productivity, total economy, 2009, 2011, 2013



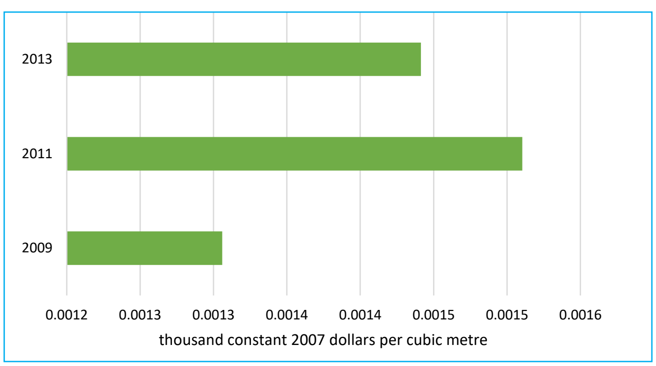
Source: Current study.

Figure 44. Water productivity, Mining, Quarrying and Oil and Gas Extraction, 2009, 2011, 2013



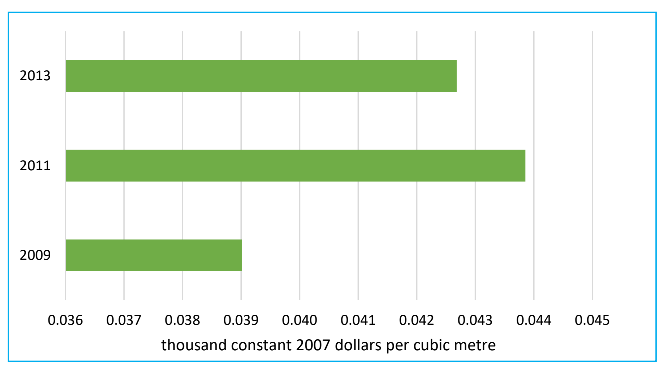
Source: Current study.

Figure 45. Water productivity, Utilities, 2009, 2011, 2013



Source: Current study.

Figure 46. Water productivity, Manufacturing, 2009, 2011, 2013



Source: Current study.

[122] Statistics Canada, *Physical Flow Account for Water Use*, CANSIM Table 153-0116 and *Gross Domestic Product at Basic Prices*, CANSIM Table 379-0031 CANSIM Table 379-0031.

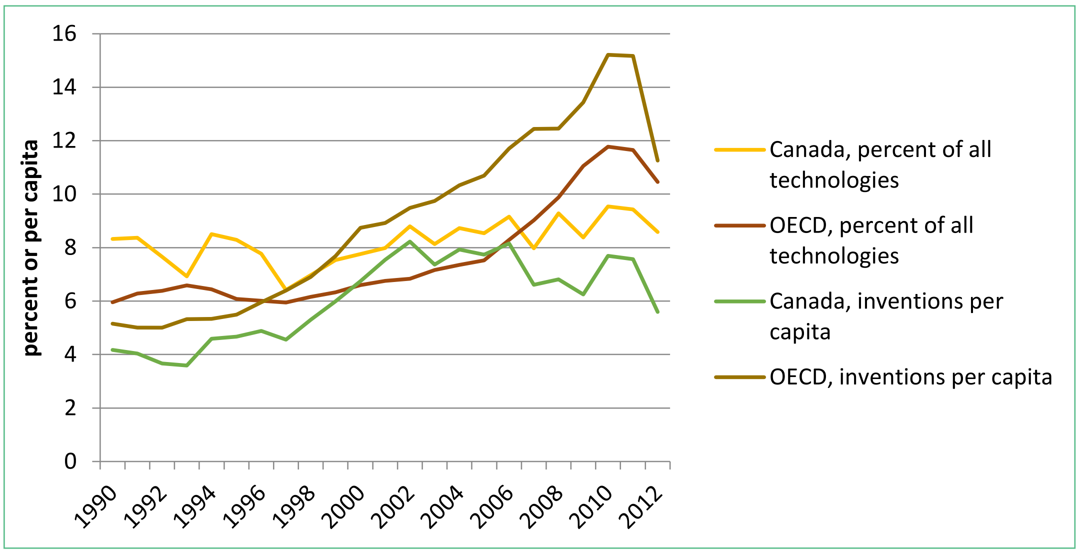
3. Environmental Innovation

The development of new technologies is an important driver of economic growth and productivity. New technologies can reduce the demands on natural capital by reducing the need for raw materials and limiting pollution emissions.

Though Canada fared relatively well compared to its OECD peers in the 1990s, by the late 2000s Canadian development of environment-related technologies had fallen behind the OECD overall in both the percentage of all technologies that are environmentally related and environmentally related inventions per capita (Figure 47).

In 2012, 8.6 per cent of new technologies were environmentally related in Canada, while 10.6 per cent of new technologies in the OECD as a whole were environmentally related. In the same year, 5.6 environmentally related inventions were created per capita in Canada, while 11.3 were created per capita in the OECD as a whole.[123]

Figure 47. **Environment-related technology development, Canada and OECD, 1990–2012**



Source: OECD.stats *Green Growth Indicators, Development of Environment-Related Technologies.*

4. Environmental Taxes

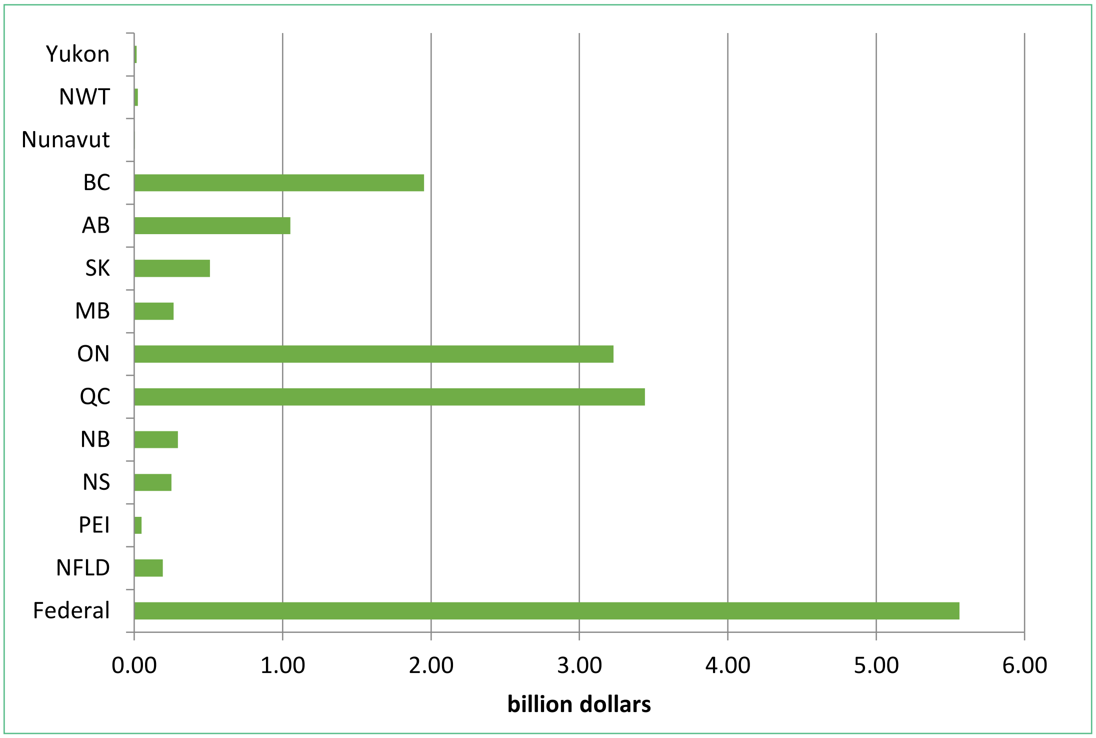
Environmental taxes[124] can help move the economy toward sustainability by ensuring consumers and producers pay prices that reflect the burdens the economy places on natural capital. The prices of most market goods and services do not currently include the costs of such things as excessive demand for raw materials or emissions of pollution. This can lead to consumption of these goods and services beyond what is optimal for overall well-being.

[123] OECD.stat, *Green Growth Indicators, Development of Environment-Related Technologies.*

[124] Environmental taxes include, among others, taxes on plastic bags and bottles, energy, water and greenhouse gas emission.

The 2012/2013 revenue from environmental taxes and fees in Canada (Arros, 2015) was estimated to be $16.8 billion. The federal government collected the largest share of this revenue. Provincially, Quebec, Ontario and British Columbia took in the most revenue (Figure 48).

Figure 48. Environment taxes and fees, Federal provincial/territorial governments, 2012, 2013



Source: Arros, 2015.

Compared to other OECD member states for which data are available, Canada ranked second last in 2013 in terms of the share of national tax revenue derived from environmental taxes at 3.7 per cent (Table 17).[125]

Table 17. Environmental taxes as a share of national tax revenue, OECD member states, 2013

Rank	OECD Member State	Environmental taxes as a share of national tax revenue (percent)
1	Turkey	13.9
2	Slovenia	11.6
3	Israel	9.3
4	Korea	9.3
5	Ireland	8.3
6	Czech Republic	8.2
7	Denmark	8.1
8	Greece	8.1
9	Estonia	7.8
10	United Kingdom	7.6
11	Hungary	7.1
12	Finland	6.7
13	Switzerland	6.6
14	Italy	6.5
15	Portugal	6.4
16	Slovak Republic	5.9
17	Spain	5.7
18	Iceland	5.7
19	Luxembourg	5.7
20	Germany	5.6
21	Chile	5.6
22	Sweden	5.5
23	Norway	5.4
24	Austria	5.3
25	Belgium	4.4
26	France	4.4
27	New Zealand	4.2
28	Canada	3.7
29	United States	3.0

Source: OECD.stat, *Green Growth Indicators*, *Environmentally Related Taxes, of Total Tax Revenue.*

125 OECD.stat, *Green Growth Indicators*, *Environmentally Related Taxes, of Total Tax Revenue.*

Comprehensive Wealth

HUMAN CAPITAL

Indicator HC1 – Human Capital Index

Theme: Human Capital

Geographic Scope: National

Time series: 1980 to 2013

Frequency: Annual

Description: The Human Capital Index measures the aggregate value of real (inflation-adjusted) per capita human capital, which represents the skills, experiences and competencies embodied in the population. These can be thought of as stocks of capital that provide economic returns in the form of higher incomes and greater productivity. Human capital is developed both through formal learning (such as the education system and on- the-job training) and informal learning (such as interaction with friends and family). The development of human capital takes place over a person's whole lifetime. The accumulation of human capital is therefore said to be *lifelong* and *life-wide* (UNU–IHDP & UNEP, 2014).

Relevance to comprehensive wealth: Human capital represents a very large share of comprehensive wealth in every country. In Canada, human capital accounted for 83 per cent of the aggregate value of nominal produced, natural and human capital on average during the period from 1980 to 2013. Investment in human capital generates economic benefits for individuals and for the broader community. As people invest in human capital they become more employable and may also enjoy higher wages. Businesses experience benefits from a more productive workforce. However, the benefits of human capital investment are not just economic, since individuals and the community also enjoy non-economic benefits, such as improved subjective well-being and greater civic engagement (UNU–IHDP and UNEP, 2014).

Method of Calculation: The Human Capital Index presented here is taken from a Statistics Canada research study (Gu & Wong, 2010)[126] that used a variant[127] of the Jorgenson–Fraumeni lifetime-income approach to estimate human capital in Canada. The lifetime-income approach measures human capital as the net present value of expected future wages (see Section 4.2.2 and Annex 4 for further information on the approach).[128] The index is measured in chained 2007 dollars.

Limitations: The primary limitation of the lifetime-income approach to the measurement of human capital is the assumption that differences in income truly reflect differences in productivity and, implicitly, differences in the value of human capital from person to person. Incomes vary for many reasons, not all of which are attributable to productivity differentials. Estimates of human capital based on wages may therefore be somewhat distorted (Le et al., 2003).

Reliability: The Human Capital Index is considered to be reliable. If it was considered an official statistic by Statistics Canada rather than the result of a research study, it would be considered very reliable.[129]

[126] The authors of this study kindly provided updated human capital estimates to 2014 for use here (Gu, personal communication).

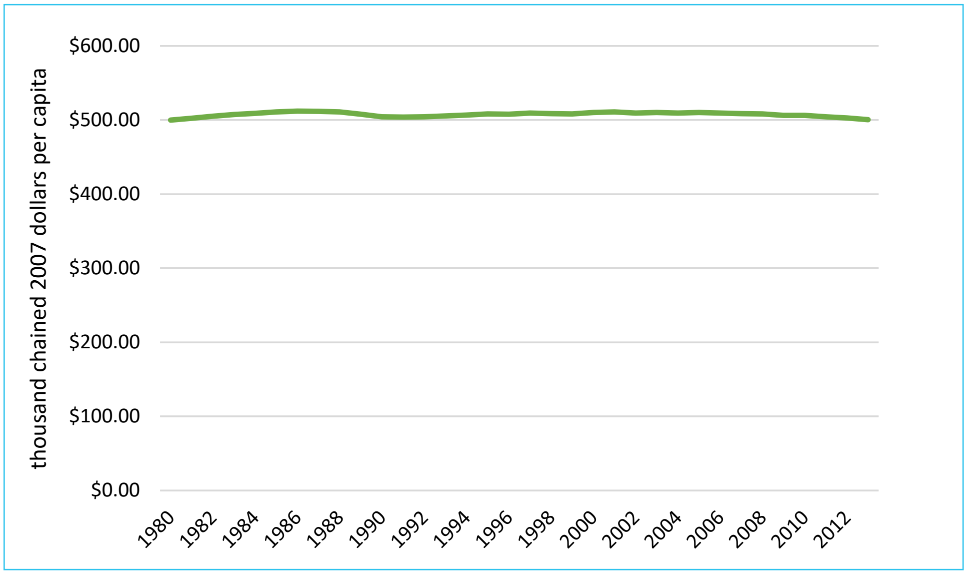
[127] Gu and Wong treat non-market activities differently than Jorgensen and Fraumeni, who estimated the value of non-market activities (including leisure) using the same wage rate as market work. This implies the same level of human capital whether a country is fully employed or has significant unemployment. Jorgensen and Fraumeni were criticized for providing an unrealistic measure of the value of non-market time in their approach. Gu and Wong, on the other hand, leave non-market time out of their analysis entirely and focus only on the value of time spent in market employment. While arguably more realistic than Jorgensen and Fraumeni's approach, it is also a distortion to say that non-market activities have no value (Le et al., 2003).

[128] No national statistical office, including Statistics Canada, currently produces official estimates of human capital. Statistics Canada is one of only a handful that have studied the issue as a research topic.

[129] See Footnote 6 for details of the reliability scale used in this report.

Analysis: The Human Capital Index showed no growth between 1980 and 2013. The average Canadian ended the period with essentially the same level of human capital at his/her disposal as in 1980 (Figure 49).

Figure 49. Human Capital Index, 1980–2013



Source: Current study.

One factor that stands out as an explanation of the stagnation in human capital is the aging of the population. As the average Canadian worker gets older, his/her remaining years in the work force drop. Fewer years left to work translates into less lifetime-income for the average worker and, other things equal, less human capital.

Another factor is the degree to which Canada has invested in the creation of human capital through formal education and on-the-job training. Based on currently available data, the level of this investment is uncertain. See the following discussion of the Educational Spending Index (Indicator HC2) for further details.

Indicator HC2 – Educational Spending Index

Theme: Human Capital – *Educational inputs*

Geographic Scope: National

Time series: 1980/81 to 2013/14

Frequency: Annual

Description: The Educational Spending Index measures real per-pupil spending on elementary, secondary and post-secondary education nationally.

Relevance to comprehensive wealth: Spending on the education system is an important indicator of the investment in human capital. It is important to capture spending by both public and private organizations as well as by individuals (UNU–IHDP & UNEP, 2014).

Method of Calculation: The Educational Spending Index is measured by combining Statistics Canada's estimates of spending on public and private elementary/secondary schools,[130] community colleges[131] and universities[132] (adjusted for inflation[133] and divided by student enrolments[134] to convert them to a per-pupil basis) into an annual total for 1980 to 2013. The total is measured in chained 2007 dollars.

Limitations: Statistics Canada's data source for post-secondary educational spending changed in the early 2000s, causing a break in the time series in 2004 (see footnotes 128 and 129).

Statistics Canada's data source for prices levels in elementary/secondary schools changed in the early 2000s, causing a break in the time series in 2003 (see Footnote 130).

Statistics Canada's data sources for student enrolments changed in the 1990s, causing breaks in the time series for elementary/secondary enrolments in 1997 and for post-secondary enrolments in 1992 (see Footnote 131).

Though educational spending data are measured on a fiscal year basis, they have been treated as though they are on a calendar year basis for the purposes of this indicator. The starting year of fiscal years has been taken to represent the corresponding calendar year (e.g., data for 1980/81 have been taken to represent 1980).

The use of the *Educational Price Index* (CANSIM Table 478-0013) to adjust all spending on post-secondary education may overstate the overall impact of inflation on post-secondary spending, since the index reflects only price changes in household spending on post-secondary education (mainly tuition and

[130] *Public and Private Elementary and Secondary Education Expenditures*, CANSIM Table 478-0015.

[131] **For 1980 to 2004:** *Postsecondary Non-university Education (College) Expenditure*, CANSIM Table 478-0004. **For 2005 to 2013**: *Financial Information of Community Colleges and Vocational Schools, Revenues by Type of Fund*, CANSIM Table 477-0060.

[132] **For 1980 to 2004**: *University Education Expenditures*, CANSIM Table 478-0007. **For 2005 to 2013**: *Financial Information of Universities and Degree-Granting Colleges, Revenues by Type of Funds*, CANSIM Table 477-0058.

[133] Price indexes from Statistics Canada were used to adjust educational spending for inflation. All post-secondary spending was adjusted using the "Education" component of the Consumer Price Index (CANSIM Table 326-0021). Elementary/secondary spending was adjusted using the an education-specific price index that was discontinued in 2003 (CANSIM Table 478-0013); this index was updated to 2013 using the "All-goods" component of the *Consumer Price Index* to move the 2003 level of the *Education Price Index* forward.

[134] For elementary and secondary levels, enrolment data are based on data from CANSIM Table 477-0025 (Number of Students in Regular Programs for Youth, Public Elementary and Secondary Schools) for the period 1997 to 2013 and on data from the publication Education in Canada (Catalogue No. 81-229; available only in hard copy) for the period 1980 to 1996. For colleges and universities, enrolment data are based on data from CANSIM Table 477-0019 (Postsecondary Enrolments, by Registration Status, Pan-Canadian Standard Classification of Education) for 1992 to 2013 and on data from the publication Education in Canada (Catalogue No. 81-229; available only in hard copy) for the period 1980 to 1991. College and university data from Education in Canada for 1980 to 1991 were adjusted upward to make them consistent with data from CANSIM Table 477-0019. The adjustment was based on the average of the ratio of enrolments from the two sources for the period 1992 to 1996 when both are available.

books). Price changes in other aspects of post-secondary education (salaries, for example, may have changed at different rates from the Education Price Index.

Data for the Territories are incomplete for the early years of the time series, so they are not included separately in the analysis. They do, however, figure in the Canada totals. Given the above, trends in the Education Spending Index should be interpreted with caution.

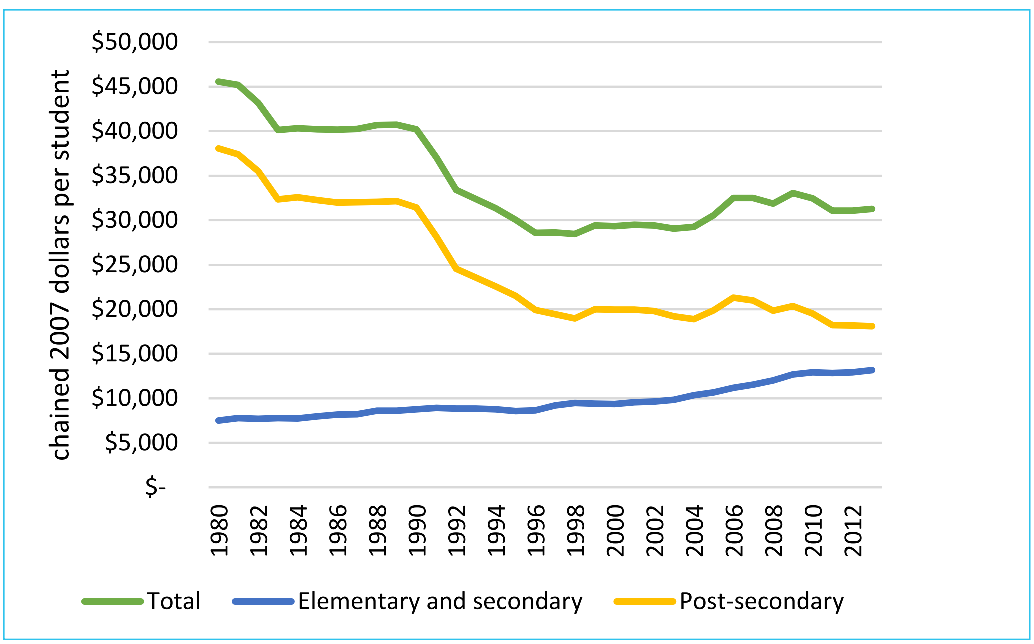
Reliability: The Educational Spending Index is considered only acceptable due to the various time-series breaks and data adjustments required for its compilation.[135]

Analysis: The Educational Spending Index fell considerably between 1980 and 2013 (Figure 50). Real education expenditures per pupil started the time period at about $45,600 and ended it at $31,300, an annual average decrease of 1.14 per cent. The majority of the decline in spending took place during the early 1990s, a period of significant government cost cutting across the country. Total expenditures have been more or less stable since 1995. When the split between elementary/secondary and post-secondary spending is considered, it becomes clear that all of the decline in total spending was due to declines in post-secondary spending in the early 1990s. Elementary/secondary spending was actually up in real per-pupil terms over the time period (1.72 per cent annually) while post-secondary spending per pupil declined at an annual average rate of 2.23.

Other Statistics Canada data suggest different trends in educational investment. A research paper on the value of educational output (Gu & Wang, 2012) found that real per-pupil investment grew modestly overall between 1976 and 2005 (0.48 per cent annually). Dividing the official estimate of real output (value added) of the education industry from the national accounts[136] by enrolment suggests that output per pupil grew at an annual rate of 1.66 per cent between 1997 and 2013.

Clearly, assessing the trend in educational investment is not straightforward given existing data. Depending on the data sources used and assumptions made, the trend could be up strongly, up weakly or down strongly. Further research is required.

Figure 50. **Educational Spending Index, 1980–2013**



Source: Current study.

[135] See Footnote 6 for details of the reliability scale used in this report.

[136] CANSIM Table 379-0031, *Gross Domestic Product (GDP) at Basic Prices*

Indicator HC3 – Educational Attainment

Theme: Human Capital

Geographic Scope: National, provincial/territorial

Time series: 1986, 1991, 1996, 2001, 2006, 2011

Frequency: Every five years

Description: *Educational Attainment* measures the highest certificate, diploma or degree held by the population at the federal and provincial/territorial levels. The hierarchy used is:

- No certificate, diploma or degree
- Secondary school diploma or equivalent
- Apprenticeship or trades certificate or diploma
- College, CEGEP or other non-university certificate or diploma
- University certificate or diploma below bachelor level
- University certificate, diploma or degree at bachelor level or above: bachelor's degree; university certificate or diploma above bachelor level; degree in medicine, dentistry, veterinary medicine or optometry; master's degree; earned doctorate

Relevance to comprehensive wealth: Formal education is an important part of human capital development and investment. An indicator of educational attainment is useful as a complement to the value of human capital (Indicator HC1 – Human Capital Index). It provides an alternative means of judging the success of Canadian education investments.

Method of Calculation: "Highest certificate, diploma or degree" is a variable derived from the Census of Population.[137] Respondents are asked to report all certificates, diplomas and degrees earned.

Limitations: For 2011, the National Household Survey replaced the Census of Population for certain variables, including educational attainment. Differences in the two surveys mean that comparisons of the data for 2011 with other years should be undertaken with caution.

As with all non-monetary indicators, Educational Attainment is not directly comparable with other indicators in this report.

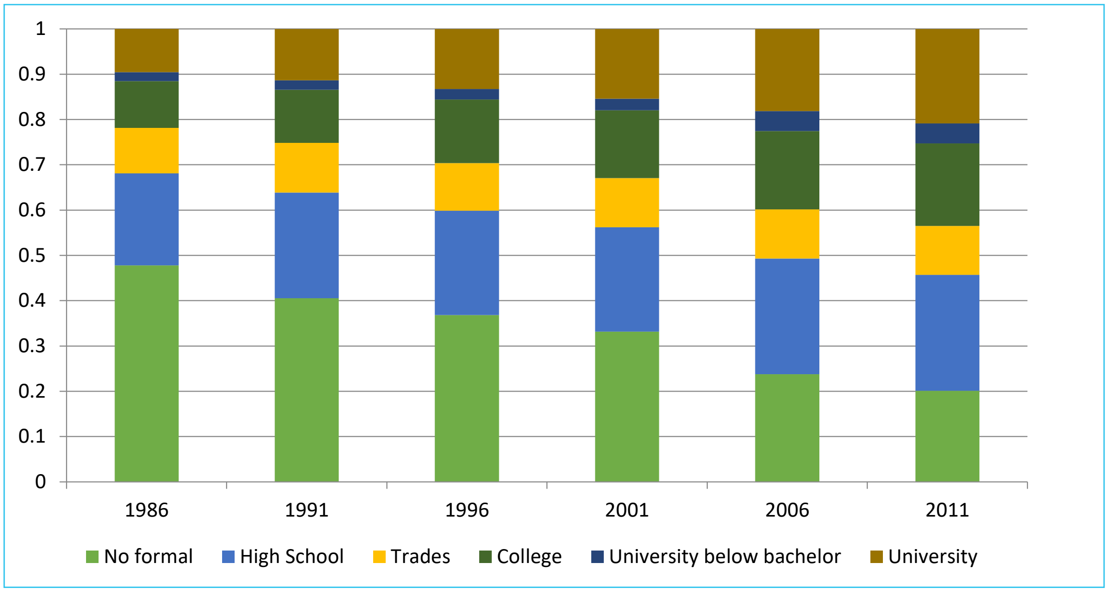
Reliability: Educational Attainment is considered very reliable.[138]

Analysis: Canadians became significantly better educated between 1986 and 2011 (Figure 51). In 1986, 47 per cent of the population age 15 and over had no formal educational certificate, diploma or degree and only 9 per cent had a university degree. By 2011, only 20 per cent had no formal certificate, diploma or degree, while 20 per cent had a university degree. All provinces followed the national trend.

[137] In 2011, from the *National Household Survey.*

[138] See Footnote 6 for details of the reliability scale used in this report.

Figure 51. Highest level of education, Canada, percent of total



Source: Current study.

The share of the population holding no certificate, diploma or degree fell by 28 per cent between 1986 and 2011 (Table 18). The share of the population attaining all other levels of education rose.

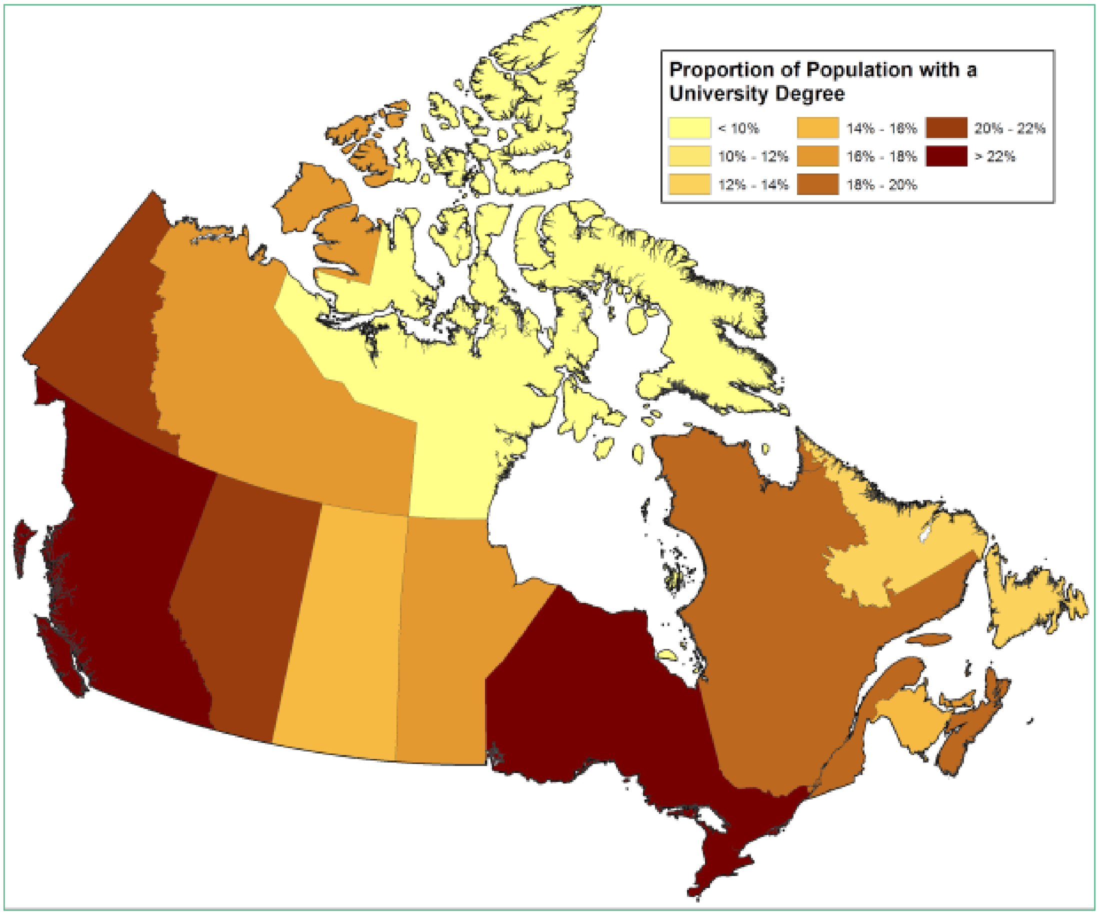
Table 18. Percentage point change of educational attainment, 1986–2011

	Percentage point change
No certificate, diploma or degree	-28
High school	5
Trades	1
College	8
University below Bachelor	2
University	11

Source: Current study.

Provincially, Newfoundland and Labrador had the highest percentage of inhabitants with no certificate, diploma or degree in 2011 (28 per cent), while British Columbia had the lowest (17 per cent). Newfoundland and Labrador also had the lowest share of inhabitants with a university degree (13 per cent), while Ontario had the highest (23 per cent).

Figure 52. **Proportion of population with a university degree, 2011**



Source: Current study.

Indicator HC4 – Adult Skills

Theme: Human Capital

Geographic Scope: National, provincial/territorial

Time series: 2012

Frequency: Intermittent

Description: Adult Skills measures adult literacy, numeracy and problem solving[139] skills based on results from the Programme for the International Assessment of Adult Competencies (PIAAC), an initiative of the OECD. Technological change and the rapid expansion of information and communication technologies have changed the skills needed in the workplace and in daily life.

Relevance to comprehensive wealth: Adult skills are an important part of human capital that do not always arise from formal education. For this reason, an indicator based on data that directly measure skills is an important complement to the indicators of educational spending and attainment presented above (indicators HC2 and HC3).

Technology has become a central aspect of everyday life, and the labour market has increasingly shifted toward valuing skills related to analyzing and communicating information. Low proficiency in information processing skills results in worse results in the labour market and fewer opportunities to improve those skills. This results in people being left behind and in lower economic growth for the economy as a whole.

Method of Calculation: PIAAC was designed by a group of international experts and is administered in Canada by Statistics Canada (Statistics Canada, 2013B). PIAAC is an internationally comparable survey of the cognitive and workplace skills needed to participate in society and in the economy. The survey was undertaken in Canada at the national and provincial/territorial level in 2012 and measured the population aged 16 to 65. It consisted of a background questionnaire and a competencies assessment.

Limitations: PIAAC has only been administered once in Canada, so it is not yet possible to assess how adult skills have changed over time. However, Canadian results can be compared to OECD averages and provinces/territories can be compared with one another.

As with all non-monetary indicators, *Adult Skills* is not directly comparable with other indicators in this report.

Reliability: Adult Skills is considered very reliable.[140]

[139] Specifically, problem solving in technology-rich environments.

[140] See Footnote 6 for details of the reliability scale used in this report.

Analysis: Canadians scored just above the OECD average for literacy in 2012 (Table 19). PEI, Nova Scotia, Ontario, Manitoba, Alberta, British Columbia and the Yukon all scored above the OECD average. Newfoundland and Labrador, New Brunswick, Quebec, Saskatchewan, the Northwest Territories and Nunavut all fell below the OECD average. Alberta was the highest-scoring jurisdiction in terms of literacy; Nunavut scored lowest.

Table 19. Literacy, Canada and provinces

	Average Score	Percent of the population scoring at or above level three
Canada	273.5	51.5
Newfoundland and Labrador	265.4	45.3
Prince Edward Island	277.5	54.7
Nova Scotia	273.9	49.7
New Brunswick	268.3	46.5
Quebec	268.6	46.8
Ontario	275.5	53.2
Manitoba	273.9	51.7
Saskatchewan	271.6	50.1
Alberta	277.7	55.1
British Columbia	274.8	54.1
Yukon	277.2	55.7
Northwest Territories	253.3	36.1
Nunavut	219.1	16.9

Source: Statistics Canada, 2013b.

Canada scored 265.5 in numeracy, below the OECD average of 269 (Table 20). All provinces and territories scored at or below the OECD average. Nationally, Alberta scored the highest in numeracy (269.1). Nunavut scored the lowest (200.5), well below the OECD average.

Table 20. Numeracy, Canada and provinces

	Average Score	Percent of the population scoring at or above level three
Canada	265.5	45.3
Newfoundland and Labrador	251.9	34.5
Prince Edward Island	265	44.2
Nova Scotia	262.8	41.8
New Brunswick	255.7	36.9
Quebec	264.9	56.1
Ontario	266.3	46.2
Manitoba	264.2	45.2
Saskatchewan	262.8	43.5
Alberta	269.1	47.3
British Columbia	266.3	47.7
Yukon	263.1	44.2
Northwest Territories	239.4	30.3
Nunavut	200.5	12.5

Source: Statistics Canada, 2013b.

Problem solving was assessed using proficiency levels rather than scores. Thirty-seven per cent of Canadians scored at or above level 2 proficiency, which was above the OECD average of 34 per cent. The share of inhabitants at level 2 was at least as high in all provinces/territories (other than Nunavut and Newfoundland and Labrador) as the OECD average.

Comprehensive Wealth

SOCIAL CAPITAL

Indicator SC1 – Participation in Group Activities

Theme: Social Capital – *Civic engagement*

Geographic scope: National and provincial

Time series: 2003, 2008, 2013

Frequency: Every five years

Description: Participation in Group Activities tracks the percentage of people who participated in or were members of a group, organization or association[141] in the previous year.

Relevance to comprehensive wealth: There is a synergistic relationship between Participation in Group Activities and interpersonal trust. As individuals participate more in their communities and in other group activities, they learn to trust others more. Likewise, greater trust in others makes people more likely to participate in groups. The result is a virtuous circle in which trust promotes cooperation and cooperation promotes trust.

Group participation brings diverse people together, strengthening social ties and encouraging the development of collective social capital. Participation in groups, organizations or associations aids in the development of certain behaviours and democratic principles such as cooperation, participation and interpersonal trust, even when these behaviours are not the primary aim of the group (Putnam, 2000; Newton & Norris, 2000).

Method of calculation: Data are collected via Statistics Canada's General Social Survey (GSS) cycle on social engagement, which is administered every five years. The social engagement cycle is aimed at gathering data to monitor changes in the living conditions and well-being of Canadians and to provide information on specific social policy issues of current or emerging interest. A question on group participation has been part of the GSS social engagement cycle since 2003. The GSS targets all people age 15 years of age and older and covers all 10 provinces by telephone interview. Data are broken down by sex, age and province.

Limitations: Data are not available for the Territories.

As with all non-monetary indicators, Participation in Group Activities is not directly comparable with other indicators in this report.[142]

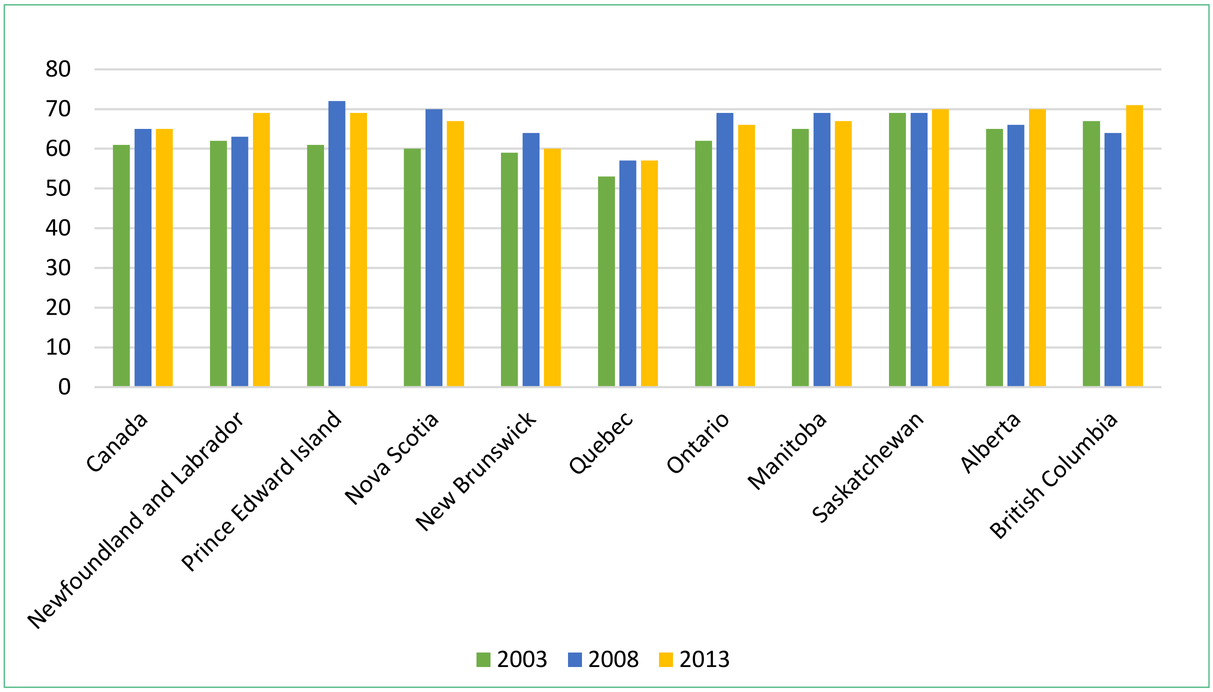
Reliability: The estimates of Participation in Group Activities are considered very reliable (Class 1).

[141] The list of groups, organizations and associations is quite broad. It includes unions or professional organizations, political organizations, sports or recreational groups, cultural or educational groups, social clubs, youth groups and others.

[142] See Footnote 6 for details of the reliability scale used in this report.

Analysis: The percentage of people who participated in group activities increased from 2003 to 2013. In 2003, 61 per cent of Canadians took part in a group compared to 65 per cent who did so in 2013. This upward trend was evident in all provinces, though the change was negligible in New Brunswick and Saskatchewan (Figure 53). Overall, the results across time and across regions were quite uneven, suggesting that no clear trend in group activity participation is evident.

Figure 53. Share of the population participating in group activities, by province, 2003, 2008 and 2013



Source: Turcotte, 2015a.

All age groups showed an increase in group participation between 2003 and 2013, including those 75 years and older. The increased involvement of seniors likely reflects the better health status of that group (Turcotte, 2015a).

Quebec had the lowest group participation rate in 2013 (57 per cent); British Columbia had the highest rate (73 per cent). While all provinces saw increases in participation from 2003 to 2013, many saw decreases between 2008 and 2013.

Indicator SC2 – Volunteering

Theme: Social Capital – *Civic engagement*

Geographic scope: National and provincial

Time series: 2004, 2007, 2010, 2013

Frequency: Every three years

Description: *Volunteering* measures the share of persons aged 15 and over who took part in any activities without pay on behalf of a group or organization at least once in the preceding 12 months, including any unpaid help provided to schools, religious organizations, sports or community associations.

Relevance to comprehensive wealth: Rates of volunteering provide an additional lens on the extent of Canadians' civic engagement (complementing Indicator SC1 – *Participation in Group Activities*) that is focused more closely on tangible benefits.

Volunteers provide time and expertise to services and programs that may not otherwise be delivered. Volunteerism is strongly related to the vitality of communities and helps meet basic needs of vulnerable populations.

Method of calculation: Data are collected via Statistics Canada's Survey of Giving, Volunteering and Participation, which has been undertaken every three years since 2004 and is now part of the regular General Social Survey (GSS) cycle. The GSS targets all people age 15 and older and covers all 10 provinces by telephone interview. Data are broken down by sex, age and province.

Data limitations: Data are available for the Territories for 2004, 2007 and 2010 but not for 2013.

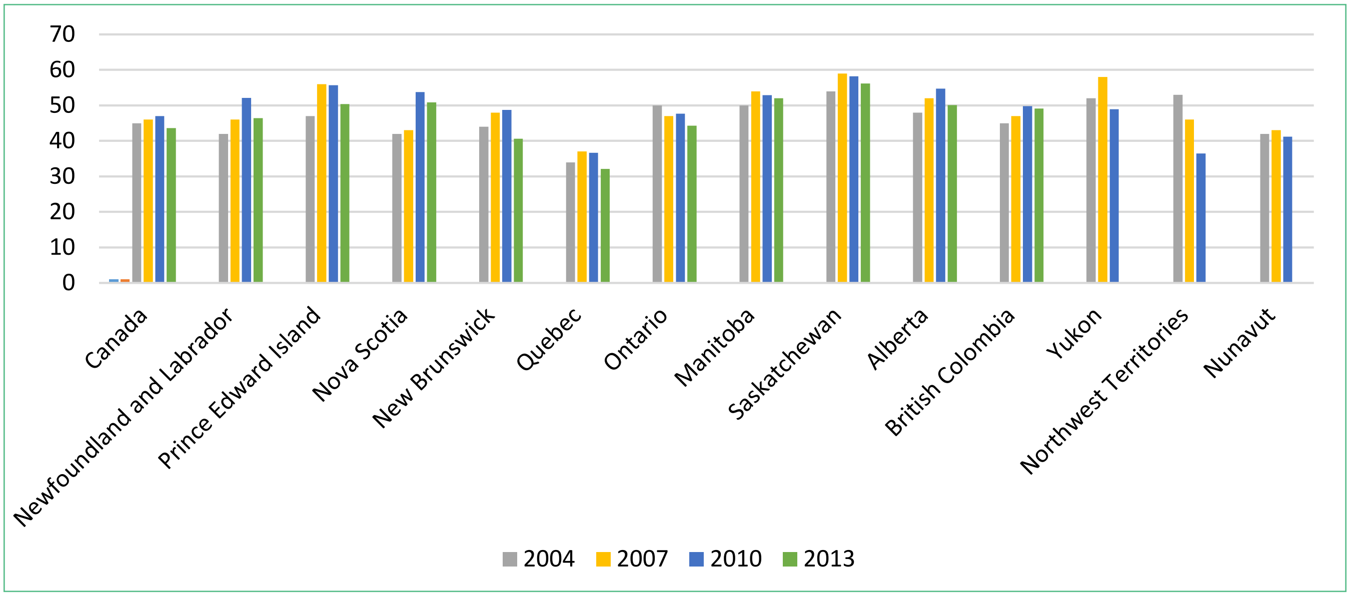
As with all non-monetary indicators, *Volunteering* is not directly comparable with other Comprehensive Wealth indicators in this report.

Reliability: Volunteering is considered very reliable.[143]

Analysis: The volunteer rate in Canada rose from 45 per cent in 2004 to 47 per cent in 2010 before falling to 43.6 per cent in 2013 (Figure 54). Saskatchewan had the highest volunteer rate in 2013, at 56.2 per cent. As with Indicator SC1 – *Participation in Group Activities*, Quebec was again the province with the lowest rate (32.1 per cent) in 2013.

[143] See Footnote 6 for details of the reliability scale used in this report.

Figure 54. Volunteering rates, Canada and provinces/territories, 2004–2013



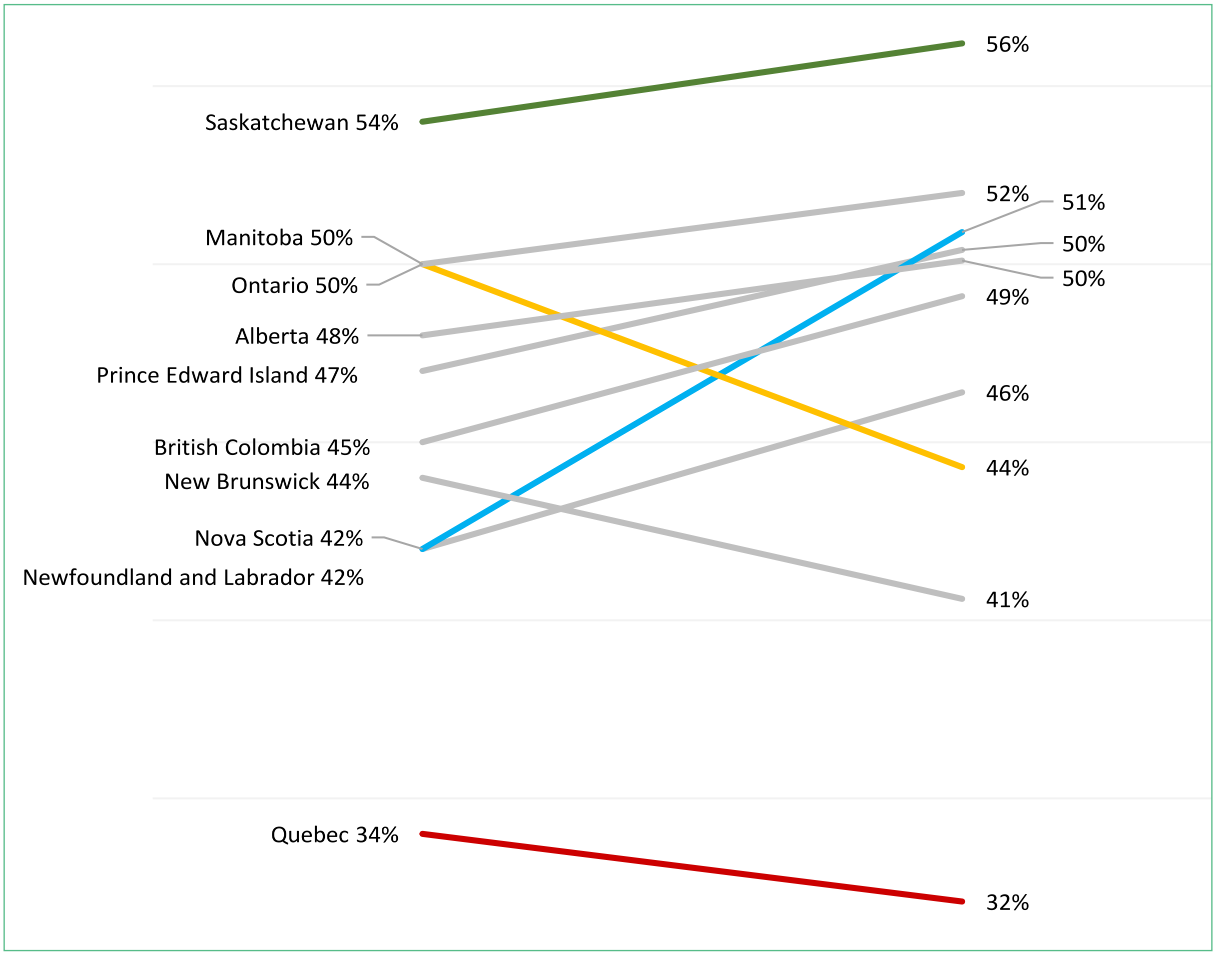
Sources: Hall Lasby, Gumulka, & Tryon, 2006; Vezina & Crompton, 2012; Turcotte, 2015b.
Note: Data are not available for the Territories for 2013.

Only three provinces (Quebec, Ontario and New Brunswick) saw declines in volunteerism between 2004 and 2013 (Figure 55). The large share of the country's population in Ontario and Quebec meant that these provinces drove an overall decline in the national volunteer rate. The largest decline by any one province was that of Ontario, falling from 50 per cent in 2004 to 44 per cent in 2013. The largest increase in volunteer rate was seen by Nova Scotia, rising from 42 per cent in 2004 to 51 per cent in 2013.[144]

Overall, the results across time and across regions were quite uneven, suggesting that no clear trend in volunteering is evident.

[144] It is possible that the decline in 2013 is a statistical artefact rather than a reflection of an actual decline in the rate of volunteering.

Figure 55. Change in volunteering rate from 2004 to 2013, by province



Source: Turcotte, 2015b.

Indicator SC3 – Diversity in Social Networks

Theme: Social Capital – *Civic engagement*

Geographic scope: National and provincial

Time series: 2003, 2008, 2013

Frequency: Every five years

Description: Diversity in Social Networks measures the number of people who in the past month were in contact with at least a few friends from an ethnic group visibly different from their own.

Relevance to comprehensive wealth: Measuring diversity in social networks reveals whether "bonding" or "bridging" linkages are being made in Canadian society. "Bridging" linkages are those made between groups that are different. The opposite is "bonding" linkages, those made when people make connections only with other people like themselves. Bonding links help create more tightly knit groups. Bridging links are important for the opportunities they provide for sharing of knowledge and ideas and the creation of consensus between diverse groups.

Method of calculation: Data are collected via Statistics Canada's General Social Survey (GSS) cycle on social engagement, which is administered every five years. The social engagement cycle is aimed at gathering data to monitor changes in the living conditions and well-being of Canadians and to provide information on specific social policy issues of current or emerging interest. A question on diversity in social networks has been part of the GSS social engagement cycle since 2003. The GSS targets all people 15 years of age and older and covers all 10 provinces by telephone interview. Data are broken down by sex, age and province.

Limitations: Diversity in Social Networks reveals only one type of "bridging": that between visibly different ethnic groups. An indicator of bridging might also look at bridging among individuals from different income categories, regions, linguistic groups, religions and educational levels.[145] As with all non-monetary indicators, Diversity in Social Networks is not directly comparable with the other indicators in this report.

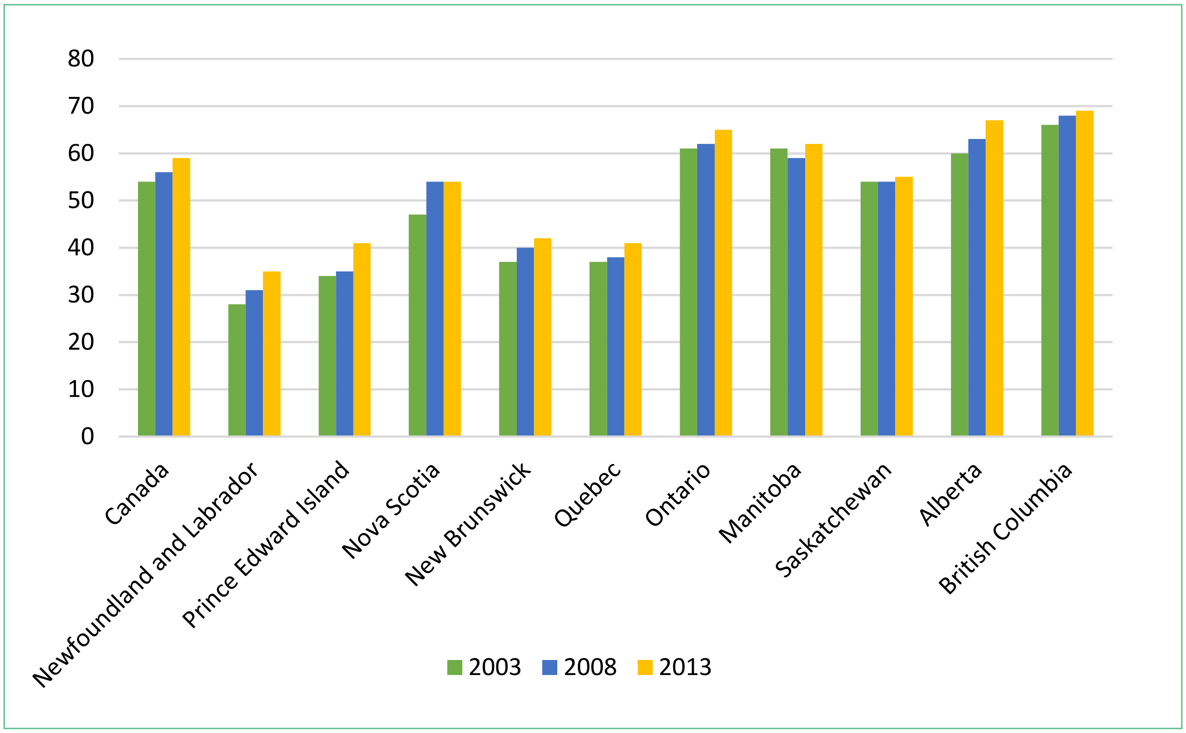
Reliability: Diversity in Social Networks is considered very reliable.[146]

Analysis: The proportion of people in Canada who were in contact with at least a few friends from a visibly different ethnic group increased from 54 per cent in 2003 to 59 per cent in 2013 (Figure 56). An upward trend in the diversity of social networks was apparent in all provinces.

[145] All of these dimensions, except religion, are captured by the GSS.

[146] See Footnote 6 for details of the reliability scale used in this report.

Figure 56. Share of people who in the past month were in contact with at least a few friends from an ethnic group visibly different than their own, by province, 2003, 2008 and 2013



Source: Statistics Canada, General Social Survey, 2003, 2008 and 2013.

The greatest increases in the diversity of social networks took place in Newfoundland and Labrador, Prince Edward Island, Nova Scotia and Alberta, which all experienced a 7 per cent increase between 2003 and 2013.

Diversity in social networks varied considerably between the provinces. British Columbia, Alberta, Ontario and Manitoba all had levels of diversity in social networks greater than 60 per cent. Levels in Quebec, New Brunswick, Prince Edward Island and Newfoundland and Labrador, on the other hand, were 41 per cent or less. This variance may be related to the ethnic diversity of the provinces themselves, as British Columbia, Ontario, Alberta and Manitoba have the highest proportion of visible minorities, while Newfoundland and Labrador, New Brunswick, and Prince Edward Island have the lowest (Turcotte, 2015a). Quebec seems to be an outlier, as it has a relatively high proportion of visible minorities but a low diversity of social networks.

Overall, the results were quite consistent over time and across regions, suggesting the upward trend in diversity in social networks is real.

Indicator SC4 – Control Over Public Decisions

Theme: Social Capital – *Civic engagement*

Geographic scope: National and provincial

Time series: 1993–2015

Frequency of update: Intermittent / during federal elections

Description: Control Over Public Decisions measures the percentage of Canadians that feel they have a say in the public decisions that affect their everyday lives.

Relevance to comprehensive wealth: A feeling of having a high level of control over government decisions can encourage further civic engagement and lead to improved performance of institutions. People are more likely to participate in and trust their government if they feel they have control over government decision making. This leads to a positive cycle of increasing participation and increasing trust.

Method of calculation: Data are collected as part of the Canadian Election Study (CES) administered by a group of academics led by Professor Patrick Fournier of the University of Montreal (Fournier et al., 2011). The CES began as an academic project in 1965 to examine attitudes toward Canadian elections and democracy. Similar studies are carried out in the United States, United Kingdom, the Netherlands and New Zealand. Elections Canada has participated in the CES since 1997.[147]

Limitations: Data were not collected for the 1997 election or for elections prior to 1993.

As with all non-monetary indicators, Control Over Public Decisions is not directly comparable with other Comprehensive Wealth indicators in this report.

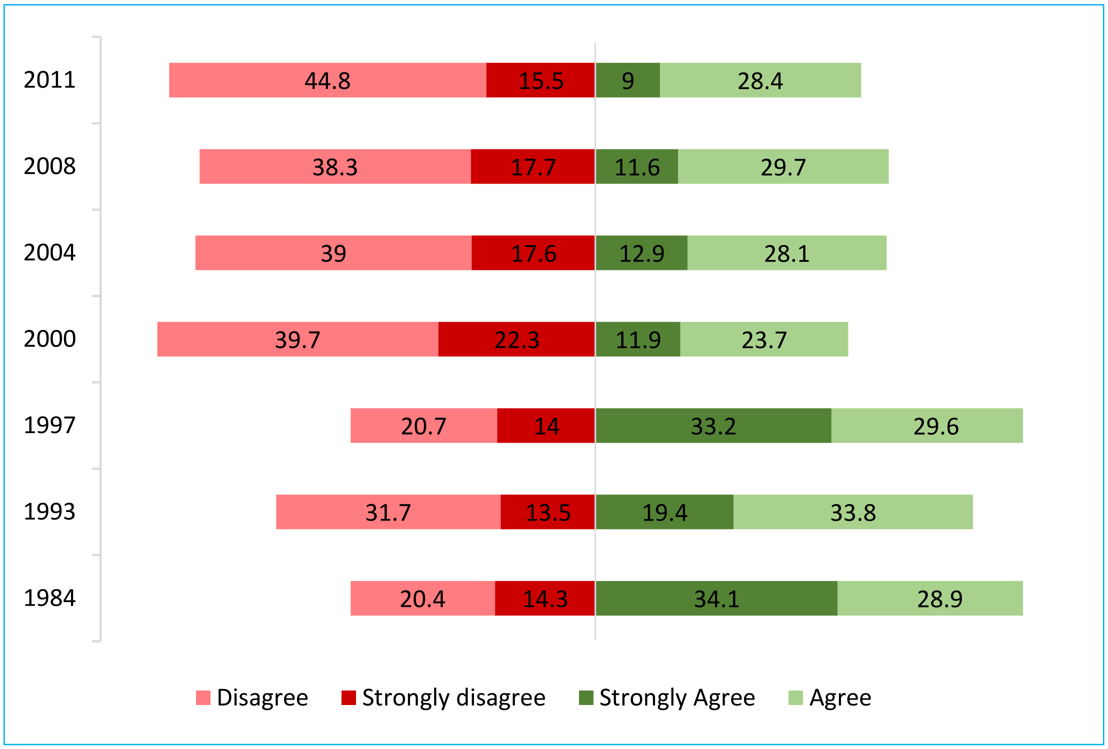
Reliability: Control Over Public Decisions is considered reliable.[148]

Analysis: Data suggest there was been an increase during the 1990s in individuals' feelings of control over public decisions (Figure 57). Since 2000, a fairly stable majority of people (56–62 per cent) have disagreed with the statement "People like me don't have any say about what the government does," though there was slight drop between 2008 and 2011.

[147] Historical data from the CES back to 1965 can be accessed via Queen's University's *Canadian Opinion Research Archive* (http://130.15.161.246:82/webview/).

[148] See Footnote 6 for details of the reliability scale used in this report.

Figure 57. Share of people who believe "People like me don't have any say about what the government does," 1993, 2000, 2004, 2008 and 2011



Sources: Fournier et al., 2011; Gidengil et al., 2008; Blais et al., 2004, 2000, 1997; Johnston et al., 1993

Indicator SC5 – Voter Turnout

Theme: Social Capital – *Civic engagement*

Geographic scope: National, provincial/territorial and municipal (Census Metropolitan Areas)

Time series: 1990 to 2015

Frequency: Each federal, provincial/territorial and municipal election

Description: Voter Turnout measures the percentage of registered voters who turn out to vote in elections.

Relevance to comprehensive wealth: Voter turnout provides a measure of civic engagement and the extent to which people are involved in government decision making. Elections are the most fundamental processes of democratic engagement, and high turnouts are generally considered to be positive.[149] A common concern is that low voter turnouts undermine the notion that electoral outcomes (and therefore policies of government) reflect the will of the general population.

Method of calculation: Data on voter turnout are provided by Elections Canada. Voter turnout is calculated by the number of votes cast divided by the number of registered voters.

Limitations: The denominator of voter turnout, "registered voters," may be changing over time, since not all eligible voters necessarily register to vote. The rate of this change is unknown. This is particularly a problem for municipal elections, for which consistent methods for voter registration do not exist. Other factors may limit the comparability of results across jurisdictions; for instance, it may be more convenient to vote in some jurisdictions (easier registration, more numerous polling stations).

As with all non-monetary indicators, Voter Turnout is not directly comparable with other Comprehensive Wealth indicators in this report.

Reliability: Voter Turnout is considered very reliable.[150]

Analysis: Provincial elections tend to have the highest voter turnouts, with an average of 67.5 per cent of registered voters voting in elections held between 1990 and 2015 (Table 21). Municipal voter turnout is often quite low, with an average of just 40.3 per cent in elections held from 1990 to 2015. High variability in voter turnout is seen in elections at all levels.

Table 21. Voter turnout results in municipal, provincial and federal elections held between 1990 and 2015 (percent)

	Municipal elections	Provincial/ territorial elections	Federal elections
Max	58.4	85.8	69.6
Min	19.6	40.6	58.8
Average	40.3	67.5	64.4

Sources: Federal data from Elections Canada. Provincial data from provincial election authorities. Municipal data was obtained from municipal websites, provincial election authorities and the Association of Municipalities Ontario.

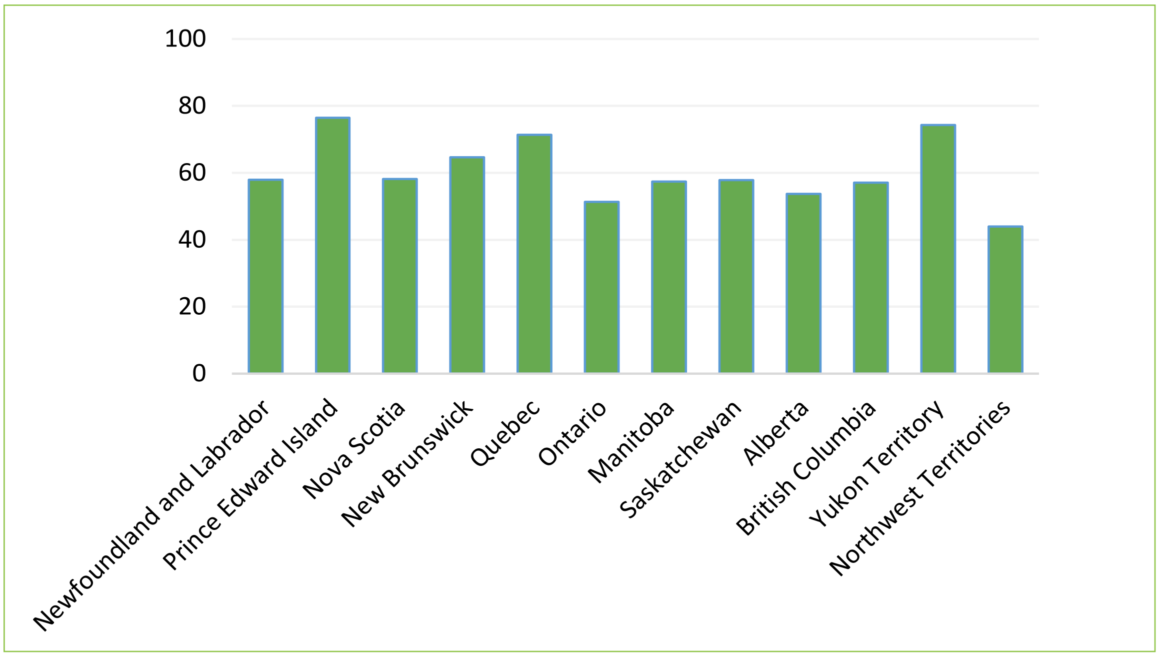
[149] High turnout cannot always be taken as a sign of high voter engagement, as governments in several countries, including Australia, have compulsory voting laws.

[150] See Footnote 6 for details of the reliability scale used in this report.

Prince Edward Island had the highest voter turnout in the most recent provincial election (Figure 58) and the highest turnout (among provinces) in the most recent federal election (Figure 59). Ontario had the lowest voter turnout in the most recent provincial election, while Nunavut and Newfoundland and Labrador had the lowest turnout in the most recent federal election.

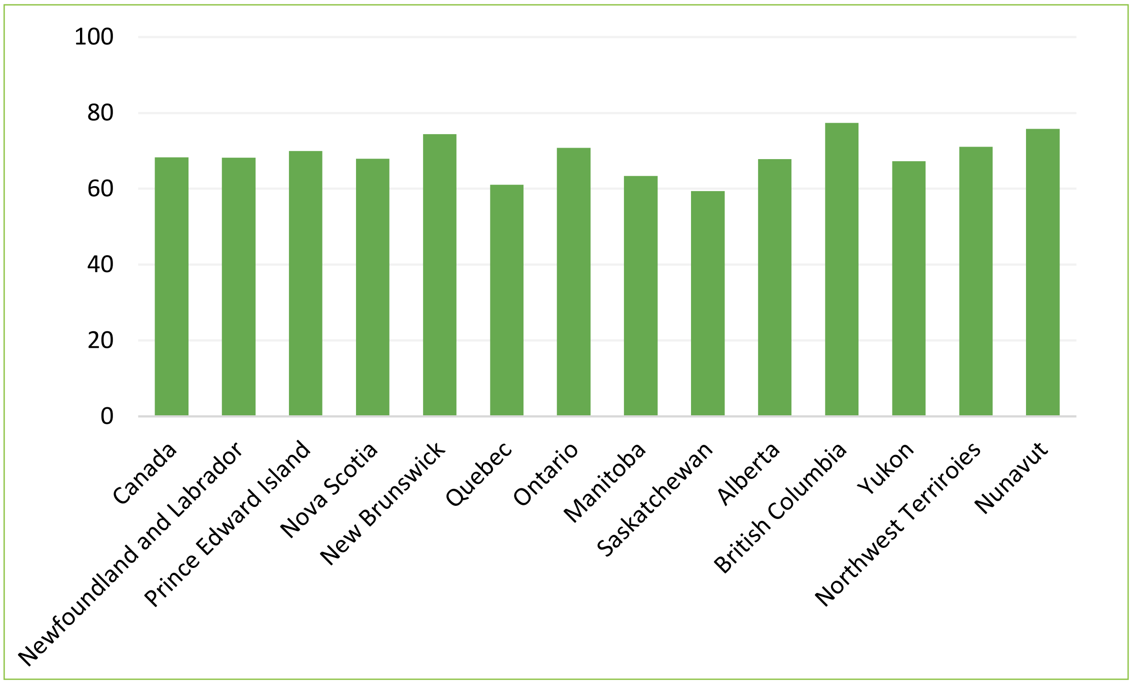
Voter turnout in federal elections generally declined between 1993 and 2011, taking an upturn in the 2015 election to reach almost its 1993 level (Figure 60). It is too early to tell whether this represents the beginning of a return to voting rates similar to those in the 1980s or simply a temporary bend in the overall downward trend.

Figure 58. **Voter turnout, most recent provincial/territorial elections (per cent)**



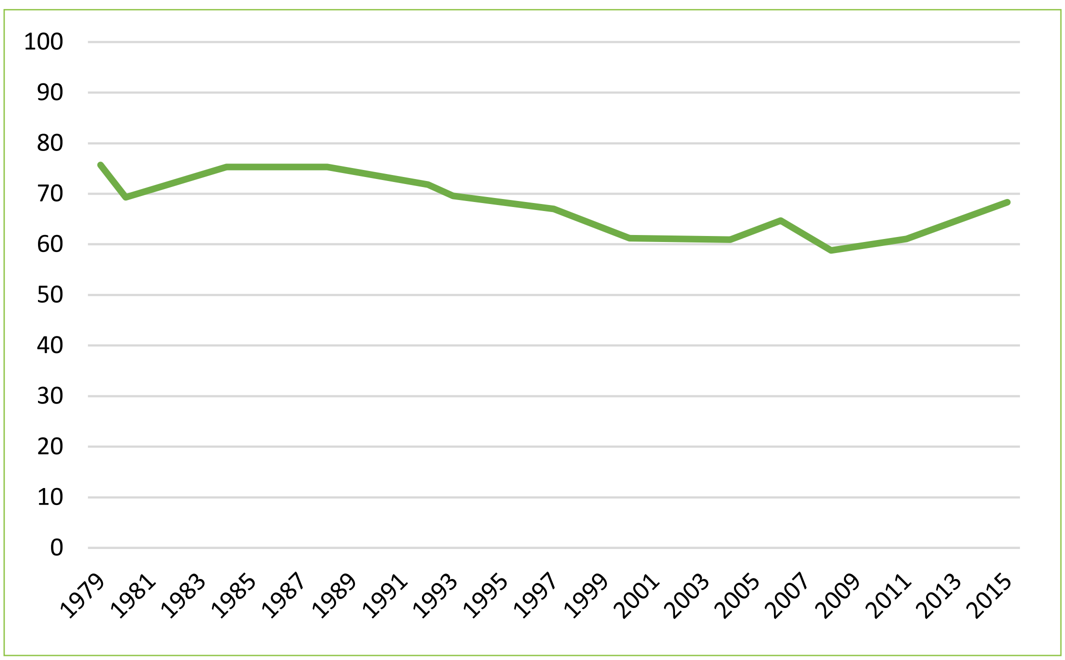
Sources: Elections Newfoundland and Labrador, 2012; Elections Prince Edward Island, 2011; Elections Nova Scotia, 2013; Elections New Brunswick, 2014; Elections Quebec, 2014; Elections Ontario, 2015; Elections Manitoba, 2016; Elections Manitoba, 2013; Elections Saskatchewan, 2016; Elections Alberta, n.d.; Elections BC, n.d.; Elections Yukon, 2012; Elections NWT, 2015.

Figure 59. Voter turnout, most recent federal election (per cent)



Source: Elections Canada, 2016.

Figure 60. Voter turnout, federal elections from 1979 to 2015 (per cent)



Source: Elections Canada, n.d.

Indicator SC6 – Generalized Trust

Theme: Social Capital – *Trust and cooperative norms*

Geographic scope: National and provincial

Time series: 2003–2013

Frequency of update: Every five years

Description: Generalized Trust measures the share of Canadians who think that, in general, most people can be trusted.

Relevance to comprehensive wealth: Trust in others, particularly in strangers and people who are different, is referred to as *generalized trust*. A degree of trust in strangers is necessary for the creation and maintenance of productive social norms. Generalized trust "is often considered an element facilitating social contracts: higher levels of trust mean lower transaction costs and improved likelihood of productive interactions." Trust in others is an important element of collective social capital. Trust in strangers is important for the survival of community institutions and networks (Turcotte, 2015a).

Method of calculation: Data are collected via Statistics Canada's General Social Survey (GSS) cycle on social engagement, which is administered every five years. The social engagement cycle is aimed at gathering data to monitor changes in the living conditions and well-being of Canadians and to provide information on specific social policy issues of current or emerging interest. A question on generalized trust has been part of the GSS social engagement cycle since 2003. The GSS targets all people age 15 years of age and older and covers all 10 provinces by telephone interview. Data are broken down by sex, age and province.

Limitations: Data are not available for the Territories.

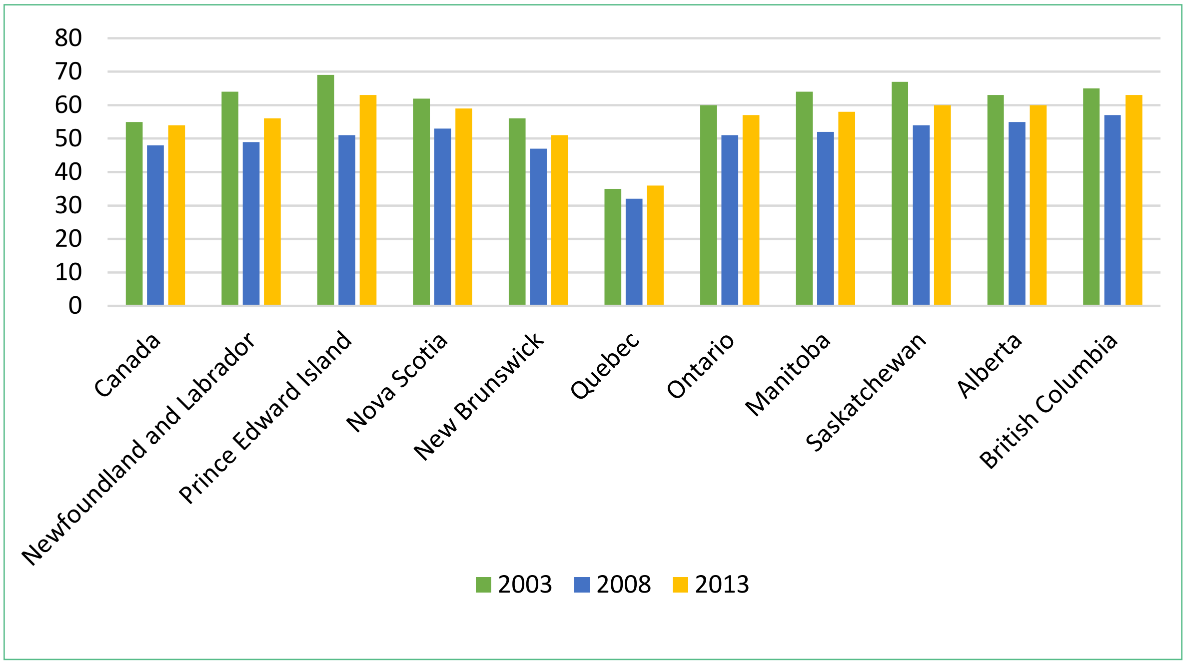
As with all non-monetary indicators, *Generalized Trust is not directly comparable with other Comprehensive Wealth indicators in this report.*

Reliability: Generalized Trust is considered very reliable.[151]

Analysis: In 2013, about half of Canadians (55 per cent) felt that most people can be trusted (Figure 61), essentially unchanged from 2003. Prince Edward Island and British Columbia had the highest levels of generalized trust in 2013 (63 per cent). As with other indicators (Participation in Group Activities – SC1, Volunteering – SC2 and Diversity in Social Networks – SC3) Quebec had lower levels of generalized trust than other provinces. A notable trend is that generalized trust fell from 2003 to 2008 and then rose again in 2013 in all provinces. With the exception of Quebec, generalized trust remained below 2003 levels in 2013. Overall, the results across time and across regions were quite uneven, suggesting that no clear trend in generalized trust is evident.

[151] See Footnote 6 for details of the reliability scale used in this report.

Figure 61. **Share of Canadians who feel that most people can be trusted, Canada and provinces, 2003, 2008 and 2013**



Source: Statistics Canada, General Social Survey, 2003, 2008 and 2013

Indicator SC7 – Trust in Neighbours and Strangers

Theme: Social Capital – *Trust and cooperative norms*

Geographic scope: National and Provincial

Time series: 2003–2013

Frequency of update: Every five years

Description: Trust in Neighbours and Strangers measures the share of Canadians who trust their neighbours and strangers.

Relevance to comprehensive wealth: The percentage of Canadians who believe that, generally speaking, most people can be trusted is a standard question used to evaluate generalized trust (see Indicator SC6 – Generalized Trust). However, since there is some uncertainty in interpreting the results of this question (for example, how do respondents interpret "most people" and what kind of situations are they considering?), additional indicators are helpful to assess Canadians' level of trust in one another.

Method of calculation: Data are collected via Statistics Canada's General Social Survey (GSS) cycle on social engagement, which is administered every five years. The social engagement cycle is aimed at gathering data to monitor changes in the living conditions and well-being of Canadians and to provide information on specific social policy issues of current or emerging interest. A question on trust in neighbours and strangers has been part of the GSS social engagement cycle since 2003. The GSS targets all people age 15 years of age and older and covers all 10 provinces by telephone interview. Data are broken down by sex, age and province.

Limitations: Data are not available for the Territories.

As with all non-monetary indicators, Trust in Neighbours and Strangers is not directly comparable with other Comprehensive Wealth indicators in this report.

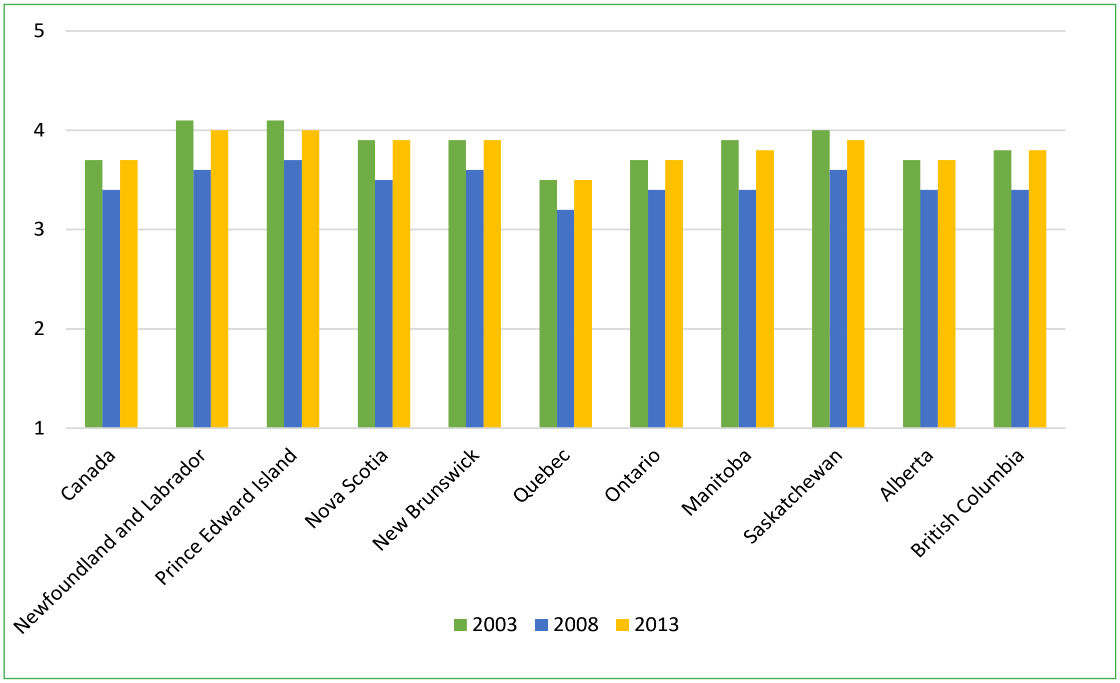
Reliability: Trust in Neighbours and Strangers is considered very reliable.[152]

Analysis: In 2013, the average trust in neighbours in Canada was 3.7 on a scale of 1 to 5 where 1 is low, essentially the same level as in 2003 (Figure 62). Newfoundland and Labrador and Prince Edward Island had the highest trust in neighbours in 2013 at 4. Quebec scored the lowest on this indicator (3.5).

[152] See Footnote 6 for details of the reliability scale used in this report.

As with Generalized Trust (Indicator SC6) all provinces saw a significant decline in trust in neighbours from 2003 to 2008 followed by a subsequent rise in 2013. There was little difference between the 2003 values and the 2013 values except in Newfoundland and Labrador, PEI, Manitoba and Saskatchewan, where levels remained slightly below 2003 in 2013.

Figure 62. Trust in neighbours, Canada and provinces, 2003, 2008 and 2013



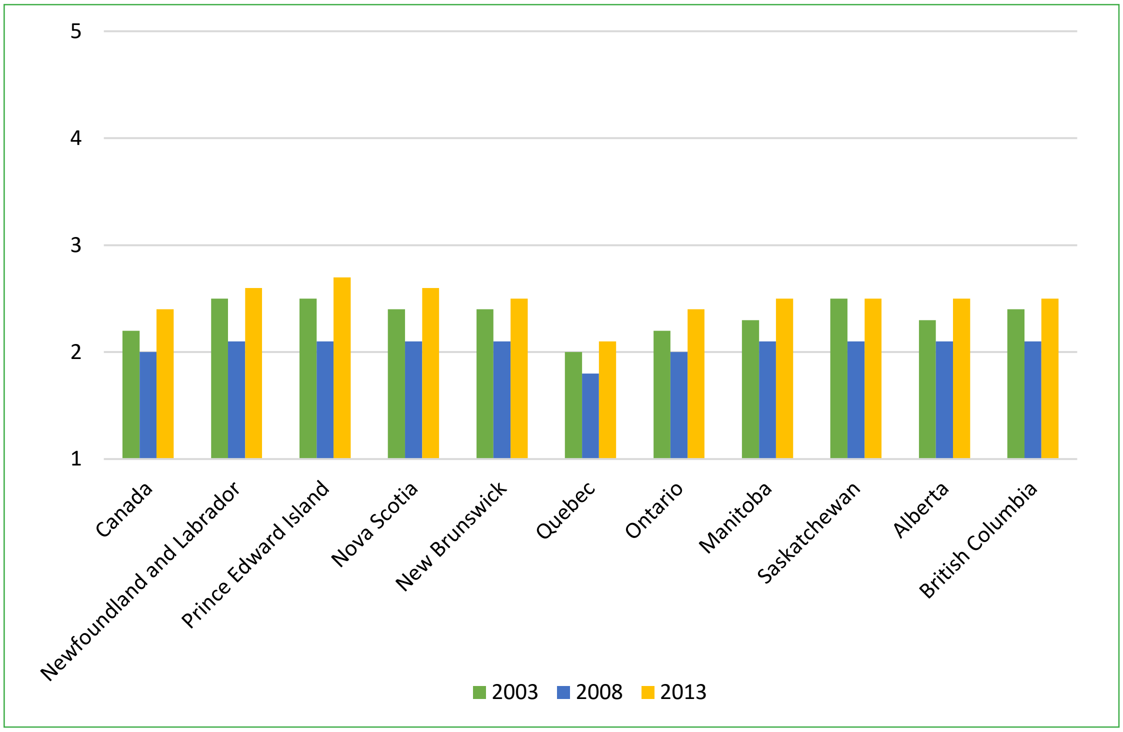
Source: Statistics Canada, General Social Survey, 2003, 2008 and 2013.

http://www.statcan.gc.ca/pub/89-652-x/2015002/t/tbl14-eng.htm

Note: 1 is “Cannot be trusted at all” and 5 is “Can be trusted a lot”

With respect to trust in strangers, the average level across the country in 2013 was 2.4 (again on a scale of 1 to 5). Prince Edward Island had the highest level of trust in strangers in 2013, with a score of 2.7. Quebec scored the lowest at 2.1. Across all provinces trust in strangers is lower than trust in neighbours. As with generalized trust and trust in neighbours, trust in strangers dropped in 2008 and rose again in 2013. However, unlike trust in neighbours, there were increases in all provinces in trust in strangers from 2003 to 2013 (Figure 63).

Figure 63. Trust in strangers, Canada and provinces, 2003, 2008 and 2013



Source: Statistics Canada, General Social Survey, 2003, 2008 and 2013.

http://www.statcan.gc.ca/pub/89-652-x/2015002/t/tbl14-eng.htm

Note: 1 is "Cannot be trusted at all" and 5 is "Can be trusted a lot"

Overall, the results across time and across regions were quite uneven, suggesting that no clear trend in either trust in neighbours or strangers is evident.

Indicator SC8 – Trust That a Lost Wallet Will Be Returned

Theme: Social Capital – *Trust and cooperative norms*

Geographic scope: National and provincial

Time series: 2003, 2008, 2013

Frequency of update: Every five years

Description: Trust That a Lost Wallet Will Be Returned measures the share of Canadians who believe a lost wallet or purse would be returned with the money in it by someone who lives close by.

Relevance to comprehensive wealth: The indicators of Generalized Trust (Indicator SC6) and Trust in Neighbours and Strangers (Indicator SC7) bring progressively more focus to the measurement of trust. This indicator provides an even more concrete assessment of trust. Trust is a broad and abstract concept and it is useful to evaluate it using the specific example of a lost purse or wallet. Doing so reflects trust in the shared values and understandings of how people are expected to behave in society.

Method of calculation: Data are collected via Statistics Canada's General Social Survey (GSS) cycle on social engagement, which is administered every five years. The social engagement cycle is aimed at gathering data to monitor changes in the living conditions and well-being of Canadians and to provide information on specific social policy issues of current or emerging interest. A question on trust in neighbours and strangers has been part of the GSS social engagement cycle since 2003. The GSS targets all people age 15 years of age and older and covers all 10 provinces by telephone interview. Data are broken down by sex, age and province.

Limitations: Data are not available for the Territories.

As with all non-monetary indicators, Trust That a Lost Wallet Will Be Returned is not directly comparable with other Comprehensive Wealth indicators in this report.

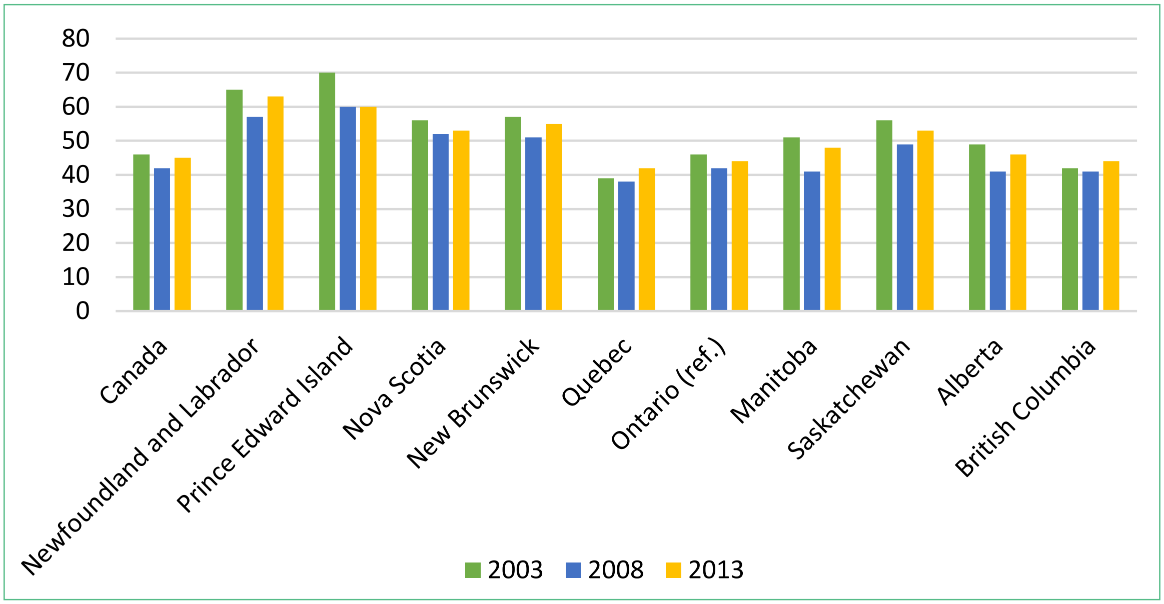
Reliability: Trust That a Lost Wallet Will Be Returned is considered very reliable.[153]

Analysis: In 2013, the share of Canadians who felt they were very likely to have a lost purse or wallet returned if found by a neighbour was 45 per cent (Figure 64). This was a decrease of one per cent from 2003 (46 per cent). As with Generalized Trust and Trust in Neighbours and Strangers, the majority of provinces showed a decline in 2008 followed by a rebound in 2013. Newfoundland and Labrador had the highest percentage of people who felt they were very likely to have a purse or wallet returned (63 per cent). As with other social capital indicators, Quebec scored the lowest (42 per cent). However, Quebec was one of only two provinces (along with British Columbia) where the belief that a lost wallet or purse would be returned increased from 2003 to 2013.

[153] See Footnote 6 for details of the reliability scale used in this report.

Overall, the results across time and across regions were quite uneven, suggesting that no clear trend in Trust That a Lost Wallet Will Be Returned is evident.

Figure 64. **Share of Canadians who believe it is very likely a lost wallet or purse will be returned if found by a neighbour, by province, 2003, 2008 and 2013**



Source: Statistics Canada, General Social Survey, 2003, 2008 and 2013.

http://www.statcan.gc.ca/pub/89-652-x/2015002/t/tbl15-eng.htm

Indicator SC9 – Trust in Institutions

Theme: Social Capital – *Trust and cooperative norms*

Geographic scope: National

Time series: 1993 to 2011

Frequency of update: Intermittent / during federal elections

Description: Trust in Institutions measures the confidence that Canadians place in the government. Unlike the previous trust indicators, which focused on trust in individuals, this indicator measures the trust people place in institutions.

Relevance to comprehensive wealth: Trust in institutions (the electoral system, parliament, the judicial system, or government more broadly) is essential for the smooth functioning of society. Like generalized trust, trust in institutions likely reduces transaction costs. It also affects peoples' relationship with the state—e.g., the extent to which they are willing to vote in elections (Pammett & LeDuc, 2003) or pay or avoid paying their taxes (Putnam, 2001).

Trust in institutions is often gauged via questions about trust or confidence in either (a) specific institutions (e.g., parliament, police, media, corporations, etc.) or (b) government more broadly. Either approach is reasonable, but trust in government provides a broader view of social capital and trust in institutions.

Method of calculation: Data are collected as part of the Canadian Election Study (CES) administered by a group of academics led by Professor Patrick Fournier of the University of Montreal (Fournier et al., 2011). The CES began as an academic project in 1965 to examine attitudes toward Canadian elections and democracy. Similar studies are carried out in the United States, United Kingdom, the Netherlands and New Zealand. Elections Canada has participated in the CES since 1997.[154]

Limitations: Due to data limitations, the indicator measures trust in the federal government only.

Data were not collected for the 2006 election or consistently prior to the 1993 election.

As with all non-monetary indicators, Trust in Institutions is not directly comparable with other indicators in this report.

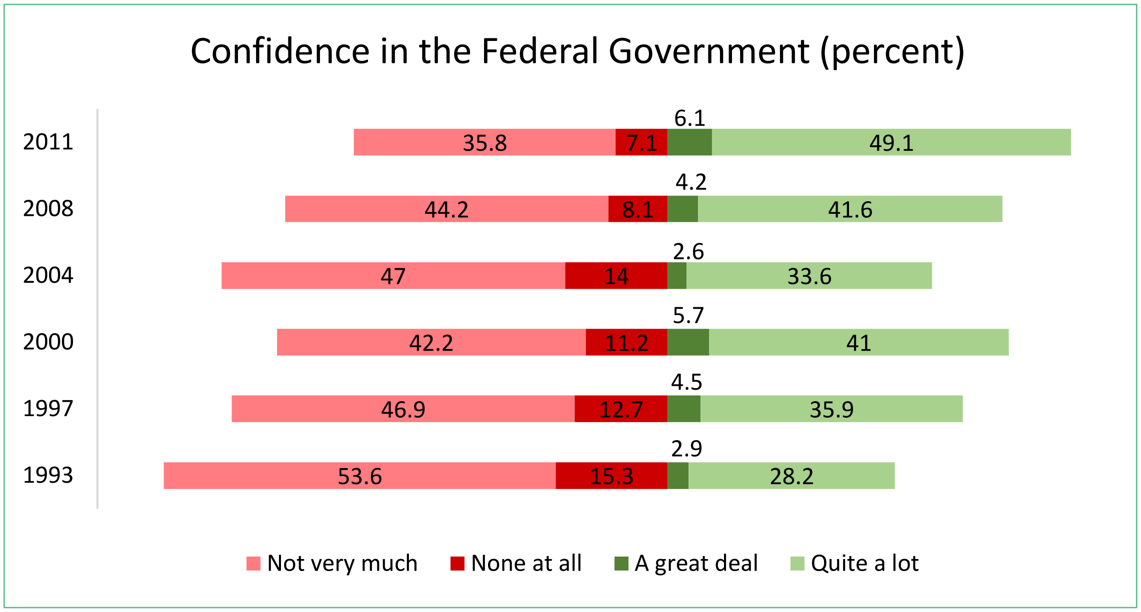
Reliability: Trust in Institutions is considered reliable.[155]

[154] Historical data from the CES back to 1965 can be accessed via Queen's University's *Canadian Opinion Research Archive* (http://130.15.161.246:82/webview/).

[155] See Footnote 6 for details of the reliability scale used in this report.

Analysis: Confidence in the federal government varied considerably from 1993 to 2011, though there was a general trend toward greater confidence. Only 31.1 per cent of people reported having some degree of confidence in 1993, whereas 55.2 per cent had confidence in the government in 2011, the first year that more than half of the population felt that way (Figure 65). The percentage of people who have a great deal of confidence varied but remained consistently low, peaking at 6.1 per cent in 2011. The percentage of people who have no confidence at all, in contrast, fell more or less steadily from 15.3 per cent in 1993 to 7.1 per cent in 2011.

Figure 65. **Share of Canadians expressing confidence in the federal government, 1993, 1997, 2000, 2004, 2008 and 2011**



Source: Fournier et al., 2011.

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ANNEX

Annex 1. Valuation of Market Natural Assets

The valuation of market natural assets is based on the concept of resource rent. Rent is the return to the natural asset as a factor of production in an economic activity, e.g., the return to the commercial forest as an input into timber harvesting industry.

Resource rent is calculated as the difference between the revenues earned in a resource extraction activity in a given year and the costs of that activity, including materials, energy, labour and produced capital inputs (opportunity cost plus depreciation):

$$RR = TR - C - (rK + \partial)$$

where,

RR = annual resource rent
TR = total revenue from resource extraction (net of subsidies)
C = total extraction costs (materials, energy, labour)
r = rate of interest
K = the value of the produced capital stock used in the extraction process
d = depreciation of the produced capital stock.

Following economic theory that says the value of an asset is equal to the present value of the expected future income from its use, the in situ value of market natural assets can be estimated as:

$$V = \int_{t=1}^{T} RR/(1+r)^t$$

where,

V = in situ value of the natural resource asset
t = time
T = the expected remaining asset life156
RR = annual resource rent (calculated as above).

Various assumptions can be made regarding the evolution of revenues and costs over time. The simplest assumption is constancy, meaning that resource rent remains constant over the life the asset. Projected changes in revenues and costs can also be modelled if sufficient information is available about their likely rates of change.

The valuation method described here is consistent with that recommended by the United Nations in the System of Environment-Economic Accounting (United Nations et al., 2014). It is the same approach used in the global inclusive wealth reports published by UNEP (UNU–IHDP and UNEP, 2012 and 2014) and by Statistics Canada (1997).

[156] In the case of sustainably managed renewable resources such as timber and fish, asset life can be assumed to be infinite (though the effect of discounting future income is such that the value of resource rents more than about 40 years in the future is essentially zero). In the case of non-renewable resources, asset life is generally assumed to be equal to the ratio of remaining reserves to current extraction; for example, an iron mine with 100 megatonnes of reserves and annual extraction of 5 megatonnes would have an expected asset life of 20 years.

Annex 2. Comprehensive Wealth Index Methodology

The Comprehensive Wealth Index (Indicator CW1) reported in this study has been compiled by the authors using data from Statistics Canada. The index is a chained Törnqvist volume index of per capita produced, natural and human capital. The details of the calculation are as follows.

First, Statistics Canada estimates of nominal and real produced (non-residential[157] and residential[158]), natural[159] and human capital[160] for the period 1980-2013[161] were converted to per capita terms by dividing by population for the appropriate year.

Using the nominal per capita values as weights and the real per capita values as quantities, the three series were then aggregated into a chained volume index following the Törnqvist formula:

Equation 1. Törnqvist chained volume index of comprehensive wealth

$$
\begin{aligned}
Q_{t-1} = Q_t / \Bigg[& \left(\frac{q_{P,t}}{q_{P,t-1}}\right)^{0.5(\$C_{P,t-1}/\Sigma\$C_{CW,t-1} + \$C_{P,t}/\Sigma\$C_{CW,t})} \\
& * \left(\frac{q_{Res,t}}{q_{Res,t-1}}\right)^{0.5(\$C_{Res,t-1}/\Sigma\$C_{CW,t-1} + \$C_{Res,t}/\Sigma\$C_{CW,t})} \\
& * \left(\frac{q_{Timber,t}}{q_{Timber,t-1}}\right)^{0.5(\$C_{Timber,t-1}/\Sigma\$C_{CW,t-1} + \$C_{Timber,t}/\Sigma\$C_{CW,t})} \\
& * \left(\frac{q_{N,t}}{q_{NKt-1}}\right)^{0.5(\$C_{N,t-1}/\Sigma\$C_{CW,t-1} + \$C_{N,t}/\Sigma\$C_{CW,t})} \\
& * \left(\frac{q_{H,t}}{q_{H,t-1}}\right)^{0.5(\$C_{H,t-1}/\Sigma\$C_{CW,t-1} + \$C_{H,t}/\Sigma\$C_{CW,t})} \Bigg]
\end{aligned}
$$

where:

Q_t = chained Törnqvist volume index for year t

$q_{x,t}$ = real *per capita* value of capital type x in year t

$\$C_{x,t}$ = nominal *per capita* value of capital type x in year t

$\Sigma\$C_{CW,t}\Sigma\$C_{CW,t}$ = Sum of the nominal values of all capital types in year t

P refers to non-residential produced capital

Res refers to residential produced capital

Timber refers to commercial timber natural capital

N refers to mineral, fossil fuel and agricultural land natural capital, and

H refers to human capital.

The Produced Capital Index (Indicator PC1), Natural Capital Index (Indicator NC1) and Human Capital Index (Indicator HC1) are just the relevant sub-indexes of the Comprehensive Wealth Index.

[157] *Flows and Stocks of Fixed Non-Residential Capital, by Industry and Asset*, CANSIM Table 031-0005).

[158] *Flows and Stocks of Fixed Residential Capital*, CANSIM Table 031-0008.

[159] For minerals, fossil fuels and agricultural land, an updated version of the natural capital volume index found in Islam (2007) was provided on special request by Statistics Canada (Islam, personal communication). For timber, value data were taken from CANSIM Table 153-0121, *Value of Selected Natural Resource Reserves* and quantity data were estimated by the authors by extending Statistics Canada's time series of commercial timber volume (CANSIM Table 153-0030, *Timber Assets*), which ended in 2003. This extension was accomplished by moving the Statistics Canada volume data forward using annual allowable cut figures from Natural Resources Canada. See Annex 3 for further details.

[160] An updated time series of the human capital estimates found in Gu and Wang (2010) data were provided on special request by Statistics Canada (Gu, personal communication).

[161] The time period was chosen because it reflects the earliest and most recent years for which data are available on natural capital.

Annex 3. Timber Volume Estimation Methodology

Until 2003, Statistics Canada published an annual time series of commercial timber stock volumes as part of its *Natural Resource Stock Accounts.*[162] Publication ended because a key data source Statistics Canada had relied upon to produce its estimates was replaced and the new source did not offer the detail required to permit continuation of the time series.

In order to include timber in the Comprehensive Wealth Index and compiled for this report, it was necessary to extend the timber volume series to 2013. This was accomplished using data on annual allowable cut (Natural Resources Canada, n.d.) to move the volume series forward. As shown in Table A1, the ratio of the annual allowable cut (AAC) to Statistics Canada's estimates of commercial timber volumes from 1990 to 2003 is quite constant at about 1.85 per cent. This share was applied to the average AAC for 2011 to 2013 to estimate the timber volume for 2013. The years 2004 to 2012 were then filled in using linear interpolation.

Table A1. Annual allowable cut and timber volumes, 1990-2013

Year	Annual allowable cut (AAC)	Commercial timber volume	AAC as a share of volume
1990	249.6	13,276,208	1.88
1991	246.8	13,224,545	1.87
1992	242.4	13,184,110	1.84
1993	239.1	13,127,030	1.82
1994	239.2	13,099,983	1.83
1995	235.6	13,001,332	1.81
1996	236.3	12,934,019	1.83
1997	238.7	12,874,517	1.85
1998	238.1	12,826,804	1.86
1999	238.7	12,765,677	1.87
2000	234.7	12,726,149	1.84
2001	236.9	12,680,889	1.87
2002	237.7	12,618,653	1.88
2003	238.8	12,647,058	1.89
2004	245.9	12,590,569	1.85
2005	244.1	12,534,081	1.85
2006	246.2	12,477,592	1.85
2007	250.7	12,421,104	1.85
2008	249.5	12,364,615	1.85
2009	240.0	12,308,126	1.85
2010	234.9	12,251,638	1.85
2011	228.6	12,195,149	1.85
2012	225.9	12,258,665	1.85
2013	223.7	12,215,511	1.85

Annex 4. Technical details of the lifetime-income (Jorgenson–Fraumeni) approach to human capital measurement

The formula for average human capital per capita is formula (1):

$$h_{e,a} = w1,a \quad ey^{e}_{1,a} + w^{e}_{2,a}y^{e}_{2,a} + sr_{a,a+1}h_{e,a+1}(1+g)/(1+r)$$

Where:

aa = age: 15 to 74;

ee = educational attainment levels (1 to 5): 1 = zero to eight years of school, 2 = some or completed high school, 3 = some post-secondary education below bachelor's degree, 4 = bachelor's degree, 5 = master's degree or above;

$h_{e,a}h_{e,a}$ = average human capital or average lifetime labour income per capita for individuals with age (aa) and education level (ee);

$w^{e}_{1,a}w^{e}_{1,a}$ = probability of engaging in paid employment for individuals with age (aa) and education level (ee), defined as the number of paid workers over the population for that cohort;

$y^{e}_{1,a}y^{e}_{1,a}$ = annual labour compensation of paid workers with age (aa) and education level (ee);

$w^{e}_{2,a}w^{e}_{2,a}$ = probability of engaging in self-employment for individuals with age (aa) and education level (ee);

$y^{e}_{2,a}y^{e}_{2,a}$ = annual labour compensation of self-employed workers with age (aa) and education level (ee);

$sr_{a,a+1}sr_{a,a+1}$ = the probability of surviving on more year from age (aa);

gg = real income growth rate; and

rr= discount rate.

This equation is estimated separately for men and women. The equation requires an estimate of the growth rate of real income. In this case, it is assumed to equal labour productivity growth in the Canadian business sector for the period measured, as real income growth has closely followed labour productivity in the past. Following Gu and Wong, the discount rate is set at 5.1 per cent, which is the weighted average of real rates of return to equity and debt.

Modifications are made to formula (1) in order to account for individuals pursuing further studies so as to incorporate the increase in human capital. Individuals who pursue further education have two possible earning streams, one at their current education level and one at their higher education level. Giving us formula (2):

$$h_{e,a} = w^{e}_{1,a}y^{e}_{1,a} + w^{e}_{2,a}y^{e}_{2,a} + \frac{(1 - senr^{e}_{a})sr_{a,a+1}h_{e,a+1}(1+g)}{1+r} + \sum_{m=1}^{M_e}\left(\frac{senr^{e}_{a}}{M_e}\right)sr_{a,a+m}h_{e+1,a+m}(1+g)^{m}/(1+r)^{m}$$

[162] CANSIM Table 153-0030, *Timber Assets*

where,

$senr_a^e senr_a^e$ = School enrolment rate, which is defined as the proportion of individuals with education level (ee) who are studying for a higher education level ($e+1e+1$); and

$M_e M_e$ = number of years that the individuals with education level (ee) spends to complete a higher education level ($e+1e+1$).

The total value of human capital is the sum of all individuals being counted. Human capital is impacted by the makeup of the population being measured. The total value of human capital will be smaller for a population with a large proportion of individuals at an older age, as this group has fewer earning years ahead of them. Proportion of the population with a certain educational level and wages paid also impact the level of human capital.

In addition to the total value of human capital, it is also useful to measure changes in the value of human capital. Changes can occur either because of changing prices or changing volumes of human capital. A weighted volume estimate provides a measure that is abstracted from changing prices. The difference between the growth of the weighted and unweighted counts is the growth of human capital per capita. Human capital per capita will reflect changes in the makeup of the population being studied, for example as the population ages or becomes more educated.

The weighted volume index is calculated by formula (3):

$$\Delta \ln K = \sum_s \sum_e \sum_a \bar{v}_{s,e,a} \Delta \ln L_{s,e,a}$$

where,

KK = the volume index of aggregate human capital stock

$L_{s,e,a} L_{s,e,a}$ = the number of individuals with gender (ss) age (aa), and education level (ee),

$\bar{v}_{s,e,a} \bar{v}_{s,e,a}$ = the weighted sum of the growth rate of individuals with gender (ss) age (aa), and education level (ee),

$\Delta\Delta$ = a first difference, or change between two consecutive periods, for example:

$$\Delta \ln K = \ln K(t) - \ln K(t-1)$$

Separate aggregate accounts can be constructed based on gender, age or education to examine the impact of demographic changes. Partial volume accounts capture the shift of the population distribution between categories such as men and women, or the five educational levels.

The net present value of lifetime-income of a person is their current income plus the present value of his/her income in remaining years of his/her life. The lifetime-income approach assumes that the future income of an individual is equal to the current incomes of individuals with the same gender and education but one year older. The expected lifetime-income of a person is his/her current income plus his/her expected income in the following period multiplied by the probability of surviving to the following period. Lifetime incomes are calculated with a backwards recursion beginning at age 74, as it is assumed that all individuals are retired by age 75. So, the lifetime-income of a 73-year-old is his/her current income, plus the current income of a 74-year-old with the same education and gender.

Individuals are classified into five educational levels: zero to eight years of schooling, some or completed high school, some post-secondary school below bachelor's degree, bachelor's degree, and master's degree or higher. It is assumed that individuals with zero to eight years of schooling take three years to complete the next education level (some or completed high school). All other education levels are expected to take two years.

The evolution of human capital over time can be examined by breaking the changes in human capital into three components: investment in human capital, depreciation of human capital and revaluation of human capital. Investment in human capital reflects changes in the working age population due to raising children, formal education and migration. Depreciation is the result of aging, death and emigration. Revaluation is the change in the human capital of individuals over time.

Annex 5. Additional Details of Ecosystem Indicators Methods

Natural Capital - Ecosystems

Time Series: 2000–2011

Frequency: Intermittent

Description: The ecosystem indicators in this report address ecosystems from two perspectives:

- change in extent of ecosystems between 2000 and 2011
- pressure on ecosystems as of 2015 from the cumulative development of human land uses.

The ecosystems covered in the report (forests, wetlands, surface freshwater and grasslands) were selected given their relative importance in Canada. Forests are the primary land cover across Canada and a source of much market and non-market wealth. Wetlands are widespread, rapidly disappearing in some parts of the country and also a source of considerable wealth. Grasslands are widespread in the southern Prairies and under extreme threat from development. Fresh water is essential to life and changes in the distribution and amount of freshwater are becoming increasingly important with climate change. Other ecosystems that could have been included but were not are:

- tundra, which shows very little change from 2000–2011 and is currently under little pressure from cumulative development
- coastal zones, for which change in extent is difficult to measure, and
- agricultural land, which shows very little change from 2000–2011 and is, by definition, completely impacted by human land use.

Method of calculation and data sources: The primary data source for the terrestrial ecosystem indicators is the *Land Cover Time Series 2000-2011* spatial dataset compiled by the Canada Centre for Remote Sensing of Natural Resources Canada (Canada Centre for Remote Sensing, 2012). The LCTS 2000–2011 is the most current, publicly available land-cover dataset that provides complete coverage of Canada. It is derived from 250 metre spatial resolution satellite imagery that is designed to be temporally consistent. For the purposes of this report, the 25 land cover classes in the LCTS were generalized to seven terrestrial ecosystem classes (forests, grasslands, tundra, wetlands, agriculture, "disturbance"[163],and urban) to conduct analysis. The LCTS raster layers were re-projected to the Canada Albers Equal-Area projection and intersected with Statistics Canada's 2011 cartographic provincial boundary file[164] to calculate provincial land cover values. A basic analysis of land cover change was conducted using the years 2000 and 2011 to provide a basis for examining the loss or gain in each type of ecosystem.

Statistics Canada's digital boundary files (Statistics Canada, 2012) were used to determine the area of surface freshwater ecosystems in Canada. The area of freshwater lakes and rivers was taken directly from the *Hydrographic Reference Layer* and the extent of rivers was derived from the length of rivers present in Statistics Canada's *River Water Layer*, both using the Canada equal-area conic projection.

To determine the impact of cumulative human development on ecosystems, a spatial dataset of human land uses was created by Global Forest Watch Canada (GFWC). GFWC combined numerous spatial datasets to create a cumulative picture of human access features (such as roads) and combined this with various datasets of land disturbance. The resulting cumulative development dataset includes roads, railways, pipelines, powerlines, oil/gas wells, seismic lines, settlements (point locations), mines, dams, forest clearcuts, water reservoirs, urban areas (built-up extent) and agricultural areas. Linear features were converted to a 1-square kilometre grid and large point features such as mines, dams and settlements were assigned to a 10-square kilometre grid.

To assess the pressure on ecosystems from human development, the cumulative development dataset was intersected with the LCTS (terrestrial ecosystems) and hydrographic (surface freshwater) datasets. For terrestrial ecosystems, this was a simple matter of overlaying the two spatial raster (grid) datasets. For surface freshwater, the cumulative development dataset was first converted to a vector (polygon based) format and then area values were calculated based on the Canada equal-area conic projection.

Limitations: The LCTS dataset is intended to be used for national to regional modelling and assessment studies where information on land-cover dynamics are needed; provincial values will have a higher degree of uncertainty as a results.

GFWC's cumulative development dataset is a compilation of numerous different datasets, all of which were created for different purposes for different regions and using different methodologies. Thus, the extent, accuracy, resolution and reference periods of each of the original data sources are not consistent. The dataset does not represent the extent of development at any one point in time but rather a cumulative picture of development over time. As such, not all areas indicated as "developed" may presently have a physical human footprint and some areas may have returned to a natural state. To account for the ecological effects of human disturbance, a conservative ecological buffer of 500 metres is applied to linear disturbances (since disturbances are assigned to a 1-square kilometre grid). Ecological buffers differ for different species, however, and other human footprint studies have extended buffers as far as 15 km (Sanderson et al., 2002), so the buffer here may underestimate the degree of "development" for some ecosystems.

Reliability: Overall, the ecosystem indicators are considered reliable.[165]

The LCTS dataset is obtained from Natural Resources Canada and has been published in the peer-reviewed scientific literature (Pouliot et al., 2014) and was used in a Statistics Canada (2013a) report on measuring ecosystem goods and services. This dataset should be considered very reliable.

Statistics Canada's *Hydrographic Reference Layer* is a standardized product and should be considered very reliable.

The GFWC cumulative development dataset is compiled from a variety of publicly available datasets of varying quality that do not provide consistent spatial or temporal coverage across Canada. The data should be considered acceptable.

[163] "Disturbance" includes the "burned forests" and "shrubland/low vegetation cover" land-cover classes in the *Land Cover Time Series 2000-2011.*

[164] Statistic Canada, Boundary Files , available at https://www12.statcan.gc.ca/census-recensement/2011/geo/boundlimit/bound-limit-eng.cfm.

[165] See Footnote 6 for details of the reliability scale used in this report.

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