CANADA'S ENVIRONMENTAL RECORD: AN ASSESSMENT

A Study prepared for the David Suzuki Foundation
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EXECUTIVE SUMMARY

ES.1 BACKGROUND

1. Canadians have a strong desire to achieve environmental sustainability. Eight out of ten Canadians believe that environmental protection should receive priority over economic growth and nine out of ten Canadians rate the environment as one of their top concerns. According to international public opinion research, Canadians are the strongest supporters of environmental protection of 30 countries surveyed.

2. A recent study by Boyd (2001) compared Canada's environmental performance to 29 OECD countries based on 25 environmental indicators. The study found that Canada ranked second last: 28th out of the 29 OECD countries. Only the United States had a poorer environmental record.

3. The discrepancy between Canada's environmental commitment and environmental performance can be termed the **Canadian Environmental Paradox.** How can Canadians be among the strongest supporters of sustainability yet have one of the poorest environmental records of any developed country?

4. In response to Canada's poor environmental record, the David Suzuki Foundation (DSF) published *Sustainability within a Generation*, a framework that would help achieve a sustainable society by the year 2030 (Boyd 2004). The implementation of the DSF plan would fulfill the goals of the Canadian public and governments to become world leaders in sustainable management.

5. A key step in achieving environmental sustainability is to have an environmental sustainability reporting system (ESR) that tracks environmental progress. Canada's state of environment reporting was discontinued in 1996 due to budget cuts and, according to the Commissioner of Environment and Sustainability, environmental assessment of federal government activities is poor to nonexistent. Although Canada is making progress in ESR, Canada currently has no comprehensive ESR and is therefore unable to track progress towards environmental sustainability.

6. DSF requested the Sustainable Planning Research Group (SPRG) in the School of Resource and Environmental Management at Simon Fraser University to prepare an independent evaluation of Canada's environmental performance. The SPRG assembled a multidisciplinary team of fourteen researchers to complete the study. The research team completed a draft of the report, which was then submitted to a peer review undertaken by experts in the private, public, and nongovernmental organization sector. The report was revised based on the peer review and submitted to a second more limited peer review prior to publication.

ES.2 REPORT OBJECTIVES

7. The purpose of this study is to develop and apply ESR to assess Canada's progress towards environmental sustainability. The application of ESR will assist policy makers and the public in identifying strengths and weaknesses in Canada's environmental performance, identify key issues, and identify successes in environmental sustainability both within Canada and in other nations that can be analyzed in more detail to develop best practice environmental management strategies. Specifically, the objectives of this report are to:
   - Develop a methodology for assessing progress towards environmental sustainability.
   - Provide a benchmark for Canadian environmental sustainability performance that can be used to measure future progress.
   - Assess trends in environmental sustainability to identify key successes and failures in Canadian sustainability initiatives.
   - Identify the most environmentally successful countries that should be analyzed in more detail to develop best practices for sustainable environmental management.

8. It should be noted that this study focuses on environmental sustainability. Social and economic sustainability issues are not included. This study also does not seek to explain differences in environmental performance or keys to achieving successful environmental strategies. Instead, this study seeks to develop and apply an ESR as part of a strategic scan to pinpoint successes and failures in environmental strategies that should be analyzed in more detail to help develop environmental "best practices."

9. The development of the ESR for this study utilizes the sustainability framework developed by DSF based on nine critical sustainability challenges summarized below.

SUSTAINABILITY CHALLENGE	SUSTAINABILITY GOAL
1. Generating Genuine Wealth	*Canada becomes a world leader in innovative ways of living sustainability and protecting the environment. To do so, we must measure progress by supplementing the narrow concept of economic growth with an effort to measure all factors that make life worthwhile.*
2. Improving Environmental Efficiency	*Canada becomes a world leader in the efficient and effective use of energy and resources, enabling us to improve our quality of life while reducing energy and material use. If we are to live within our means, this goal is critical because it recognizes the limits of Earth's natural system.*
3. Shifting to Clean Energy	*Canada moves to the forefront of the global clean energy revolution, reducing fossil fuel production, use, and export, harnessing low-impact renewable energy sources, and moving toward a hydrogen economy. These steps are vital for addressing the grave threat posed by climate change.*
4. Reducing Waste and Pollution	*Canada becomes a world leader in modifying production and consumption patterns to mimic nature's closed-loop cycles, thus dramatically reducing waste and pollution.*
5. Protecting Water	*Canada becomes a world leader in water stewardship by protecting and restoring the quantity and quality of fresh water in Canadian ecosystem, and by guaranteeing access to clean water in the Canadian Charter of Rights and Freedoms.*

6. Producing Healthy Food	*Agriculture in Canada provides nutritious, healthy foods for Canadians as well as people around the world, while safeguarding the land, water, and biodiversity.*
7. Protecting and Restoring Nature	*Canada becomes globally renowned for our leadership in conserving, protecting and restoring the health and diversity of our ecosystem, the magic of our parks and wilderness areas, and the natural beauty of our nation.*
8. Building Sustainable Cities	*Canadian cities become vibrant, clean, livable, prosperous, safe, and sustainable.*
9. Promoting Global Sustainability	*Canada returns to being one of the most compassionate and generous nations on earth, a global leader in securing peace, alleviating poverty, and promoting sustainability in the developing world.*

ES.3 METHODOLOGY

10. The development of an ESR was based on the following steps. First, existing ESR studies were reviewed to identify alternative ESR methods. Based on this review, a list of environmental indicators was prepared and assessed by the following criteria:
    - The indicator must provide a meaningful measure of environmental sustainability.
    - The indicator must be generally understandable for a nontechnical audience.
    - The data required for the indicator must be available in a timely fashion, produced on a regular basis using consistent definitions for OECD countries, and be reliable.
    - The indicator should not directly replicate other indicators.

11. Based on the evaluation, 37 indicators were chosen for this study and 29 of the 38 indicators for which OECD data were available were used for international comparisons. Due to data limitations, a smaller number of indicators (22) were used for provincial comparisons. The indicators were grouped under one of the nine thematic categories used in the DSF *Sustainability within a Generation* report.

12. Once the indicators were selected, data for each indicator were collected for each OECD member country (including Canada) and the ten Canadian provinces. Most statistical data for Canada and other OECD countries originate from the OECD's Environmental Data Compendiums (OECD 2005). OECD data were used because of the due diligence data assessment undertaken by the OECD to ensure reliability and comparability of data. Provincial data are mainly from Statistics Canada sources. Data for each indicator were assembled for the years 1990 to the most current year available. In some cases, data were available for only a portion of this time frame.

13. The next step was to interpret the data to evaluate progress towards sustainability. Three methods for evaluating environmental performance were reviewed: objectives-based performance that measures performance against optimal objectives, time-series performance that measures performance trends, and cross-sectional performance that measures or "benchmarks" performance against other jurisdictions. The objectives-based performance method could not be used because there are no comprehensive environmental objectives.

The time-series method was rejected because it provides no reference point to assess whether the performance is satisfactory. Therefore, the cross-sectional performance method was chosen for this study because it provides reference points to evaluate performance based on the performance of other countries, and the data necessary to complete a cross-sectional analysis are available.

14. The cross-sectional evaluation used in this study is based on two components: environmental performance and environmental improvement. Environmental performance evaluates current performance and environmental improvement evaluates the change in environmental performance over time.

15. Canada's current environmental performance is assessed based on two measures:
    - **Environmental Performance Rank (EPR),** defined as Canada's ordinal rank relative to OECD countries for each indicator.
    - **Environmental Performance Grade (EPG)**, defined as Canada's performance relative to the OECD country with the best performance for each indicator. The best performing country receives an EPG of 100%. The EPG for Canada indicates the magnitude of the difference between Canada's performance and the best performing country.

16. Unless otherwise stated, Canada's environmental improvement is assessed by calculating the percentage change for each environmental indicator over the period 1992 to 2002. The rate of change is assessed to determine if the indicator value is improving or deteriorating and by how much. The Canadian trend is then compared to the OECD average and OECD best trend over the same period. The EPR and the EPG are also calculated for 1992 and compared to the 2002 results to determine if environmental performance is improving or deteriorating. It is important to emphasize that percentage change in environmental indicators depends on the starting point and does not necessarily signify good or poor environmental performance. A country with poor performance may have a large percent improvement, but still be at a relatively poor performer.

17. It is important to keep the following qualifications in mind when interpreting the results of this study. First, overall country and provincial rankings and grades give equal weight to each indicator. Different weightings would produce different results. Second, differences in environmental performance are due to a number of factors, some of which may be beyond the control of the country, or generated by the consumption patterns in a separate importing country. Third, although the OECD tries to use common definitions and data assessment, the quality and currency of data varies among jurisdictions thus making cross country comparisons less than perfect. Fourth, composite country rankings are sensitive to the method and indicators used. Different indicators and different aggregation methods will produce different results. For this reason, it is important to focus on the disaggregated results by indicator, as well as the composite results. More specifically, the ordinal ranking system used in this report measures only whether one country is ahead of another. Ordinal ranking does not measure the magnitude of differences between countries. Countries wide apart in rank may have very small differences in environmental performance. The EPG calculation, however, addresses this deficiency in the ordinal rank by measuring these differences.

ES.4 FINDINGS

18. Canadian environmental policy has been evaluated on the basis of a comprehensive set of environmental indicators using different measures of comparison. The results for all evaluative measures show that Canada's environmental performance is poor.
    - Canada's current composite environmental performance is the third worst of any OECD country: 28th out of 30 (table ES.1).
    - Canada's environmental performance is worse than the OECD average for 17 of 29 indicators.
    - Canada's environmental performance is worse than the OECD best performing country for all 29 indicators.
    - Canada's EPG is only 26.7% (table ES.1).

19. Environmental trend line analysis shows equally poor results. On the positive side, Canada recorded an improvement in 17 of 28 indicators over the last decade (1992-2002). However, Canada's rank remains 28th of 30 countries and Canada's composite EPG actually declined. Canada's environmental performance therefore shows no improvement relative to other OECD countries. Specifically, the comparative trend line analysis for 1992 to 2002 shows that:
    - Canada's rate of improvement is below the OECD average rate of improvement for 17 of 28 indicators.
    - Canada's rate of improvement is below the OECD best rate of improvement for 27 of 28 indicators.
    - Canada's relative position remained unchanged at 28th of 30 countries, and Canada's EPG deteriorated slightly from 28.7% in 1992 to 26.7% in 2002 (table ES.2).

20. Canada's failure to improve its environmental performance faster than the OECD average is surprising. Countries like Canada, which have inferior environmental performance, should be able to improve at a faster rate than the average OECD country because they can adopt existing best practices and technology used by the best performing countries. The best performing countries face the more difficult challenge of developing new technologies and practices.

ES.5 CAUSES FOR CANADA'S POOR PERFORMANCE

21. Canada's poor environmental performance may be due to a combination of factors including geography, climate, resource endowment, economic structure and poor environmental policy. Some factors are exogenous constraints that can not be easily altered and some factors are endogenous constraints that can be mitigated by improved policy.

22. The relative significance of factors explaining Canada's poor performance awaits further study. However, independent evaluations by the OECD and the Canadian Commissioner of Environment and Sustainable Development indicate that poor public policy is a major factor explaining Canada's poor environmental performance.

Table ES.1: Canada's 2002 environmental performance relative to OECD

CHALLENGE	INDICATOR	RANK	EPG*
Environmental Efficiency	1. Energy Consumption (toe/cap)	28th of 30	13.3%
	2. Energy Intensity (toe/US$1,000 GDP)	29th of 30	45.5%
	3. Water Consumption (m^3/cap)	29th of 30	9.2%
	4. Environmental Pricing (environmental taxes as % of GDP)	28th of 29	27.7%
Clean Energy	5. GHG Emissions (tonnes CO_2 equiv/cap)	26th of 29	15.5%
	6. Renewable Energy including Hydro (as % of electricity)	5th of 29	59.8%
	7. Renewable Energy excluding Hydro (as % of electricity)	18th of 30	8.3%
Waste & Pollution	8. Sulfur Oxides (kg/cap)	27th of 28	3.4%
	9. Nitrogen Oxides (kg/cap)	26th of 28	15.8%
	10. VOCs (nonmethane) (kg/cap)	29th of 29	12.9%
	11. Carbon Monoxide (kg/cap)	28th of 28	8.7%
	12. Ozone-Depleting Substances (kg/cap)	12th of 14	4.0%
	13. Municipal Waste (kg/cap)	19th of 28	61.2%
	14. Recycling of Municipal Waste (% of municipal waste)	9th of 30	52.7%
	15. Nuclear Waste (kg/cap)	30th of 30	0.0%
	16. PAC Expenditures (% of GDP)	13th of 25	45.8%
Water Quality	17. Municipal Sewage Treatment (% population with treatment)	14th of 28	73.1%
Healthy Food	18. Pesticide Use (kg/km^2 arable land)	8th of 30	4.0%
	19. Fertilizer Use (tonnes/km^2 arable land)	2nd of 29	83.8%
	20. Livestock (sheep equiv/km^2 arable and grassland)	2nd of 29	48.8%
Nature	21. Number of Species at Risk	26th of 30	10.0%
	22. Percent of Species at Risk	8th of 30	32.5%
	23. Protected Areas (as % of land base)	16th of 30	26.6%
	24. Timber Harvest (m^3/ km^2 forestland)	2nd of 29	39.9%
	25. Timber Harvest-Forest Growth Ratio	5th of 29	25.0%
	26. Per Capita Capture Fisheries (kg/cap)	20th of 28	0.8%
	27. Fisheries as Percent of World Catch	15th of 23	10.0%
Sustainable Cities	28. Distance Traveled (1,000 vehicle-km/cap)	29th of 30	6.4%
Global Sustainability	29. Official Development Assistance (% of GNI)	12th of 27	29.2%
	Overall Average	**28th of 30**	**26.7%**

Table ES.2: Canada's performance addressing sustainability's critical challenges

CHALLENGE	CANADA EPG 2002	CANADA EPG 1992
Genuine Wealth Indicator	0%	0%
Environmental Efficiency	23.9%	25.4%
Clean Energy	27.9%	33.1%
Waste & Pollution	22.7%	16.9%
Water (sewage treatment)	73.1%	64.3%
Healthy Food	45.5%	49.9%
Conserving Nature	20.7%	29.7%
Sustainable Cities	6.4%	4.8%
Global Sustainability	29.2%	39.7%
Overall Average	**26.7%**	**28.7%**

23. The role of poor public policy is also illustrated by success stories in Canada in areas such as sulfur oxides and ODS reductions. These success stories show that significant improvements are possible with the right public policy.

24. The role of public policy is further illustrated by the superior environmental performance of high-income countries such as Switzerland, Denmark, Germany, Austria, Sweden, and the Netherlands, which have superior environmental records than Canada despite having many characteristics such as income levels and industrial structure in common.

ES.6 RECOMMENDATIONS

25. Regular reporting of environmental monitoring results based on a comprehensive Environmental Sustainability Reporting System (ESR) is essential to track Canada's environmental performance and assess effectiveness of environmental policies. Although Canada is making progress in environmental reporting and monitoring with initiatives such as the National Air Pollutants Surveillance System, the National Pollutant Release Inventory, and national water quality monitoring, Canada does not have an ESR to provide the public and policy makers with environmental tracking of Canada's environmental performance. Therefore, it is recommended that Canada adopt a comprehensive ESR that tracks Canada's environmental performance on an annual basis.

26. In undertaking this study it was found that there are important environmental data gaps concerning Canada and the provinces that make it difficult to track environmental performance. Key data gaps that need to be addressed include: raw materials consumption, air quality, water quality, pesticide use, species at risk, biodiversity, ecosystem-based management practices, natural assets valuation, and human health impacts of pollution.

27. The credibility and effectiveness of ESR is contingent on the process having a legislated authority and an independent, collaborative management structure. Therefore, it is recommended that either a new independent ESR agency be created (or the mandate of the existing Commissioner of the Environment and Sustainable Development be changed) with the following mandate:
    a. The ESR function is specified in legislation.
    b. The ESR statute contains a clear mandate that obligates the ESR agency to
        - complete a comprehensive assessment of Canada's environmental performance and environmental policies on an annual basis;
        - set goals, measurable objectives, and targets with timelines for Canadian environmental policy in the nine sustainability categories outlined in this report,
        - recommend policies for achieving environmental goals and objectives, which include a plan that clearly shows when and how the goals, objectives, and targets will be met; and
        - report the results of the above assessment of Canada's environmental record in an annual public report to the Canadian Parliament.
    c. The ESR agency has a multistakeholder Board of Directors compromised of representatives from government, industry, First Nations, and nongovernmental organizations.

28. This report has completed a strategic scan that shows that Canada's environmental performance significantly lags the performance of most OECD countries. It is recommended that more analysis be undertaken to assess the reasons for differences in environmental performance and to identify keys to the success of the best performing jurisdictions. The best practices assessment should then be used to evaluate Canadian environmental policy and identify changes required to improve Canada's environmental performance.

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LIST OF ACRONYMS

AGPI	Alberta Genuine Progress Indicator Accounting Project
CBC	Conference Board of Canada
CEC	Commission for Environmental Cooperation
CESCC	Canadian Endangered Species Conservation Council
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CUTA	Canadian Urban Transit Association
DSF	David Suzuki Foundation
EBM	ecosystem-based management
ESR	environmental sustainability reporting system
EPG	Environmental Performance Grade
ESI	Environmental Sustainability Index
EPR	Environmental Performance Rank
ESR	Environmental Sustainability Reporting System
ESDI	Environment and Sustainable Development Indicators
GDP	gross domestic product
GHG	greenhouse gas
GPI	Genuine Progress Indicator
GPI Atlantic	GPI Atlantic Natural Resource and Environmental Accounts/Genuine Progress Index for Nova Scotia
GNI	gross national income
GWI	genuine wealth indexes
HCFC	hydrochlorofluorocarbon
HFC	hydrofluorocarbon
IUCN	World Conservation Union
m^3	cubic meters
MUD	Municipal Water Use Database
N_2O	nitrous oxide
NPRI	National Pollutant Release Inventory

NRTEE	National Round Table on the Environment and the Economy
ODA	Official Development Assistance
ODP	ozone-depleting potential
ODS	ozone-depleting substance
OECD	Organization for Economic Cooperation and Development
PAC	pollution abatement and control
PFC	perfluorocarbon
PM	particulate matter
$PM_{2.5}$	particulate matter 2.5 microns in diameter or less
SF_6	sulfur hexafluoride
SPRG	Sustainable Planning Research Group
toe	tonnes of oil equivalent
UNFCCC	*United Nations Framework Convention on Climate Change*
VOC	volatile organic compound
WCED	World Commission on Environment and Development
WWF	World Wildlife Fund

CHAPTER 1:
INTRODUCTION

1.1 BACKGROUND

With the publication of *Our Common Future* in 1987 (World Commission on Environment and Development (WCED)) sustainability emerged as a dominant theme in public policy. The WCED defined sustainable development as "meeting the needs of the present generation without sacrificing the needs of future generations" (WCED 1987: 43).

Canada, like most other nations, enthusiastically adopted the goal of sustainability as a priority in the nation's agenda. The creation of the National Round Table on the Environment and the Economy (NRTEE), the mandate of Environment Canada, and the creation of the Commissioner on the Environment and Sustainable Development all attest to Canada's commitment to achieve a sustainable future.

The Canadian public also strongly endorses the goals of sustainability. Nine out of ten Canadians rate the environment as one of their top concerns (Canada, Statistics Canada 2000) and eight out of ten Canadians believe that environmental protection should be given priority over economic growth. According to Environics, the level of support for environmental protection in Canada is the highest of the 30 countries surveyed (Pynn 1999).

How successful has Canada been in achieving sustainability? David Boyd addressed this question in a study that compared Canada's environmental performance to 29 Organization for Economic Cooperation and Development (OECD) countries based on 25 environmental indicators derived from OECD environmental data (Boyd 2001). According to the analysis, Canada ranked second last: 28th out of the 29 OECD countries. Only the United States had a poorer environmental record. Other studies also show that Canada lags other OECD countries in environmental performance (see appendix B)

The discrepancy between Canada's environmental commitment and environmental performance can be termed the **Canadian Environmental Paradox.** How can Canadians be among the strongest supporters of sustainability yet have one of the poorest environmental records of any developed country?

In response to demand for a more sustainable future, the David Suzuki Foundation (DSF) published *Sustainability within a Generation*, which provides a framework for how to achieve a sustainable society by the year 2030 (Boyd 2004). Implementation of the DSF plan would help fulfill the goals of the Canadian public and governments to become world leaders in sustainable management.

The need for sustainability has never been as pressing. In 2005, the United Nations published the Millennium Ecosystem Assessment, which assessed consequences of ecosystem change for human well-being and options for responding to those changes (Sarukhan and Whyte 2005). This report contains four key findings:

1. Humans have changed ecosystem faster and more extensively over the past 50 years than during any other period in human history.
2. Degradation of ecosystem services could significantly worsen during the next 50 years.
3. Degradation of ecosystem imposes significant costs including reduced quality of life, poorer human health, increased risk of abrupt change, and increased poverty for some groups of people.
4. Restoration of ecosystem presents a challenge that requires significant changes to policies, institutions, and practices.

This recent report by the United Nations is an urgent call for a stronger effort to achieve environmental sustainability. The DSF plan (Boyd 2004) is a blueprint for how to meet the sustainability challenge.

To assist in meeting the sustainability challenge, DSF requested the Sustainable Planning Research Group (SPRG) in the School of Resource and Environmental Management at Simon Fraser University to prepare an independent evaluation to benchmark Canada's environmental performance. The SPRG assembled a multidisciplinary team of fourteen researchers to complete the study. The research team completed a draft of the report, which was then submitted to a peer review undertaken by experts in the private, public and non-governmental organization sector. The report was revised based on the peer review and submitted to a second more limited peer review prior to publication.

1.2 REPORT OBJECTIVES

As the DSF *Sustainability within a Generation* plan shows, achieving sustainability involves three key components: setting goals, objectives, and targets, preparing and implementing plans to achieve targets, and monitoring environmental conditions to assess progress in meeting environmental objectives. This study focuses on focuses on the third component: the creation and application of an environmental sustainability reporting system (ESR) that tracks environmental progress.

In his comparative study of OECD countries, David Boyd provides a framework for ESR. The purpose of this study is to update and extend Boyd's framework to develop and apply ESR to assess Canadian progress towards environmental sustainability. This report extends Boyd's analysis in three ways. More indicators are used, additional interpretative indexes are calculated, and a systematic time-series analysis is done based on the period 1992 to 2002. The application of ESR will assist policy makers and the public to identify strengths and weaknesses in Canada's environmental performance, identify key issues, and identify successes in environmental sustainability both within Canada and in other nations that can be analyzed in more detail to develop best practice environmental management strategies that can form the basis for effective sustainability plans. Specifically, the objectives of this report are to:

- Develop a methodology for assessing progress towards environmental sustainability.
- Provide a benchmark for Canadian national and provincial environmental sustainability performance that can be used to measure future progress.
- Assess trends in environmental sustainability to identify key successes and failures in Canadian sustainability initiatives.

- Identify the most environmentally successful countries that should be analyzed in more detail to develop best practices for sustainable environmental management.

It should be noted that this study focuses on environmental sustainability only. Social and economic sustainability issues are not included. This study also does not seek to explain differences in environmental performance or keys to achieving successful environmental strategies. Instead, this study seeks to develop and apply an ESR to pinpoint apparent successes and failures in environmental strategies in the hope that identification of successes and failures will stimulate additional research to develop environmental "best practices."

1.3 SUSTAINABILITY'S CRITICAL CHALLENGES

The report *Sustainability within a Generation* prepared by DSF (Boyd 2004) identifies nine critical environmental challenges that must be met to achieve sustainability. Our report uses ESR to assess progress in meeting these nine challenges summarized below.

GENERATING GENUINE WEALTH

Industrial societies currently measure their progress by gross domestic product (GDP). The problem with this approach is that GDP assigns value to only those factors that are exchanged for currency in an economic market. Environmental damage such as oil spills, preparation for war, and car accidents all increase a country's GDP. Conversely, a parent staying at home to raise children, increased leisure time, and volunteer activity to mitigate environmental damage reduce GDP even though they contribute to social well-being. Thus, better measures of progress, based on more holistic, genuine well-being indicators are needed.

IMPROVING ENVIRONMENTAL EFFICIENCY

Using natural resources responsibly means minimizing the quantity of resources used to produce a given level of goods and services. Reducing natural resource consumption through more efficient use of water, energy, and other natural resources must occur to ensure that sufficient resources are available for future generations.

SHIFTING TO CLEAN ENERGY

Much of the world continues to rely on nonrenewable forms of energy such as fossil fuels. This practice leads to human-induced climate change through the release of carbon dioxide (CO_2), as well as increased human morbidity and mortality related to poor air quality. Relying on a declining nonrenewable energy resource is also risky: at some point the resource will run out. Countries need to shift energy sources from nonrenewable to cleaner renewable sources, such as wind and solar power, to reduce environmental damage and risk.

REDUCING WASTE AND POLLUTION

Significant environmental damage is caused by emissions of waste and pollution into the environment. Increased waste damages the environment, and reduces economic efficiency. Reuse and recycling of products and by-products reduces pressures for industrial extraction of natural resources, and reduces stress on the environment's assimilative capacity.

PROTECTING WATER QUALITY

Protecting water quality and providing clean drinking water is a primary environmental challenge. Yet, threats to water quality are growing. Nations continue to exploit their waterways for human waste disposal, industrial needs, agriculture, and municipal use. This exploitation not only threatens the quality but also the quantity of available drinking water.

PRODUCING HEALTHY FOOD

Industrial agriculture can cause far-reaching and long-lasting environmental damage through pesticide contamination, soil erosion, falling water tables, soil salinization, eutrophication, surface and groundwater pollution, and the uncertain impacts of genetically modified organisms (Chambers et al. 2001). Increasing organic farming free of synthetic pesticides and herbicides and integrated pest management practices, with use of synthetic pesticides as a last resort, would help create a healthier and more sustainable agriculture industry.

CONSERVING AND PROTECTING NATURE

Urban sprawl, pollution, invasive species, resource extraction and other industrial activities are destroying natural habitat, degrading ecosystem, and increasing the number of species at risk. Habitat and ecosystem protection are key to environmental sustainability.

BUILDING SUSTAINABLE CITIES

With 80% of Canadians living in urban areas it is imperative that cities are safe, clean, livable, and sustainable. Greater emphasis on high- and medium-density housing to reduce land consumption, increased use of public transit, and green municipal infrastructure is needed to build cities that meet the needs of today’s and tomorrow’s generations.

PROMOTING GLOBAL SUSTAINABILITY

Globalization signifies an era where decisions and actions by one nation affect the lives of people throughout the world. Global environmental problems such as climate change, ozone depletion, and long-range transportation of air pollutants necessitate global cooperation. Wealthy countries, such as Canada, must show leadership in addressing these global challenges by assisting less-developed nations in achieving sustainability.

1.4 THE SUSTAINABILITY CHALLENGE

As the DSF sustainability plan shows, meeting the nine challenges for sustainability is feasible if Canada mounts a comprehensive effort to develop and implement sustainable practices. Successfully implementing sustainable practices requires a comprehensive monitoring program that assesses progress towards achieving sustainability. Without an environmental sustainability reporting system, Canada can be likened to a ship without a compass, certain to be lost at sea. The purpose of this report is to assist with the development of a sustainability-monitoring framework that will measure Canada’s progress in meeting the nine environmental challenges and provide a guide to a sustainable future.

The report begins with development of a methodology for environmental monitoring, followed by an application of the monitoring system to Canada. Presentation of the results is organized into nine chapters based on the nine sustainability challenges. Each chapter contains an overview of the issue and presentation of results in graph form for Canada. The Canadian graphs show the best three and worst three performing OECD countries plus Canada (if Canada is not among the best or worst three performers). The report concludes with a summary of key findings and recommendations.

CHAPTER 2:
DEVELOPING AN ENVIRONMENTAL REPORTING SYSTEM

2.1 ENVIRONMENTAL SUSTAINABILITY REPORTING SYSTEM

The first step in assessing Canada's progress in achieving sustainability is to develop an environmental sustainability reporting system (ESR). The ESR used in this study was developed in the following way. First, the following ten ESR methodologies that have been used to assess aspects of Canadian environmental performance are reviewed. The studies are summarized in appendix A.

1. OECD Environmental Performance Reviews for Canada (OECD 2004, 1995b)
2. Boyd's Canada vs. the OECD Review (Boyd 2001)
3. Alberta GPI Accounting Project (Anielski 2001)
4. GPI Atlantic Natural Resource and Environmental Accounts (Colman 2001b)
5. Environmental Trends in British Columbia (B.C. 2002)
6. National Round Table on the Environment and the Economy (NRTEE) Sustainability Indicators Project (Canada, NRTEE 2003)
7. David Suzuki Foundation Sustainability within a Generation Framework (Boyd 2004)
8. Fraser Basin Council (FBC) State of the Fraser Basin Report (FBC 2004)
9. Conference Board of Canada Potential and Performance Review (Canada, Conference Board of Canada 2004)
10. Yale Environmental Sustainability Index (Esty et al. 2005)

Second, a list of environmental indicators used in the ten ESR studies was compiled. Economic and social indicators were not included because they are outside the scope of this study. Third, the environmental indicators were evaluated based on the following four criteria.

- The indicator must provide a meaningful measure of environmental sustainability.
- The indicator must be generally understandable for a nontechnical audience.
- The data required for the indicator must be available in a timely fashion, produced on a regular basis using consistent definitions for OECD countries, and be reliable.
- The indicator should not directly replicate other indicators.

Based on the evaluation, 37 indicators were chosen for this study and 29 of these indicators for which OECD data were available were used for international comparisons (table 2.1). Due to data limitations, a smaller number of indicators were used for provincial comparisons. The indicators were grouped under one of the nine thematic categories used in the David Suzuki Foundation *Sustainability within a Generation* Boyd report (2004).

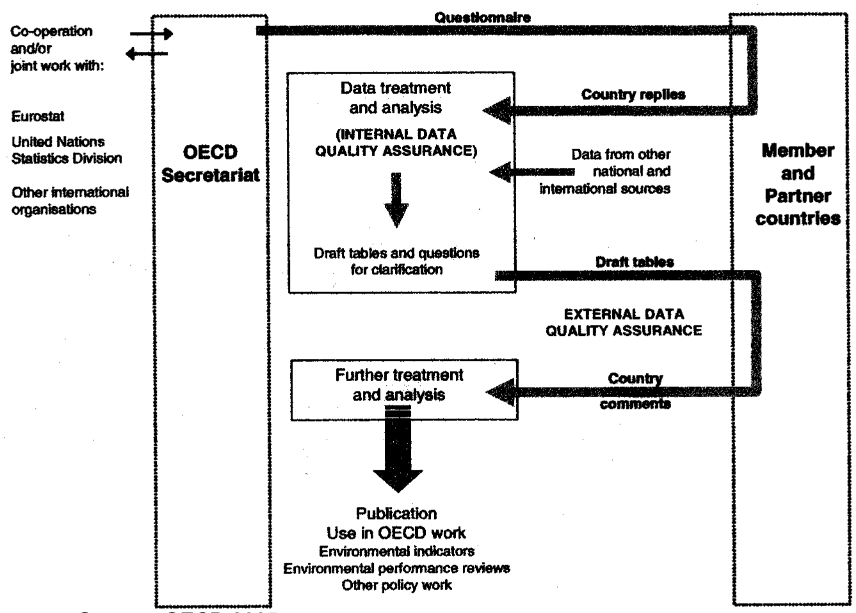
Table 2.1: Environment monitoring system indicators

CHALLENGE	INDICATOR	MEASUREMENT VARIABLE
1. Generating Genuine Wealth	1. *Development of Genuine Wealth Index*	*Reporting of GWI on regular basis*
2. Improving Environmental Efficiency	2. Energy Consumption	Tonnes of oil equivalent per capita
	3. Energy Intensity	Tonnes of oil equivalent/ US$1,000 GDP
	4. Water Consumption	Cubic meters of water consumption per capita
	5. Environmental Pricing	Environmental taxes as % of GDP
3. Shifting to Clean Energy	6. Greenhouse Gas Emissions	Tonnes of $C0_2$ equivalent emissions per capita
	7. Electricity From Renewable Resources (including hydro)	% of electricity generated from renewable resources (including hydro)
	8. Electricity From Renewable Resources (excluding hydro)	% of electricity generated from renewable resources(excluding hydro)
4. Reducing Waste and Pollution	9. Sulfur Oxides	Kilograms of sulfur oxides emitted per capita
	10. Nitrogen Oxides	Kilograms of nitrogen oxides emitted per capita
	11. Volatile Organic Compounds	Kilograms of VOCs emitted per capita
	12. Carbon Monoxide	Kilograms of carbon monoxide emitted per capita
	13. *Particulates*	*Kilograms of particulates emitted per capita*
	14. Ozone-Depleting Substances	Kilograms of ODSs released per capita
	15. Municipal Waste	Kilograms of municipal waste generated per capita
	16. Recycling	% of material recycled from municipal waste
	17. *Hazardous and Toxic Waste*	*Kilograms of hazardous waste generated per capita*
	18. Nuclear Waste	Kilograms of nuclear waste per capita
	19. Pollution Abatement and Control Expenditures	PAC expenditures as % of GDP
5. Protecting Water Quality	20. Municipal Sewage Treatment	% of population with sewage treatment (for international comparison)
6. Producing Healthy Food	21. Pesticide Use	Tonnes of pesticide used per square kilometer of arable land
	22. Fertilizer Use	Tonnes of fertilizer used per square kilometer of arable land
	23. Livestock	Sheep equivalents per square kilometer of arable and grassland
	24. *Organic Agriculture*	*Proportion of organic agricultural area to total agricultural area*

7. Protecting and Conserving Nature	25. Number of Species at Risk	Number of species at risk
	26. % of Species at Risk	% of known species at risk
	27. Protected Areas	% of land designated as protected
	28. Forest Harvested	Cubic meters of timber harvested per square kilometer of forestland
	29. Forest Harvest to Growth Ratio	Timber harvested to forest growth ratio
	30. Fisheries Harvest per Capita	Kilograms of fish harvested per capita
	31. Fisheries Harvest to World Harvest	% of world catch
	32. *Ecosystem-Based Management*	*The proportion of terrestrial and marine ecosystem in which ecosystem-based management has been implemented*
8. Building Sustainable Cities	33. *Green Infrastructure Funding*	*Per capita public transit funding*
	34. Distance Traveled	Thousands of vehicle-kilometers traveled per capita
	35. *Public Transit*	*Number of urban and suburban transit passengers per capita*
	36. *Loss of Agricultural Land*	*Thousands of square kilometers of agricultural area lost to urbanization per capita change in population*
9. Promoting Global Sustainability	37. Official Development Assistance	ODA as percentage of GNI

Note: indicators not italicized are the 29 indicators used for international comparisons.

Once the indicators were selected, data for each indicator were collected for each OECD member country, including Canada and the ten Canadian provinces. Most of the statistical data for Canada and other OECD countries originate from the OECD's Environmental Data Compendiums (OECD 2005). OECD data were used because of the due diligence data assessment undertaken by the OECD to ensure reliability and comparability of data (fig. 2.1). Provincial data are mainly from Statistics Canada sources. Data for each indicator were assembled for the years 1990 to the most current year available. In some cases, data were available for only a portion of this time frame.



Source: OECD 2005

Figure 2.1: The OECD data treatment and production cycle

The next step was to interpret the data to evaluate progress towards sustainability. Three methods for evaluating environmental performance were identified based on the review of ESR studies. The first method for evaluating progress towards sustainability is to assess the degree to which optimal environmental objectives that take into account all costs and benefits have been met. Unfortunately this approach can not be used because comprehensive environmental objectives are not available.

A second approach is to assess whether environmental performance is improving or deteriorating by examining the rate and direction of change for each indicator for the jurisdiction under evaluation. The weakness of this approach is that it does not provide an independent measure of whether the magnitude of change or the indicator value is satisfactory.

A third approach for evaluating environmental performance is a cross-sectional comparison to assess how well a jurisdiction is doing relative to other jurisdictions. Comparisons between jurisdictions can be made for each environmental indicator for the most recent year data are available and for the change in each environmental indicator over a period of time. This approach can provide the same advantages as the time-series approach: trend lines indicate whether and at what rate the environment is improving. Cross-sectional comparisons have the added advantage over time series of providing reference points or benchmarks on how well each jurisdiction is doing relative to other jurisdictions.

The approach used in this report for evaluating Canada's environmental performance is based on a cross-sectional comparison. Comparative measures are calculated to show Canada's *current* environmental performance relative to OECD countries and the *rate of improvement (or deterioration)* in Canada's environmental performance relative to OECD countries. The comparative measures calculated for Canada include:

1. Canada's rank(s) for each indicator relative to all other OECD countries for the most recent year.
2. Canada's value(s) for each indicator as a percent of the average value for all OECD countries for the most recent year.
3. Canada's value(s) for each indicator as a percent of the value for the best performing OECD country for the most recent year
4. Canada's percent change(s) in value for each indictor over the most recent decade compared to the percent change in value for other OECD countries.

Two key measures are used to assess Canada's current performance: Canada's **Environmental Performance Rank (EPR)** and Canada's **Environmental Performance Grade (EPG)**. The EPR is Canada's ordinal rank by indicator relative to the 30 OECD countries ranked from best (1) to worst (30). It should be noted that the ordinal rank only measures whether one country is ahead of another, not the magnitude of the difference. This problem with ordinal ranking is compensated for by the EPG, which is the value for each indicator for the best performing OECD country Canada divided by the value for Canada multiplied by 100. The best performing country therefore has an EPG of 100%. The benefit of the EPG is that it indicates how well Canada is doing relative to the best performer and indicates the magnitude of the difference and percent change required to equal the best performer. For example, an EPG of 30% for greenhouse gas emissions for Canada means that Canada would have to reduce greenhouse gas emissions by 70% (100%-30%), to equal the best performing country. Where an increasing value demonstrates improvement, rather than a decreasing one, such as protected areas, the EPG formula is inverted so the value for Canada is divided by the value for the best performing OECD country multiplied by 100.

1. Environmental Performance Rank (EPR)	The EPR is the ordinal rank of Canada relative to all OECD countries for all indicators.
2. Environmental Performance Grade (EPG)	The EPG is the value of the Canadian indicators relative to the best performing OECD country, which is given an EPG of 100. The EPG measures the gap between Canadian performance and the best performance.

The EPR and the EPG indicate how well Canada is doing relative to other OECD countries for each specific environmental indicator. In addition to this disaggregated performance evaluation, policy makers are also interested in an overall “bottom line” or composite measure of a jurisdiction’s environmental performance. The advantage of a single composite index is that it measures overall progress towards sustainability and answers two key questions.

- Overall how does Canada’s environmental performance compare to other jurisdictions?
- Is Canada’s environmental performance improving or getting worse?

Issues and methods for constructing composite indicators are well canvassed in the literature (Saltelli et al. 2004; Munda 2005; Munda and Nardo 2003; Freudenberg 2003) and the OECD is in the process of preparing a handbook on composite index construction. The conclusion from the research is that the composite index depends very much on the method of aggregation employed and care should be taken in interpreting the ranking results. Therefore, it is more important to focus on the performance under each indicator category instead of the composite index value.

This study uses a composite index that is based on the arithmetic average of the EPR and the EPG. The EPR ranks Canada’s overall environmental performance relative to OECD countries. Again, it should be cautioned that the ordinal ranking system used in the study only measures whether one country is ahead of another. Ordinal ranking does not measure the magnitude of the difference. Therefore countries that rank far apart may be relatively close in environmental performance. The composite EPG helps overcome this problem with the ordinal ranking by measuring the gap between Canada’s overall environmental performance and the best performing jurisdictions. The EPR and EPG can also be used to assess the degree of improvement or deterioration in Canada’s relative environmental performance by comparing EPR and EPG scores for Canada over a time period. In this report, the EPR and EPG scores are calculated for 1992 and 2002 to allow for an assessment of trends.

For more detailed discussion of methodological issues the reader is invited to consult appendix B.

2.2 STUDY LIMITATIONS

It is important to keep the following qualifications in mind when interpreting the findings of this study.

1. Although the OECD has completed a rigorous due diligence assessment to ensure comparability and quality of the environmental data used is this study (see fig. 2.1), comparability of data can vary due to differences in quality of data collection among countries, different definitions, and differences in the most recent year data is available.

2. Composite country rankings are sensitive to the aggregation method and indicators used. Different indicators, different indicator weights, and different aggregation methods will produce different results. For this reason, it is important to focus on the disaggregated results by indicator, as well as the composite results.

3. The ordinal ranking system used to rank countries only measures whether one country is ahead of another country: not the magnitude of the difference. Countries far apart in ranks may still be relatively close in environmental performance. The magnitude of the difference can be assessed by examining the EPG, which is designed to measure this difference.

4. The study does not attempt to explain the differences in environmental performance among countries. Differences may be due to exogenous variables beyond a country's control and endogenous variables such as deficiencies in environmental policy. Also, a country's environmental performance may be driven by other countries through importation or exportation of goods and services.

5. Some important indicators such as particulate concentrations in air could not be used in this study due to data limitations. If these indicators were included, rankings could change. Key data limitations are identified in the recommendations.

6. Comparing trends in environmental performance between countries should be interpreted with caution because the percent change in values depends on the starting point value. Countries may show large percent improvements simply because they may have recorded very low indicator values in the base year. Conversely, countries may show a low percent improvement because they recorded a high value in the base year. The current environmental performance could still be very poor or very good, despite the percent change in value.

2.3 ASSESSMENT OF THE POLICY FRAMEWORK FOR ACHIEVING ENVIRONMENTAL SUSTAINABILITY

Achieving a sustainable future is contingent on implementing appropriate environmental policies. Evaluating Canadian environmental policy is beyond the scope of this report. However, we provide a framework for a subsequent study to evaluate policy by using best practices criteria summarized in table 2.2. These criteria can be used to rate environmental policy for each environmental sector and identify where policies are weak, as well as what changes may be required to improve policy.

Table 2.2: Policy evaluation criteria

POLICY CRITERION	EXPLANATION
1. Clear Objectives	Clear targets with milestones and timeframes are set to achieve environmental improvement
2. Effective Strategy	Clear strategy exists for achieving objectives that shows quantitatively cause and effect relationships on how initiatives will achieve targets
3. Monitoring	Monitoring program is in place to assess progress in implementing initiatives (implementation monitoring) and achieving targets (effectiveness monitoring) and results of monitoring are reported publicly on a regular basis
4. Accountability	Roles and responsibilities for achieving targets and implementing initiatives are clearly delineated
5. Mitigative Management	Obligatory process is in place to adjust plan based on monitoring results to achieve objectives
6. Legal Framework	The plan and its implementation are clearly enshrined in a legal framework
7. Collaborative Process	The development, implementation, and monitoring of the plan is managed by a multistakeholder process

CHAPTER 3:
GENERATING GENUINE WEALTH

> The obsession with economic growth and its confusion with quality of life have led us down a dangerous and self-destructive path. It is doubtful we will leave our children a better legacy until we stop gauging our well-being and prosperity by how fast the economy is growing, and until we stop using the GDP as a measure of progress.
>
> Dr. Ronald Colman (2001: 71)[1]

Goal

Canada becomes a world leader in innovative ways of living sustainability and protecting the environment. To do so, we must measure progress by supplementing the narrow concept of economic growth with an effort to measure all factors that make life worthwhile.

Background

Governments and think tanks around the globe are developing new strategies to calculate the wellness of societies by incorporating economic, social, and environmental factors into their measurements. Termed "genuine progress indexes" or "genuine wealth indexes" (GWI), these new yardsticks seek to incorporate indicators of natural, social, human, manufactured, and financial capital in an index that gauges the genuine wealth of the nation. Such a holistic index would be a valuable policy tool to help decision makers orient their policies toward what societies truly value and to measure progress towards sustainability. In the political sphere, politicians would be assessed by the public on their ability to help the country achieve genuine wealth, not only economic prosperity. Although measuring genuine wealth does not achieve genuine wealth creation, measuring genuine wealth is a first and necessary step towards the goal of genuine wealth creation.

TRENDS

Two internationally recognized Canadian initiatives—the Alberta Genuine Progress Indicator Accounting Project (Pembina Institute) and the Genuine Progress Index for Nova Scotia (GPI Atlantic)—are making advances in developing prototype progress indexes. The Pembina Institute developed a 51-indicator measurement of Alberta's social, environmental, and economic well-being.[2] A prototype index using 22 indicators, developed by GPI Atlantic, is being tested in the community of Glace Bay, Nova Scotia.[3] By incorporating economic indicators like life span, education, and poverty with noneconomic factors like volunteerism, household work, and environmental health, these initiatives are beginning to obtain genuine

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[1] Colman, R. 2001. Measuring real progress. *Journal of Innovative Management.* 7 (1): pp 69-77.

[2] See Anielski, M. 2001. *Alberta GPI Blueprint*. www.pembina.org/publications_item.asp?id=46; accessed 27 February 2005.

[3] See Glace Bay Project website: discovery.uccb.ns.ca; accessed 2 February 2005.

wealth measurements at the community and regional levels. It is hoped they will provide the blueprint for a more holistic measurement index for the state of a nation.

Development of national GWI has been slow. In his 2000 budget speech, then Finance Minister Paul Martin set aside $9 million to form a set of national indicators on the environment. The sum was split between Environment Canada and the National Round Table on the Environment and the Economy (NRTEE) (Canada, Department of Finance 2005).

Environment Canada formed a taskforce to develop the Canadian Information System on the Environment, a program intended to provide decision makers with comprehensive data, analysis, indicators, reports, and standards.[4] NRTEE launched the Environment and Sustainable Development Indicators (ESDI) Initiative; a three-year multistakeholder program aimed at developing more comprehensive measures of well-being.[5] In May 2003, the ESDI released *Environment and Sustainable Development Indicators for Canada,* a report suggesting the use of six indicators: forest cover, freshwater quality, air quality, greenhouse gas (GHG) emissions, extent of wetlands, and educational attainment. On 3 June 2003, The House of Commons passed Joe Jordan's (Leeds-Grenville, Lib.) private member's motion, M-385, stating "That in the opinion of this House, the government should develop and report annually on a set of social, environmental, and economic indicators of the health and well-being of people, communities, and ecosystem in Canada." The following year the throne speech stated

> Building on the recommendations of the National Round Table on the Environment and the Economy, the government will start incorporating key indicators on clean water, clean air, and emissions reductions into its decision making[6].

The 2004 federal budget included $15 million, to be split between Environment Canada and Statistics Canada, in order to develop and report on these indicators (Canada, Department of Finance 2004: 185).

These initiatives suggest that a genuine wealth index could eventually be developed that integrates environmental, social, and economic data into a single, usable index of wellness. While preliminary efforts have been undertaken, the development of a comprehensive GWI is still in its embryonic stage.

[4] See Canadian Information System for the Environment website. www.cise-scie.ca/; accessed 2 February 2005.

[5] See NRTEE Indicators website: www.nrteetrnee.ca/eng/programs/Current_Programs/SDIndicators/index.html; accessed 2 February 2005.

[6] See 2004 governor-general's speech from the throne. pm.gc.ca/grfx/docs/sft_fe2004_e.pdf; accessed 3 February 2005.

CHAPTER 4:
IMPROVING ENVIRONMENTAL EFFICIENCY

Goal

Canada becomes a world leader in the efficient and effective use of energy and resources, enabling us to improve our quality of life while reducing energy and material use. If we are to live within our means, this goal is critical because it recognizes the limits of Earth's natural system.

Background

Environmental efficiency measures the amount of a natural resources used per unit of output. The higher the resources use per unit of output, the greater the stress on the environment. Higher energy consumption, for example, increases health and environmental impacts such as air pollution (Bates and Caton 2002) and climate change (Clark et al. 2001). Higher rates of natural resource consumption expedite the rate of depletion of the resource. Nonrenewable resources such as oil and gas will be used up faster, while renewable resources will reach the limits of their capacity to regenerate sooner.

Comprehensive data to measure natural resource consumption per unit of output are not available. However, data are available for two natural resource sectors: energy and water.

4.1 ENERGY CONSUMPTION

Energy consumption is measured in millions of tonnes of oil equivalent (toe), which allows for conversion of different energy types to a common measure for comparison. In 2002, Canada consumed 6.07 toe per capita, almost double the OECD average of 3.36 toe per capita. Canada ranks 28th of 30 OECD countries in energy consumption per capita (fig. 4.1A).

Total energy consumption increased in Canada by 17.8% from 1992 to 2002 and per capita consumption increased by 6.5% (OECD 2005). Canada's per capita energy consumption increase is lower than the 10% average rate of increase recorded by OECD countries over the last decade (fig. 4.1B). However, Canada's rate of increase was still significantly higher than the best improving country, Mexico, which reduced per capita energy consumption by nearly 17% in the last decade. Overall, Canada ranks 15th out of 30 OECD countries in reducing per capita rate of growth in energy consumption.

The OECD (2004) suggests that Canada's high rate of energy consumption is due to geography, climate, industrial structure, and low energy prices. Energy prices, which are a matter of public policy, are significantly lower than the OECD average. The ratio of Canadian prices relative to the OECD average by energy type are summarized in table 4.1.

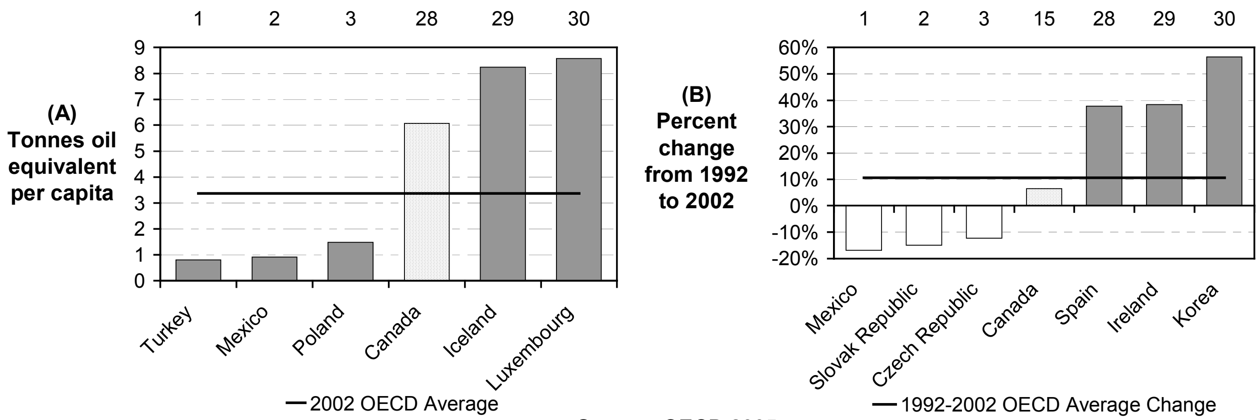


Figure 4.1: Ranking Canada's 2002 per capita energy consumption (A) and change in per capita energy consumption from 1992 to 2002 (B) among OECD member countries

Table 4.1: Canadian energy prices by type relative to OECD average prices

ENERGY TYPE	YEAR	CANADIAN PRICE TO OECD AVERAGE PRICE RATIO
Household Electricity	1994	52%
Industrial Electricity	1994	52%
Household Natural Gas	2001	76%
Industrial Natural Gas	2001	60%
Diesel Motor Fuel	2001	85%
Gasoline Motor Fuel	2001	95%

Source: OECD 2004: 43-47

4.2 ENERGY INTENSITY

Energy intensity measures the amount of energy required (toe) per unit of gross domestic product (GDP). In 2002, Canada uses 0.22 toe per US$1,000 GDP, significantly higher than the OECD average of 0.15 toe and more than twice as great as the most energy efficient countries, Ireland and Italy, which each used only 0.1 toe/US$1,000 GDP (fig. 4.2A). Overall, Canada ranks 29th of 30 OECD countries in energy intensity.

Canada reduced energy consumption per unit of GDP by about 15% from 0.26 to 0.22 toe/US$1,000 GDP over the last decade (fig. 4.2B). This improvement is more than the average OECD improvement of 12.7%. Overall, Canada ranks 14th out of 30 OECD countries in reducing energy intensity from 1992 to 2002.

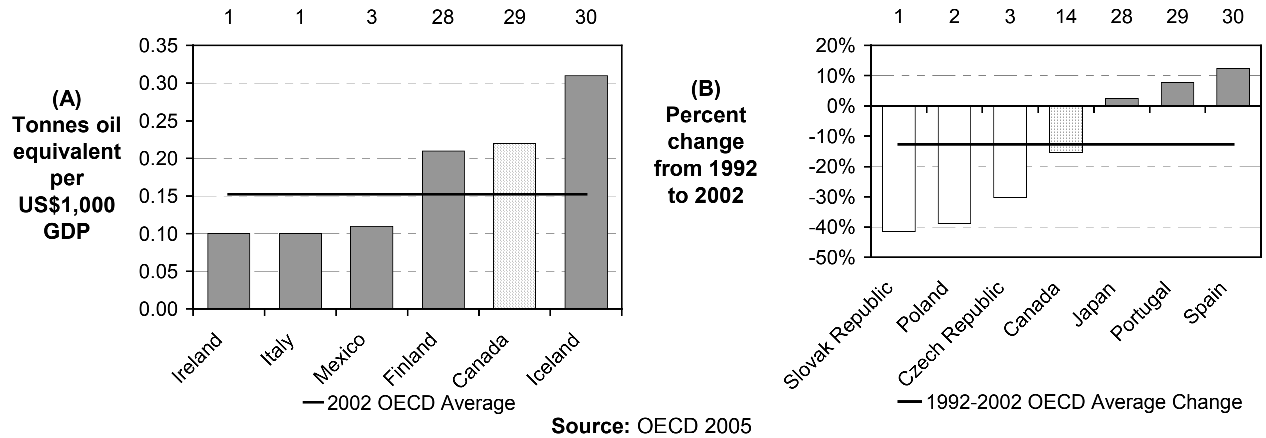


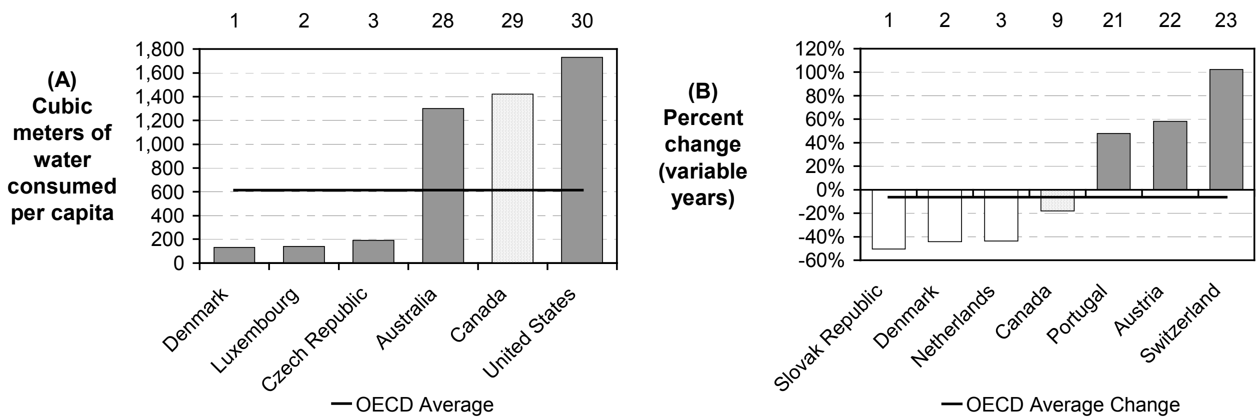
Figure 4.2: Ranking Canada's 2002 energy intensity (A) and change in energy intensity from 1992 to 2002 (B) among OECD member countries

4.3 WATER CONSUMPTION

Water consumption is measured in cubic meters (m^3) of water consumed per capita. Water consumption is defined as the difference between water withdrawn from the source and water returned to the source after use (Canada, Statistics Canada 2000). Water consumption is also measured by the OECD (2004) as a percent of the gross annual available water supply. It should be cautioned, however, that gross annual available water supply data are difficult to measure accurately. Also, national gross available water supply is not necessarily a good indicator of water availability because water demand and supply balances are usually based on regional, not national areas. Water surpluses in some regions are normally not available to meet deficits in other regions.

Canada consumed 1,420 m^3 of water per capita, more than double the average OECD per capita consumption of 613 m^3 and more than 10 times the most efficient OECD country of Denmark (fig. 4.4A). Canada ranks 29th, second last only to the Americans who consumed 1,730 m^3 of water per capita. The electricity sector consumed 64% (for cooling purposes), manufacturing 14%, and the primary-resource sector (mainly agriculture) 11% (OECD 2005). The OECD (2004) estimates that Canada consumes only 1.5% of its gross annual available water supply, well below the OECD average of 11.4%.

Canada reduced per capita water consumption by 18% from the late 1980s to 1995, well above the OECD average decrease of 6% (fig. 4.4B). Canada ranked ninth of 23 OECD countries in reducing water consumption. Topping the list was the Slovak Republic with a 50% decrease in water consumption per capita.



Source: Recent year data - OECD 2005
Base year data - OECD 1993

Figure 4.3: Ranking Canada's per capita water consumption (A) and change in per capita water consumption (B) among OECD member countries (variable years)

Note: Water consumption data in the 1993 and 2004 OECD Environmental Data Compendium referred to the latest available information. The most recent water consumption value for Canada contained in the 2004 OECD Compendium refers to 1996, while in the 1993 Compendium the year was not reported for Canada. The year water consumption data was available also differed for every country.

4.4 ENVIRONMENTAL PRICING

One of the causes of environmental damage is the failure to adequately charge for the cost of using the environment. Producers are often able to emit pollution into the environment free of charge even though there is a significant cost to society resulting from environmental damage. The failure to include the costs of environmental damage in financial analysis is a "market imperfection" that results in inefficient decision making.

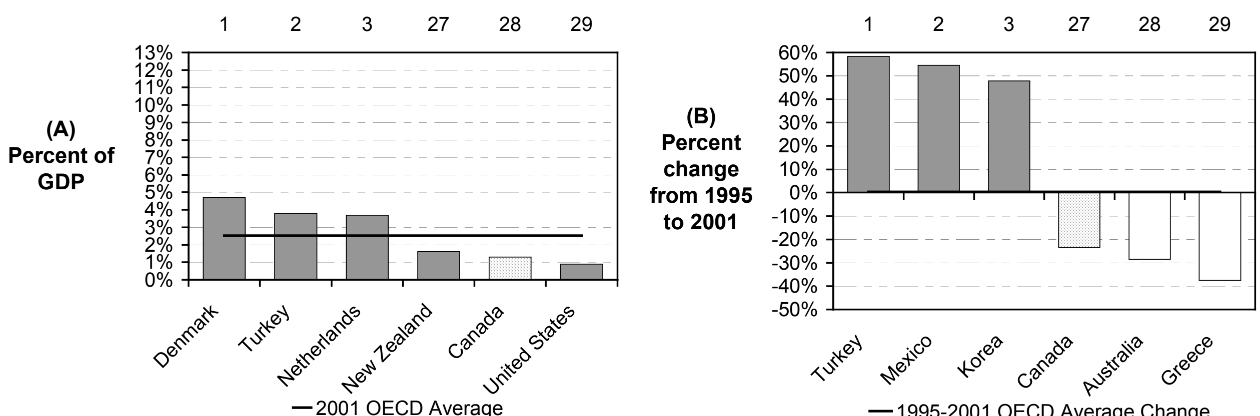
Public policy traditionally deals with environmental market imperfections by regulations that limit the amount of pollution that can be emitted. More recently, there is growing support for market mechanisms that impose charges on pollution and other activities that have environmental costs. The NRTEE (Canada, NRTEE 2002), the David Suzuki Foundation (Boyd 2004), and the OECD (2004), for example, are all strong advocates of using market mechanisms, which in Canada is referred to as ecological fiscal reform.

EFR is normally divided into three components: environmental pricing, elimination of subsidies, and direct investment in environmental protection. All three components attempt to improve economic efficiency by making sure economic markets include all relevant costs and benefits. Environmental pricing, for example, requires those causing environmental damage to bear the environmental costs. An example would be the use of a carbon tax to force users of fossil fuels to help cover the costs of climate change, and a pollution tax on environmental emissions of toxic chemicals. Including some of the cost of environmental damage in the price would reduce emissions and encourage use of more environmentally friendly technologies.

It is important to emphasize that although environmental pricing is sometimes referred to as tax shifting or green taxes it is different that most taxes in one important way: environmental taxes are a user fees for the use of the environment. Also environmental fees need not increase the revenue payments to government because they can be used to replace or offset other taxes. The tax burden of the public, therefore, is left unchanged. The only thing that changes is the price for activities that damage the environment is increased, while other taxes are reduced, leaving the public financially the same and the environment in better shape.

As a result of the growing interest in environmental pricing, the OECD began collecting data on revenues from environmental-related taxes. The OECD (2005: 286) defines environmental-related taxes as “any compulsory, unrequited payment to general government levied in tax bases deemed to be of particular environmental relevance.” Examples include fuel taxes, transportation fees, waste management fees, and charges on emissions of pollutants.

Revenue from environmental charges in Canada is equivalent to 1.3% of GDP, the second lowest of OECD countries and well below the OECD average of 2.5% (fig. 4.5A). Only the United States, at 0.9% of GDP, has lower use of environmental charges. Denmark has the highest rate of environmental charges at 4.7% of GDP. The use of environmental charges in Canada declined by almost one-quarter from 1995 (1.7% of GDP) to 2001 (1.3% of GDP). On average, OECD countries recorded virtually no change in the level of environmental fees during the same period



Source: OECD 2005

Figure 4.4: Ranking Canada's 2001 revenues from environmental fees (A) and change in revenues from environmental fees from 1995 to 2001 (B) among OECD member countries

CHAPTER 5:
SHIFTING TO CLEAN ENERGY

Goal

Canada moves to the forefront of the global clean energy revolution, reducing fossil fuel production, use, and export, harnessing low-impact renewable energy sources, and moving toward a hydrogen-based economy. These steps are vital for addressing the grave threat posed by climate change.

Background

Canada relies heavily on fossil fuels to supply its energy needs. In addition to contributing to air pollution, consumption of fossil fuels releases high levels of greenhouse gases that contribute to climate change. It is estimated that the average global air temperature rose by about 0.6ºC during the 20^{th} century, which is the fastest rate of warming that occurred in the past 1,000 years (Houghton et al. 2001). Some of the predicted impacts of climate change include higher maximum temperatures, more intense precipitation events and mid-latitude storms, droughts, floods, increased monsoon variability, rising sea levels, melting of polar ice caps, water shortages, and disruptions of forests and agriculture (UNFCCC 2003). Reducing the use of fossil fuels by reducing energy consumption and shifting towards cleaner energy sources is necessary to mitigate the negative impacts associated with global climate change and air pollution.

5.1 GREENHOUSE GAS EMISSIONS

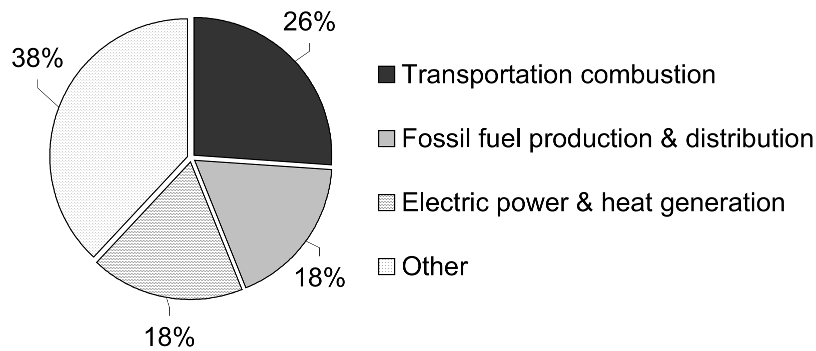
Greenhouse gases (GHGs) are released when fossil fuels are burned to produce electricity or energy for transportation, industry, and the residential and commercial sectors. The primary greenhouse gas is carbon dioxide (CO_2). Other greenhouse gases, which are produced in lesser quantities but are more potent, include methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), perfluorocarbons (PFCs), and hydrofluorocarbons (HFCs). Carbon dioxide, methane, and nitrous oxide are estimated to account for 50%, 18%, and 6%, respectively, of the overall global warming effect arising from human activities (UNFCCC 2003). The GHG emissions indicator reports the total level of emissions of all of these gases, expressed as CO_2 equivalents.

The chief sources of GHG emissions in Canada are transportation combustion (26%), fossil fuel production and distribution (18%), and electric power and heat generation (18%) (fig. 5.1). Other sources include agricultural activities, industrial and manufacturing processes, buildings, and waste handling and disposal (Canada, Environment Canada 2004).

In 1992, Canada signed the *United Nations Framework Convention on Climate Change* (UNFCCC), pledging to stabilize GHG emissions at 1990 levels by the year 2000. The signatories to the UNFCCC realized that a more detailed agreement was required specifying how stabilization of GHGs would be achieved.[1] Negotiations began immediately and the *Kyoto*

[1] UNFCCC. *Kyoto Protocol*. unfccc.int/essential_background/kyoto_protocol/items/2830.php; accessed 1 March 2005.

Protocol was adopted in 1997. Canada signed the *Kyoto Protocol* in 1998 and ratified it in 2002, thereby committing to reduce GHG emissions by six percent below 1990 levels by 2010 (UNFCCC 2003). Russian ratification, in late 2004, allowed the *Kyoto Protocol* to enter into force on 16 February 2005 (UNFCCC 2004). Among other things, the *Protocol's* entry into force means that from 16 February 2005, 30 industrialized countries will be legally bound to meet quantitative targets for reducing or limiting their GHG emissions (UNFCCC 2004). In addition, the international carbon trading market will become a legal and practical reality, enabling industrialized countries to buy and sell emissions credits to improve the efficiency and cost effectiveness of emissions reductions (UNFCCC 2004).



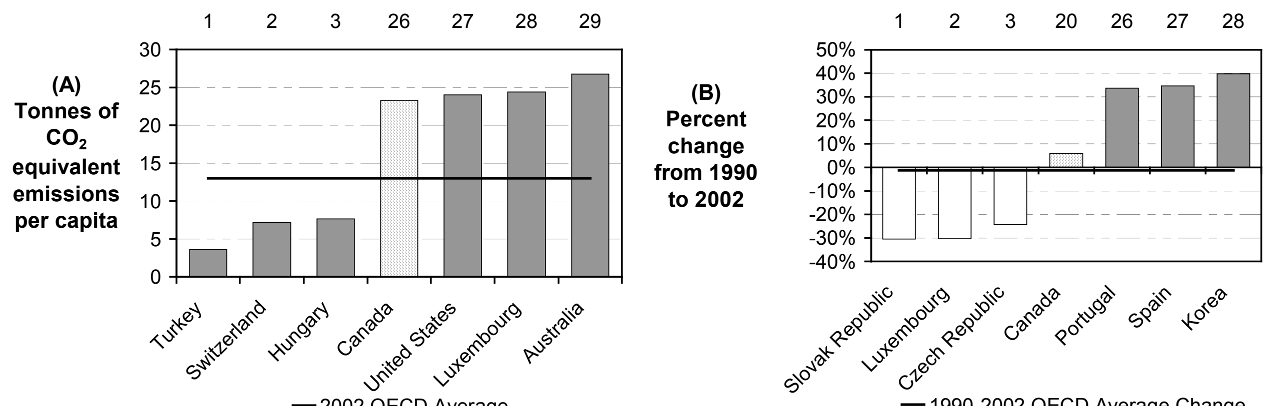
Source: Canada. Environment Canada. 2004. Canada's Greenhouse Gas Inventory 1990-2002. www.ec.gc.ca/pdb/ghg/1990_02_report/ann10_e.cfm#ta101_note1; accessed 10 February 2004

Figure 5.1: Canadian sources of greenhouse gas emissions for 2002

Note: 'Other' sources include agricultural activities, industrial and manufacturing processes, buildings, and waste handling and disposal

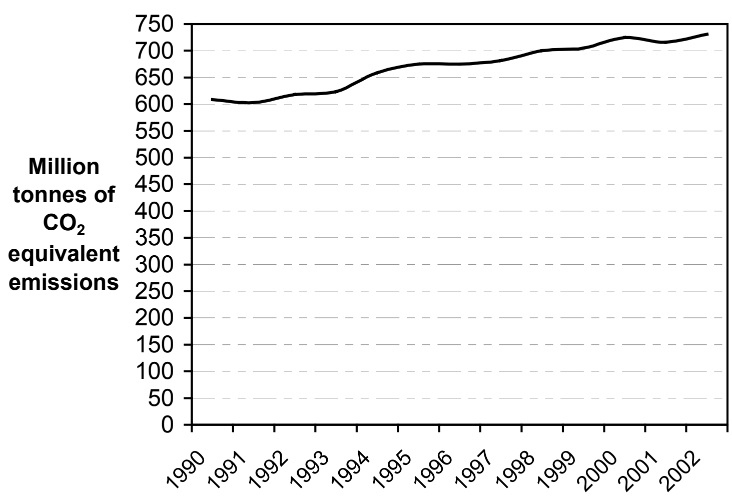
Canada is one of the world's largest GHG emitters per capita and per unit of GDP (OECD 2004: 187). Canada's 2002 production of 23.3 tonnes of GHG per capita is almost double the OECD average of 13 tonnes and more than six times that of the lowest OECD emitter (Turkey). In 2002, Canada ranked 26th of 29 OECD countries for GHG emissions (fig. 5.2A).

From 1990 to 2002, Canada's GHG emissions per capita increased by six percent from 22 to 23.3 tonnes of GHG per capita, compared to an OECD average decrease of 1.3% (fig. 5.2B). Canada's change in GHG emissions ranks 20th of 28 OECD countries. Despite Canada's pledge to stabilize total GHG emissions at 1990 levels by the year 2000, total emissions increased 20% from 1990 to 2002 (fig. 5.3).



Source: OECD 2005

Figure 5.2: Ranking Canada's 2002 per capita greenhouse gas emissions (A) and change in per capita greenhouse gas emissions from 1990 to 2002 (B) among OECD member countries



Source: Canada. Environment Canada. 2004. Canada's Greenhouse Gas Inventory 1990-2002. www.ec.gc.ca/pdb/ghg/1990_02_report/ann10_e.cfm#ta101_note1; accessed 10 February 2004

Figure 5.3: Canadian total greenhouse gas emissions from 1990 to 2002

Notes:

(a) Totals include emissions of the following GHGs: CO_2, CH_4, N_2O, SF_6, PFCs, and HFCs.

(b) As specified by the UNFCCC, country estimates of GHG emissions relate to their human (anthropogenic) activities and do not include emissions from naturally occurring sources or sinks.

(c) Provincial and territorial emission totals do not include:
- HFCs (e.g., fugitive releases from air conditioning and refrigeration system);
- PFCs (used during the fabrication of semi-conductors)
- CO_2 from limestone and soda ash use; and
- emissions associated with ammonia production.

(d) CO_2 emissions and removals in the Land Use Change & Forest Sector are not included in the national totals.

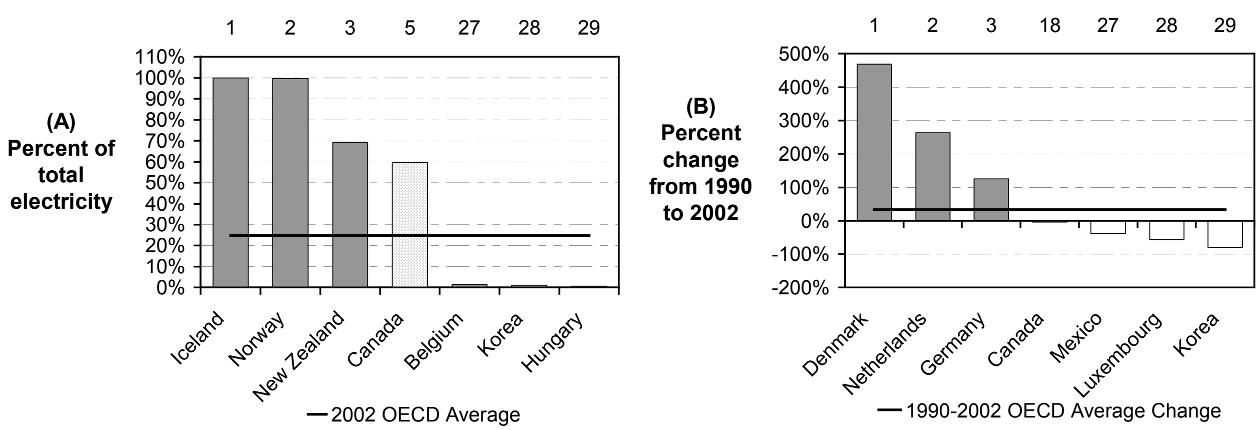
(e) Non-CO_2 emissions from fires located in the National Parks are not included in the provincial/territorial totals but are reported in the national totals.

5.2 ELECTRICITY FROM RENEWABLE SOURCES

Generating a higher proportion of electricity from clean, renewable sources of energy can mitigate some of the negative impacts of high energy consumption. The key benefit of renewable sources of energy, such as hydroelectric, wind, tidal, solar, biomass, and geothermal, is that they produce little to marginal amounts of the emissions associated with acid rain, smog, or climate change (Rudolf 2004). Consequently, Canada's *Climate Change Plan* has a target that 10% of all new electricity generating capacity be from renewable resources (OECD 2004: 49).

Although large-scale hydropower is considered to be renewable, it has a higher impact on the environment than other renewable sources. For example, large-scale hydro operations that involve flooding of large areas of vegetation can result in the release of the greenhouse gas methane, which results from vegetation decay (Canada, Statistics Canada 2004). In addition, large-scale hydro operations affect natural river system and their associated fish and wildlife populations, as well as alter natural water flows and water quality (Canada, Statistics Canada 2004). Other sources of renewable energy such as wind, tidal, solar, biomass, geothermal, run-of-the-river hydro, and small-scale hydro are considered to have the lowest overall impact on the environment. These sources have earned the title "low-impact renewable energy" or "green power" (Raynolds and Pape 2000). Low-impact renewable electricity is defined as electricity that is generated from a nondepleting resource using a process that has minimal impacts on the environment (Rudolf 2004: 3). Therefore, it is useful to distinguish between renewable energy that includes the high-impact, large-scale hydro portion from that fraction that includes only low-impact renewable energy.

In 2002, 59.7% of the total amount of electricity in Canada was generated from renewable sources in Canada, including large-scale hydro (fig. 5.4A). The share of electricity produced by renewable sources including hydro in Canada is more then double the average for all OECD countries. Overall, Canada ranks 5th of 29 OECD countries in the share of energy from renewable sources (fig. 5.4A).



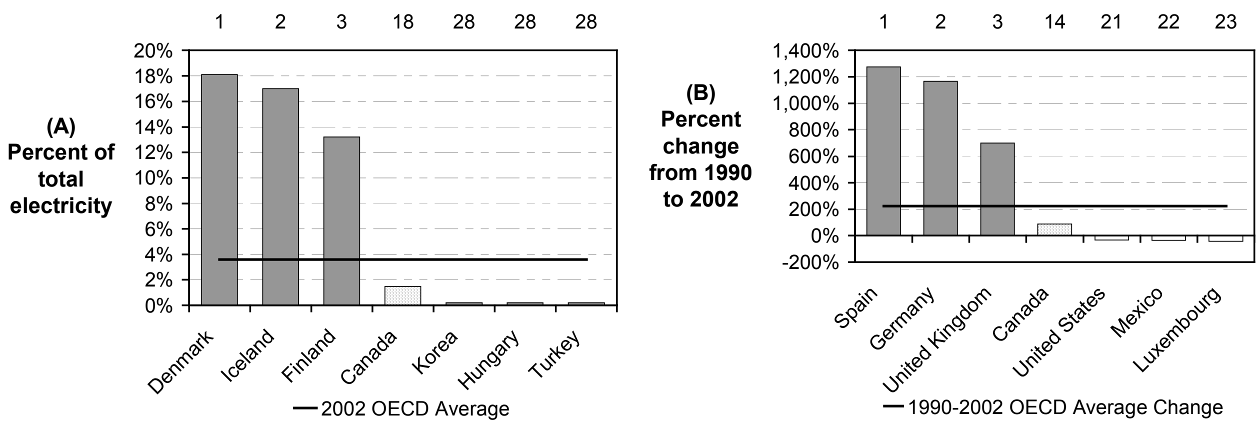
Source: International Energy Agency 2004

Figure 5.4: Ranking Canada's 2002 renewable energy production (including hydro) (A) and change in renewable energy production (including hydro) from 1990 to 2002 (B) among OECD member countries

Note: Renewable energy includes hydro, geothermal, solar, tidal, wind, municipal solid waste, and biomass and biogas.

If hydro is excluded from the renewable sources used to produce electricity, Canada's share of electricity production by renewable sources drops to 1.5%, or half of the OECD average (fig. 5.5A). Canada's performance on low-impact renewable electricity production ranks 18th of 28 OECD countries. The leader in low-impact electricity production is Denmark, which produces 18.2% of its electricity using low-impact renewable sources.

From 1990 to 2002, the share of Canadian electricity produced using renewable sources including hydro decreased by 4% compared to the OECD average increase of 33% (fig. 5.4B). This decrease in electricity produced from renewable sources ranks Canada 18th of 29 OECD countries. When hydro is excluded, Canada's share of low-impact renewable electricity increased by 88% over the last decade, from 0.8% to 1.5% (fig. 5.5B). However, this increase only ranks Canada 14th among 23 OECD countries examined. On average, the increase in renewable energy production in OECD countries is more than two times the Canadian increase.



Source: International Energy Agency 2004

Figure 5.5: Ranking Canada's 2002 renewable energy production (excluding hydro) (A) and change in renewable energy production (excluding hydro) from 1990 to 2002 (B) among OECD member countries

Note: Low-impact renewable energy includes geothermal, solar, tidal, wind, municipal solid waste, and biomass and biogas. All forms of hydro are excluded.

CHAPTER 6: REDUCING WASTE AND POLLUTION

Goal

Canada becomes a world leader in modifying production and consumption patterns to mimic nature's closed-loop cycles, thus dramatically reducing waste and pollution.

Background

Waste and pollution are by-products of poor or inefficient design; an environmentally optimal production process would create minimal to no waste, with all materials being reused. Redesigning production processes to eliminate waste would lead to dramatic improvements in environmental health and production efficiency.

6.1 SULFUR OXIDES

Sulfur oxides pose threats to human health, causing asthma attacks, eye irritation, coughing, and chest pain, as well as to the environment in the form of acid rain, which harms both aquatic and terrestrial ecosystem (Canada, Environment Canada 1996; Boyd 2001; Commission for Environmental Cooperation (CEC) 2005). Emissions of sulfur oxides occur primarily from point sources, such as power plants, pulp mills, smelters, petroleum refineries, and factories (Boyd 2001: 9; CEC 2005). The top five sources for Canada in 2000 were smelters, power plants, the upstream oil and gas industry, oil refineries, and oil sands respectively.[1]

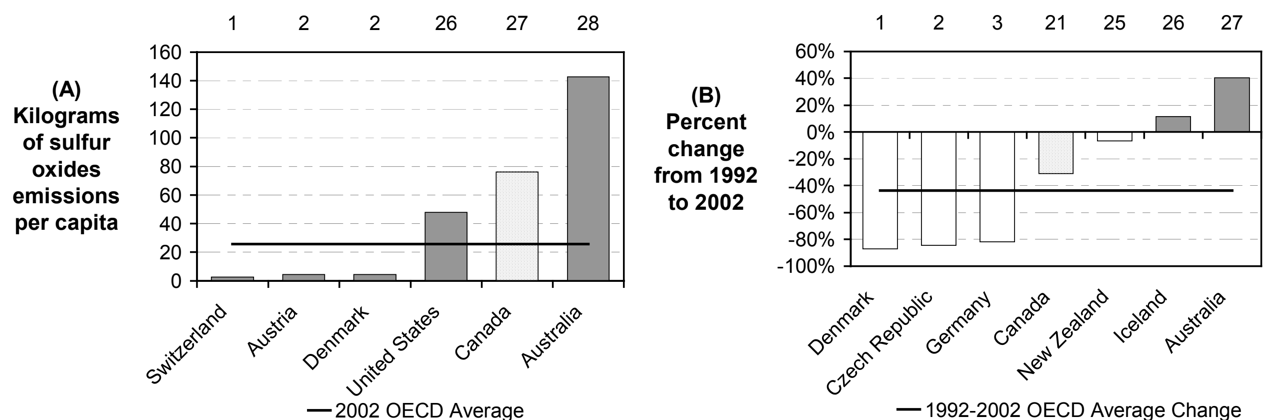
Canada produced 76.3 kilograms of sulfur oxides per capita, almost three times the OECD average and over 29 times higher than the lowest OECD emitter, Switzerland. Overall, Canada ranks 27th of 28 OECD countries for sulfur oxides emissions, second last only to Australia (fig. 6.1A).

Canada decreased sulfur oxides emissions by 31% from 110.5 kilograms per capita to 76.3 during the period 1992 to 2002 (fig. 6.1B). Most of this reduction in Canadian emissions occurred from 1991 to 1993, after Canada entered into the 1991 *Canada-U.S. Air Quality Agreement*, which stipulates the permanent national SO_2 emissions limit of 3.2 million tonnes per year (OECD 2004: 34). The Canada-wide *Acid Rain Strategy for Post 2000*, signed in 1998, established a further 50% reduction for Ontario, Quebec, New Brunswick, and Nova Scotia by 2015 for Ontario and 2010 for the remaining provinces (OECD 2004: 34).

Canada's success in reducing sulfur oxides is due in part to a policy regime based on establishing clear reduction targets (OECD 2004: 39). However, Canada's success is tempered by several important qualifications. First, recent research suggests that although 42% of monitored lakes show reduced acidity levels, lakes may be much more sensitive to acid rain than previously

[1] 2000 CAC Inventory Final.xls spreadsheet provided by Christian Vezina, Project Engineer, Air Pollution Prevention Branch, Environment Canada. Received 9 February 2005

thought. Consequently, it is estimated that a further 75% reduction in sulfur emissions beyond current reduction targets is required to protect aquatic ecosystem (OECD 2004: 39). Further, Canada's success in reducing sulfur emissions from 1992 to 2002 is below the OECD average decrease of 43.7% and well below the best performance by Denmark, which achieved an 87% reduction. Overall, Canada's rate of improvement ranked only 21st of 27 OECD countries and Canada remains the second highest emitter of sulfur oxides per capita despite the reductions.



Source: OECD 2005

Figure 6.1: Ranking Canada's 2002 sulfur oxides per capita emissions (A) and change in per capita sulfur oxides emissions from 1992 to 2002 (B) among OECD member countries

6.2 NITROGEN OXIDES

Nitrogen oxides form during the combustion of fossil fuels, mainly by vehicles, electricity generation, and industrial processes (Canada, Environment Canada 1996; Boyd 2001: 10). As with sulfur oxides, nitrogen oxides harm both human health, and the aquatic and terrestrial environment (CEC 2005). Nitrogen oxides emissions have grown since the early 1980s, reflecting the steady increase in vehicle use. However, emission standards for motor vehicles are becoming increasingly stringent, and by 2010, Canadian national standards for nitrogen oxides will be aligned with U.S. standards (OECD 2004: 18).

Canada's emissions of 78.4 kilograms per capita of nitrogen oxides are about two-and-one-quarter times higher than the OECD average of 35 kilograms per capita, and six times higher than the best OECD performance by Switzerland of 12.4 kilograms per capita. Overall, Canada ranks 26th of 28 OECD countries for their nitrogen oxides emissions (fig. 6.2A).

Canada decreased emissions of nitrogen oxides from 88.8 kilograms per capita to 78.4 in the last decade, a reduction of almost 12%. This reduction compares to an OECD average decrease of 18%. Canada ranks 18th of 28 OECD countries in terms of percent improvement in nitrogen oxides emissions (fig. 6.2B).

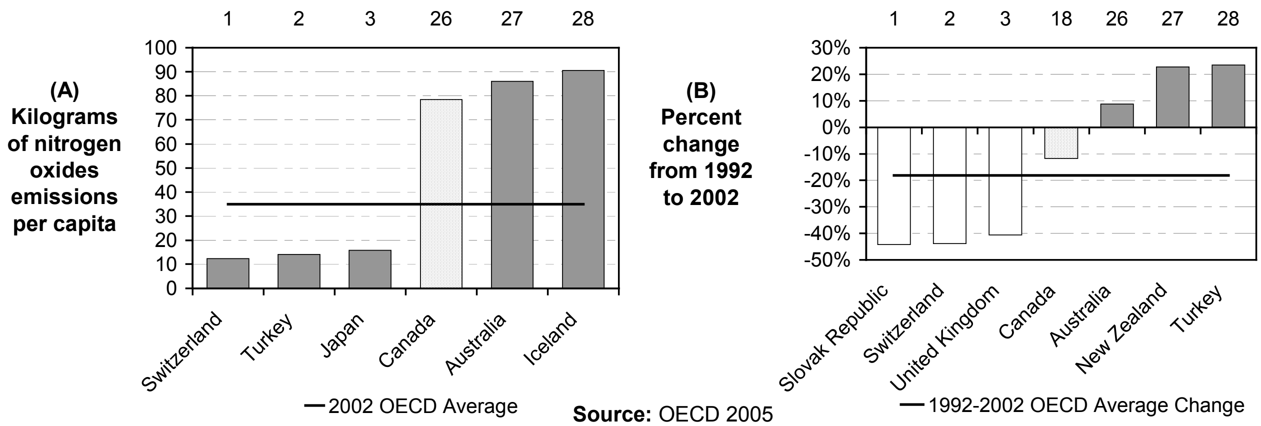


Figure 6.2: Ranking Canada's 2002 nitrogen oxides per capita emissions (A) and change in nitrogen oxides per capita emissions from 1992 to 2002 (B) among OECD member countries

6.3 VOLATILE ORGANIC COMPOUNDS

When combined with nitrogen oxides, volatile organic compounds (VOCs) produce smog and ground-level ozone (Canada, Environment Canada 1996; OECD 2005; CEC 2005). Health impacts include eye irritation and a decrease in lung function. VOCs also impair growth of agricultural products such as wheat, corn, soybeans, and tomatoes (Canada, Environment Canada 1996). VOCs are produced by vehicle emissions and chemical manufacturing, as well as through evaporation of automotive fuels, other petroleum-based products, and chemical solvents.

Canada has the worst ranking of 29 OECD countries for per capita VOCs emissions (fig. 6.3A). Canada emits 83 kilograms per capita of VOCs, almost three times higher than the OECD average and about eight times higher than the best OECD performer.

Canada reduced emissions of VOCs by 13% compared to the OECD average reduction of 23% in the last decade and a 50% reduction by Iceland, which recorded the highest reduction among OECD countries (fig. 6.3B). Canada ranks 18th of 28 OECD countries in VOC reduction. Progress in emissions reductions is constrained by Canada's failure to ratify the 1991 *Geneva Protocol to the Convention on Long-range Transboundary Air Pollution*, and failure to have explicit VOC emission reduction targets (OECD 2004: 33). Emissions may be reduced as Canada adopts more stringent U.S.-style vehicle emission standards by 2010 (OECD 2004: 18).

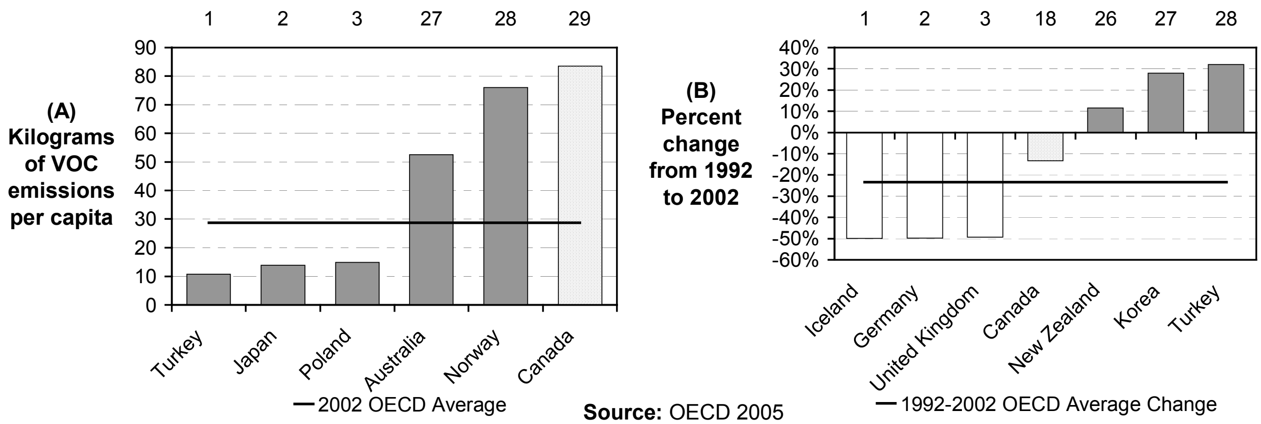


Figure 6.3: Ranking Canada's 2002 VOC per capita emissions (A) and change in VOC per capita emissions from 1992 to 2002 (B) among OECD member countries

6.4 CARBON MONOXIDE

Carbon monoxide (CO) is produced through combustion of fossil fuels, mainly by vehicles (Canada, Environment Canada 1996; Boyd 2001: 12). CO poses serious health risks by impairing the body's ability to absorb oxygen. Carbon monoxide is particularly dangerous because it is colourless, tasteless, odourless, and causes no irritation; therefore, CO is very difficult to avoid or detect before it causes damage.

Canada produced 311.2 kilograms per capita of CO, more than three times higher than the OECD average and more than 11 times higher than Japan, which achieved the lowest per capita CO emissions (27.1) (fig. 6.4A). Canada ranks last out of 28 OECD countries in per capita CO emissions.

Canada decreased per capita emissions of CO by 27.5% between 1992 and 2002. Canada's reduction is slightly lower than the average OECD reduction of 31% and significantly lower than the 77% reduction attained by Luxembourg (fig. 6.4B). Canada ranked 18th of 27 OECD countries in reducing per capita CO emissions.

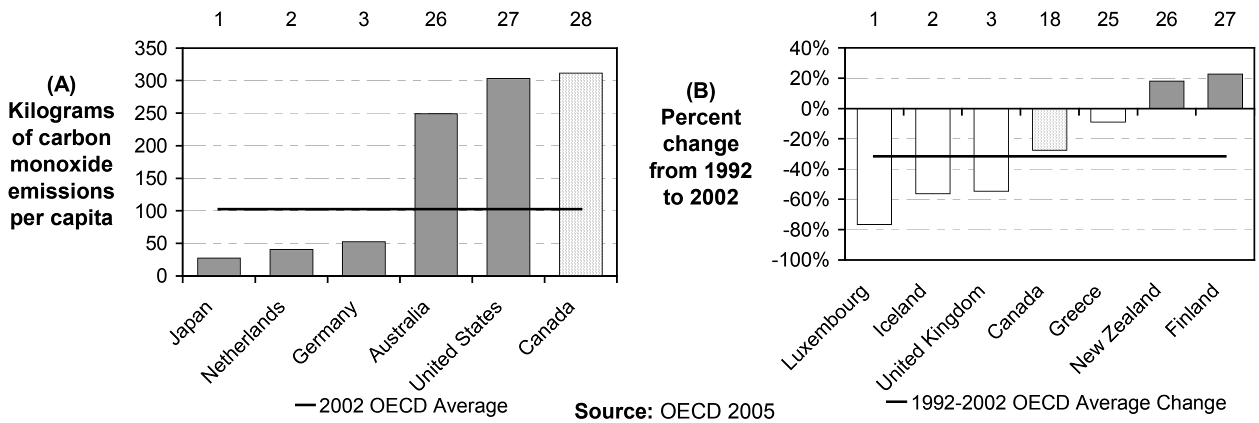


Figure 6.4: Ranking Canada's 2002 carbon monoxide per capita emissions (A) and change in carbon monoxide per capita emissions from 1992 to 2002 (B) among OECD member countries

6.5 PARTICULATES

Fine particulate matter (PM) is defined as naturally occurring dust, as well as soot, smoke, liquid droplets, and other particles emitted by vehicles, factories, power plants, construction, and other human activities (B.C. 2002: 10). PM pose a threat to health, particularly for those with respiratory or cardiovascular ailments (Canada, Environment Canada 1996).

This report uses measures of particulate matter of 2.5 microns or less; studies suggest that particles of this size pose the greatest risk to health (e.g., Ghio and Huang 2004; Grahame and Hidy 2004; Holloman et al. 2004; Jedrychowski et al. 2004). In 2000, the Canadian Council of Ministers of the Environment, with the exception of Quebec, endorsed the Canada-wide standards that sets a target for ambient concentrations of $PM_{2.5}$: a 24-hour average of 30 $\mu g/m^3$, to be achieved by 2010 (OECD 2004: 34).

Particulate numbers are largely estimates based on emissions from industrial and nonindustrial sources (Canada, Environment Canada undated). Samples of emissions are taken from various industrial sources, while emissions from other sources, such as cigarettes or nonindustrial fuel combustion, are estimated. Thus, particulate emissions are largely based on mathematical extrapolations and engineering estimates, rather than on direct measurement. Canada's PM emissions have remained relatively constant in both absolute and per capita terms from 1995 to 2002 (fig. 6.5 and 6.6). Absolute emissions experienced a small decrease between 1985 and 1995, but showed a small increase of less than 3% from 1995 to 2002. Emissions remain at high enough levels to cause health problems (OECD 2004: 50).

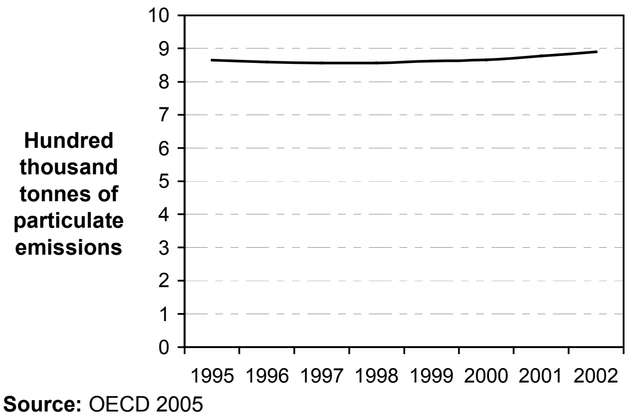


Figure 6.5: Canadian absolute particulate ($PM_{2.5}$) emissions from 1995 to 2002

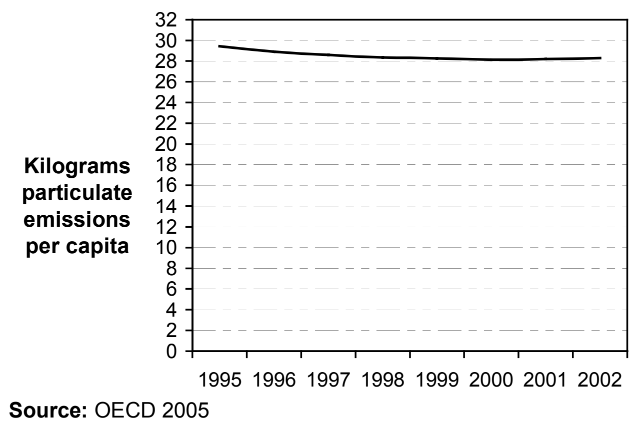


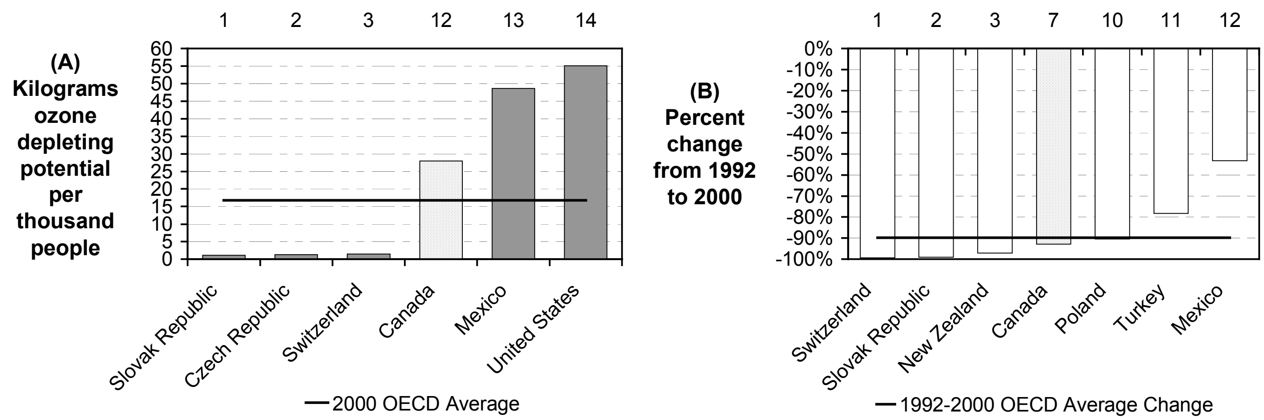
Figure 6.6: Canadian per capita particulate ($PM_{2.5}$) emissions from 1995 to 2002

Unfortunately, Canadian trends in particulates can not be compared to other OECD countries because the data published by the OECD does not use a common particulate size definition (OECD 2005).

6.6 OZONE-DEPLETING SUBSTANCES

Ozone-depleting substances (ODSs) are used in refrigeration and air conditioning equipment as coolants, in aerosol sprays, fire extinguishers, foamed plastics, and pesticides (Boyd 2001). The release of ODSs damages the earth's ozone layer, resulting in increased ultra violet radiation reaching the Earth's surface, which harms human health and the environment. Since different ODSs have different ozone depletion rates, a true comparison of releases can only be done by weighting each substance with its ozone-depleting potential (ODP). This report presents total ODSs as the sum of ODP for CFCs (*Montreal Protocol* Annex A, Group1), other fully halogenated CFCs (*Montreal Protocol* Annex B, Group 1), and hydrochlorofluorocarbons (HCFCs) (*Montreal Protocol* Annex C, Group 1).

Canada no longer produces CFCs, halons, carbon tetrachloride, or methyl chloroform (OECD 1998). Canada is still producing HCFCs, although international agreements require these chemicals be phased out by 2020 (Boyd 2001). In 2000, Canada released 28 kilograms of ODP per thousand people (fig. 6.7A). An amount more than 60% greater than the OECD average of 17, and over 25 times larger than the OECD best performer, the Slovak Republic (1.1 kg per thousand people). Canada ranked 12th of 14 countries for this performance.



Source: United Nations Environment Program. Ozone Secretariat. 2002. *Production and Consumption of Ozone Depleting Substances under the Montreal Protocol: 1986 -2000.* Nairobi, Kenya: United Nations Environment Program. <Online: www.unep.org/ozone/Publications/6iv_publications%20others.asp; accessed 26 May 2005.>

Figure 6.7: Ranking Canada's 2000 ozone-depleting substances consumption (A) and change in ozone-depleting substances consumption from 1992 to 2000 (B) among OECD member countries

Notes:
(a) Data are totals representing CFCs (*Montreal Protocol* Annex A, Group1), Other Fully Halogenated CFCs (*Montreal Protocol* Annex B, Group 1), and HCFCs (*Montreal Protocol* Annex C, Group 1).
(b) Data are weighted with the ozone depleting potential of the substance.

From 1992 to 2000, Canada managed to reduce ODSs by about 93% (fig. 6.7B). While this reduction exceeded the OECD average reduction of 90%, Canada still only ranked 7th of 12 countries. The OECD best performer, Switzerland, reduced ODSs by over 99%.

6.7 MUNICIPAL WASTE

The OECD defines municipal waste as "waste from households, including bulky waste, similar waste from commerce and trade, office buildings, institutions and small businesses, yard and garden waste, street sweepings, the contents of litter containers, and market cleansing waste" (OECD 2003c: 10). Inappropriate waste management can have a potential impact on human health and the environment. Municipal waste contributes to habitat destruction, surface and groundwater pollution and other forms of air, soil, and water contamination (OECD 2001b). Depending on the disposal method, several environmental problems can arise with negative consequences, such as the creation of toxic substances through incineration. Landfills also emit methane (which contributes to global warming) and other gases (OECD 2001b). Methane emissions from landfills can be reduced by home composting, which cut the volume of organic matter sent to landfills.

Canada's household waste composition for the year 2000 is as follows: 42% paper and paperboard, 14% organic material, 2% plastics, 5% glass, 32% metals and 4% textiles and other (OECD 2005: 176).

In 1997, Canada produced 490 kilograms of waste per capita, only slightly above the OECD average of 458 kilograms per capita but over 60% greater than Mexico, which had the lowest rate of municipal waste production among OECD countries. Overall, Canada ranks 19th of 28 OECD countries for per capita municipal waste production (fig. 6.8A).

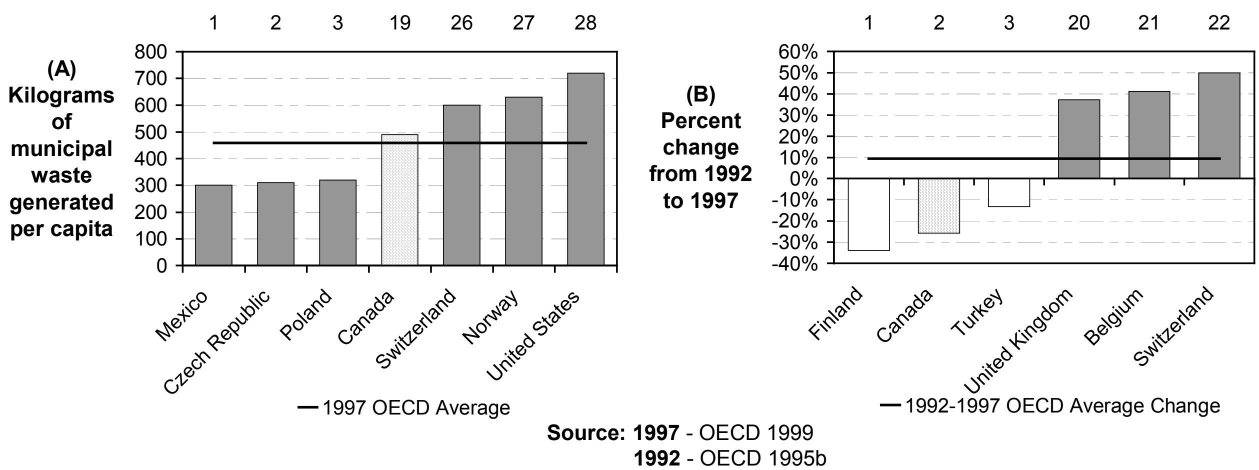


Figure 6.8: Ranking Canada's 1997 per capita rate of municipal waste generation (A) and change in per capita rate of municipal waste generation from 1992 to 1997 (B) among OECD member countries

Canada successfully decreased production of municipal waste by over 25% from 660 to 490 kilograms per capita from 1992 to 1997 (fig. 6.8B), while the OECD countries, on average, experienced a 9% increase. Canada ranks 2nd compared to other OECD countries in terms of percent change in municipal waste generation.

6.8 RECYCLING

Waste minimization encompasses three elements: "preventing and/or reducing the generation of waste at the source, improving the quality of waste generated, such as reducing the presence of hazardous materials, and encouraging reuse, recycling, and recovery" (OECD 2001a: 239). This section of the report focuses on recycling.

The OECD defines recycling as the “reuse of material in a production process that diverts it from the waste stream, except reuse as fuel” (OECD 2003c: 20). Recycling reduces the amount of material being discarded as waste and reduces consumption of natural resources (Boyd 2001).

An indicator used to measure recycling efforts is the proportion of municipal waste that is diverted to recycling. The proportion of waste recycled is the quantity of nonhazardous materials diverted from disposal facilities, and represents the sum of all materials (e.g., glass, metal, plastic, wood, paper, and cardboard) processed for recycling or reuse at an off-site recycling facility against the total generation of nonhazardous residential and nonresidential solid waste.

OECD recycling data for Canada are based on household waste, which represents about one-half of municipal waste (OECD 2005).[2] Canada’s recycling rate for household waste in 2000 was 23%, which is above the OECD average but well behind the countries with the highest recycling rates 9 (fig. 6.9A). Canada increased its rate of recycling from 1990 to 2000, but the rate of increase was only about one-quarter the average improvement for OECD countries (fig. 6.9B).

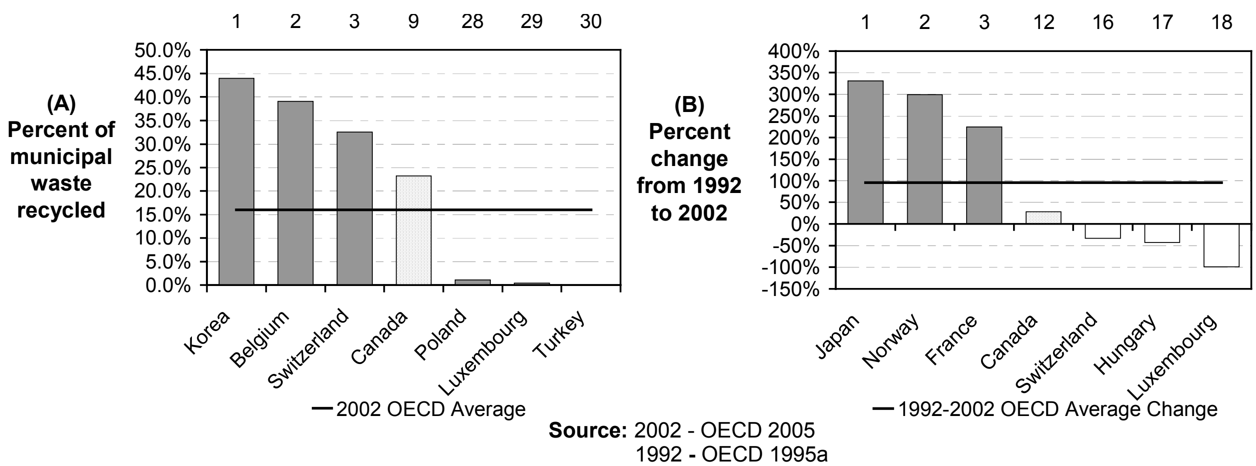


Figure 6.9: Ranking Canada’s 2002 percent of municipal waste recycled (A) and change in percent of municipal waste recycled from 1992 to 2002 (B) among OECD member countries

6.9 HAZARDOUS AND TOXIC WASTE

Hazardous wastes are defined as substances that can harm human health or the environment. Examples of hazardous wastes include acids, alkalis, solvents, medical waste, resins, sludge, and

[2] OECD recycling data for Canada are based on household waste while recycling data for other OECD countries are based on municipal waste (OECD 2005). Household waste represents about one-half of municipal waste. Therefore the recycling data for Canada and other OECD countries are based on different definitions and are not directly comparable. However, Statistics Canada recycling data for Canada for 2002 based on municipal waste indicate a recycling rate of 21%, which is very close to the Canadian household rate recorded by the OECD of 23% (Canada, Statistics Canada 2004: 96). Therefore the difference in definition and year does not affect the results or ranking of Canada.

heavy metals. If these materials are poorly managed or disposed of without proper treatment hazardous wastes can accumulate and persist in the environment causing serious, long-lasting damage to both human health, as well as terrestrial and aquatic ecosystem (Canada, Environment Canada 1996; Boyd 2004; CEC 2005). For example, long-term exposure to mercury, lead, or cadmium can damage the brain, the kidneys, the nervous system, and fetal development.

Established in 1992 and legislated under the *Canadian Environmental Protection Act*, 1999, the National Pollutant Release Inventory (NPRI) is the only national, publicly accessible inventory on the releases and transfers of key pollutants in Canada. The NPRI requires companies to report information on releases and transfers of pollutants to the Government of Canada on an annual basis. Only facilities that meet established reporting criteria are required to report to the NPRI. Mobile sources, such as trucks and cars, households, facilities that release pollutants on a smaller scale, and certain sector activities, such as agriculture and education and some mining activities, are not included in the NPRI.[3]

The federal government regulates export, import, and transits of hazardous wastes and hazardous recyclable materials but it does not regulate the generation of hazardous wastes. Environment Canada tracks the annual volumes of hazardous wastes being exported from and imported to Canada.[4] Provincial and territorial governments have jurisdiction for tracking generation, management, and transportation of hazardous wastes within their boundaries.[5]

Comparative analysis of hazardous waste generation is difficult because the definition of hazardous wastes used for data collection changes over time and between countries. Therefore it is not possible to undertake comparisons between Canada and OECD countries. However, the Commission for Environmental Cooperation (CEC) recently completed an analysis of chemical releases that used a common definition of chemicals to compare trends in the United States and Canada between 1998 and 2002 (CEC 2005). The study is based on 203 chemicals common to the Toxic Release Inventory in the United States and the NPRI in Canada. It should be noted that the data are a subset of total chemical releases, which number in the tens of thousands.

Canada released 356,000 tonnes of toxic chemicals in 2002, or 9.9 kilograms per capita, which is 10% above the per capita release recorded by the United States (fig. 6.10A). Releases from electric utilities and primary metal production accounted for about 70% of total releases. Approximately 12% of total releases in Canada and the United States are known to cause cancer and/or birth defects. Canada recorded a 7% increase in absolute emissions between 1998 and 2002, while the United States recorded an 8% decline. On a per capita basis, Canadian releases increased by about only 3%; however, the U.S. was able to reduce per capita toxic chemical releases by over 14% (fig. 6.10B).

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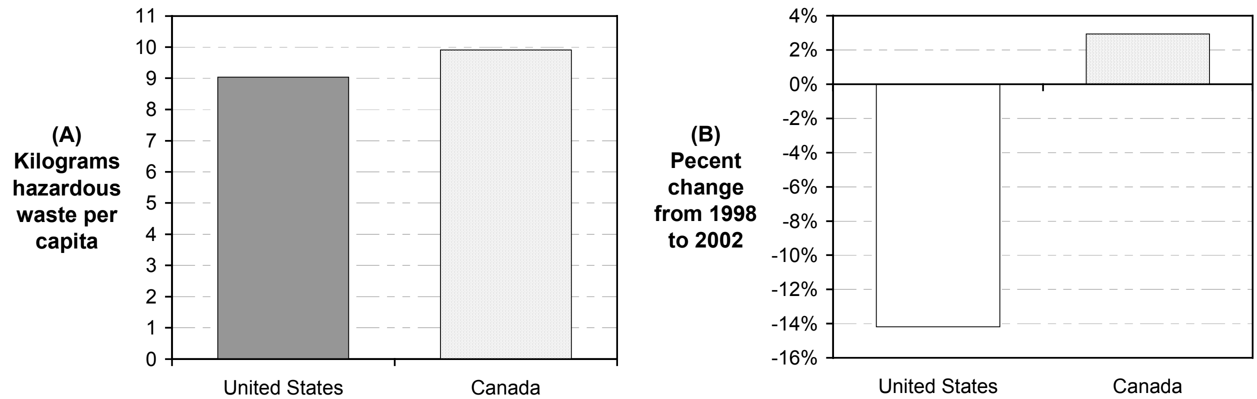
[3] Environment Canada. National Pollutant Release Inventory website. www2.ec.gc.ca/pdb/npri/npri_home_e.cfm; accessed 4 March 2005.

[4] Environment Canada. Transboundary Movement Branch website. www.ec.gc.ca/tmb/eng/tmbhp_e.html; accessed 4 March 2005.

[5] *Canadian Environmental Protection Act, 1999*. Chapter 33. Available online: www.ec.gc.ca/CEPARegistry/documents/part/RepFinDisp.cfm#32; accessed 4 March 2005.



Source: CEC 2005

Figure 6.10: Comparing Canadian and U.S. 2002 per capita toxic chemical relseases (A) and change in Canadian and U.S. per capita toxic chemical relseases from 1998 to 2002 (B)

6.10 NUCLEAR WASTE

Nuclear energy accounts for about 16% of Canadian electricity production: 45% for Ontario, 30% for New Brunswick, and 3% for Quebec (Canadian Nuclear Association 2004). The most serious environmental impact of nuclear power is the generation of radioactive waste, which is a serious threat to human health and the environment. Nuclear waste can be divided into three categories: nuclear fuel waste comprised of spent nuclear fuel bundles discharged from reactors, uranium mine tailings, and low level radioactive waste (Canada, Statistics Canada 2004). Spent nuclear fuel, which remains radioactive for over 250,000 years, is stored on-site at nuclear power plants because a technology for permanently disposing of radioactive waste does not yet exist.

The quantity of spent nuclear fuel is expected to increase almost threefold from 1998 to 2035 from 5,583 to 14,470 cubic meters (Canada, Statistics Canada 2004: 21). Low-level radioactive waste, which consists primarily of contaminated soil, is expected to increase from 1.8 million (1998) to 2.1 million cubic meters by 2035. Canada is the largest generator of nuclear waste per capita of any OECD country, producing over seven times the OECD average (fig. 6.11A). Canada did however record the largest decline in per capita production of nuclear waste from 1992 to 2002 (fig. 6.11B).

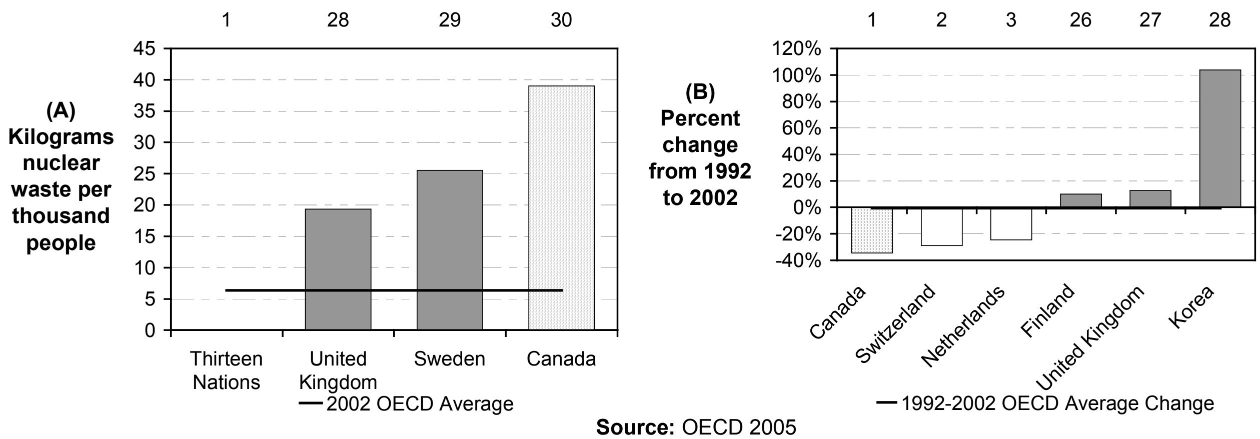


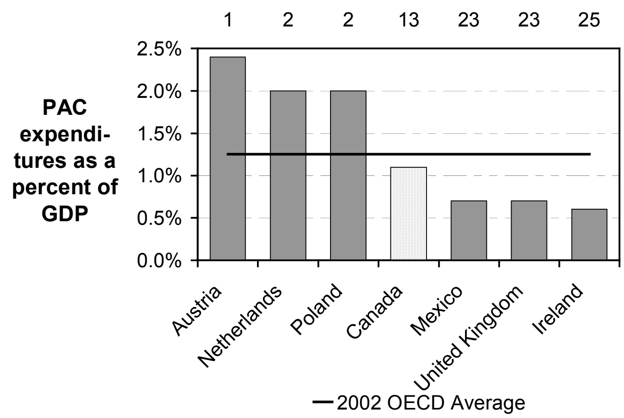
Figure 6.11: Ranking Canada's 2002 kilograms of nuclear waste per thousand people (A) and change in kilograms of nuclear waste per thousand people from 1992 to 2002 (B) among OECD member countries

6.11 POLLUTION ABATEMENT AND CONTROL EXPENDITURES

Total pollution abatement and control (PAC) expenditures are a useful measure of efforts by a society to mitigate environmental damage. The expenditures are measured as a percentage of the GDP or overall economic activity. PAC expenditures and activities include "protection of ambient air and climate, wastewater management, waste management, protection and remediation of soil, groundwater and surface water, noise and vibration abatement, and protection against radiation" (OECD 2003d: 12). The definition excludes expenditures on: resource management, including natural disaster prevention and hazard mitigation; nature protection; drinking water; workplace protection; energy saving; or improvement of production processes for commercial or technical reasons (OECD 2001a).

The federal and provincial governments report PAC expenditure as "purposeful activities aimed directly at the prevention, reduction, and elimination of pollution or nuisances arising as a residual of production processes or the consumption of goods and services" (OECD 2003d: 9). Private PAC expenditures in industry are mostly associated with air pollution, water pollution, and the disposal of hazardous waste. The polluter pays principle infers that the polluter should bear the expenses of carrying out environmental protection measures, and the costs of these measures should be reflected in the cost of goods and services which cause pollution in production or consumption (OECD 2003b).

Canada spent 1.1% of its GDP on pollution abatement, almost 20% lower than the OECD average of 1.3% (fig. 6.12). The public sector was responsible for 55% of the total PAC expenditures in Canada (OECD 2005). Canada's expenditures are less than half the level of Austria's spending, which achieved the highest level of PAC expenditures (2.4% of GDP) among OECD countries. Canada ranks 13th of 25 OECD countries in PAC expenditures as a proportion of GDP.

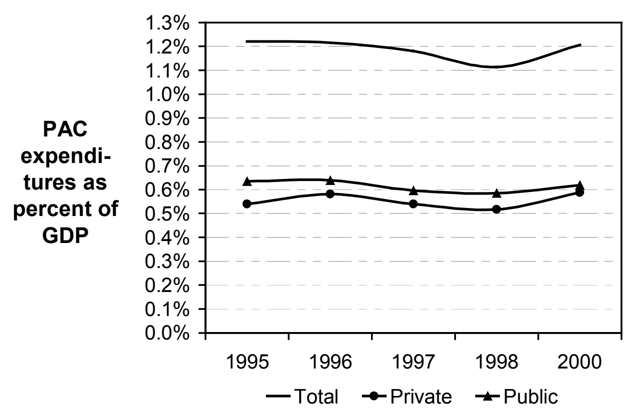


Source: OECD 2004

Figure 6.12: Ranking Canada's 2002 PAC expenditures among OECD member countries

Note: The total PAC expenditures are expressed as a percentage of GDP converted to U.S. dollars to facilitate comparison with other OECD countries.

Between 1995 and 2000, total PAC expenditures in Canada remained fairly constant, at or near 1.2%, peaking in 1995 and 1996 (1.22%) and bottoming in 1998 (1.11%) (fig. 6.13).



Source: Canada. Statistics Canada 2004

Figure 6.13: Canadian public, private, and total PAC expenditures as a percentage of GDP from 1995 to 2000

Note: Public PAC expenditures include federal, provincial, and municipal expenditures on curative or preventative efforts to reduce environmental pressure. From 1994 onwards the Environmental Protection Expenditure Survey collects information on capital, or operating expenditures, (end-of-pipe and process-integrated) and investment expenditures made by businesses to comply with environmental regulations or voluntary agreements (OECD 2005).

CHAPTER 7:
PROTECTING WATER QUALITY

Goal

Canada becomes a world leader in water stewardship by protecting and restoring the quantity and quality of fresh water in Canadian ecosystem, and by guaranteeing access to clean water in the Canadian Charter of Rights and Freedoms.

Background

> In recent years two *serious drinking water incidents* have served as urgent "wake-up calls" for water managers throughout Canada.
>
> OECD 2004: 57 (*emphasis in original)*

Industrial effluent, agricultural run-off, and municipal sewage pollution are among the many threats facing Canadian water quality. Industry alone is responsible for 20 million kilograms of toxic chemicals being dumped into Canadian rivers, lakes, and streams, and 135 million kilograms of contaminates into groundwater (Canada, Environment Canada 1999). The millions of kilograms of toxic industrial chemicals released each year are leading to increased eutrophication of fresh water bodies, and contamination of groundwater. Industry, agriculture, and human wastewater are all releasing harmful chemicals, many of which disrupt endocrine system in humans and animals, and cause reproductive and immune dysfunctions, neurological, behavioral, and developmental disorders, as well as various cancers (B.C. 2002).

Electricity facilities have also significantly impacted water resources. Cooling in electricity production uses twice as much water as all other sources combined (OECD 2004). The infrastructure, facilities, and processes involved in producing hydroelectricity have severe implications on the landscape, including the inundation of large tracts of land, alteration of river flows, and harm to aquatic species.

7.1 WATER QUALITY

A comprehensive assessment of Canadian water quality is not possible due to a lack of national water quality monitoring data. However, the Canadian Council of Ministers of the Environment completed the first partial assessment of national water quality based on results from 319 measuring stations using consistent standards of evaluation (OECD 2004). The results show that about one-half of the water bodies tested recorded good to excellent water quality and the other half recorded poor to fair water quality (table 7.1)

Table 7.1: Water quality in Canada from 1997 to 2001

WATER QUALITY	NUMBER OF STATIONS	%
Excellent	57	18
Good	104	33
Fair	90	28
Marginal	38	12
Poor	30	9
Total	**319**	**100**

Source: OECD 2004: 58

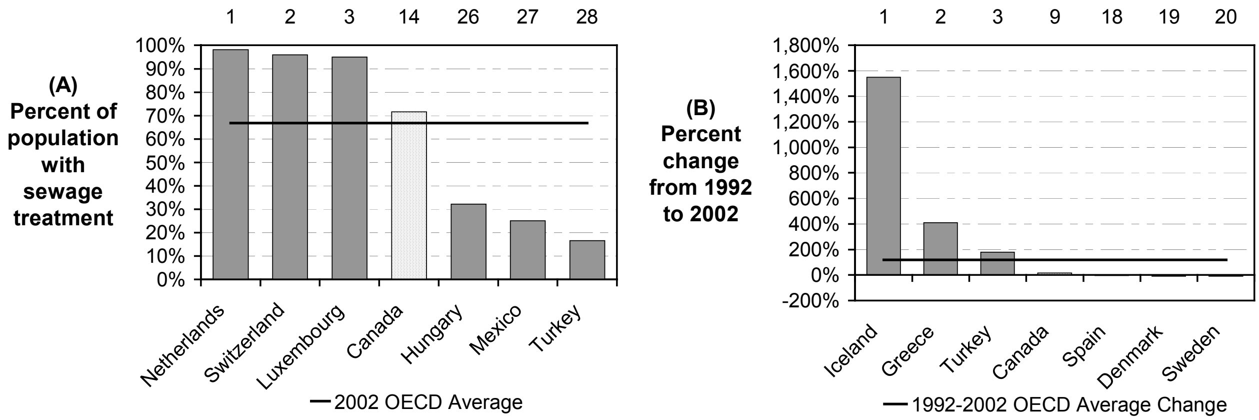
Drinking water quality is of particular concern. It is estimated that about one million Canadians depend on groundwater that does not meet water quality guidelines. Of particular concern are First Nation communities where a recent assessment showed that 75% of communities surveyed had water system that were classified as medium to high risk (OECD 2004: 63). Recent examples of serious incidents occurred at Walkerton, Ontario, resulting in seven deaths and over 2,300 illnesses, and North Battlefield, Saskatchewan, involving about 7,000 illnesses (OECD 2004: 57).

7.2 MUNICIPAL SEWAGE TREATMENT

Untreated or poorly treated municipal sewage is a major source of water contamination. Many water bodies have suffered from fishing, swimming, and shellfish closures due to the release of untreated sewage waste and contaminants from nonpoint sources (Boyd 2004). Unnaturally high nutrient levels from agricultural run-off and sewage are leading to eutrophication and toxic algal blooms in many water bodies. Further, the release of untreated human excrement (raw sewage) leads to unsafe levels of fecal coliforms that increase the presence of disease causing pathogens (Boyd 2001, 2004).

The impact of sewage on water can be reduced by various forms of sewage treatment, normally categorized as primary, secondary, and tertiary. During primary treatment, large solids, sediment, and organic matter are removed using filters and screens. Secondary treatment biologically processes waste using bacteria and microorganisms. Tertiary treatment uses a variety of processes to remove additional nutrients, toxic compounds, salts, acids, and metals.

Seventy-two percent of the Canadian population currently has access to sewage treatment and 58% have access to either secondary or tertiary treatment. Nine percent of Canadians are connected to an industrial wastewater plant, or have some form of personal sewage treatment system such as septic tanks or disposal fields (Boyd 2001, 2004; OECD 2003c). The remaining 19% are connected to a sewer service, but the sewage is not treated. Overall, Canada ranks 14th of 28 OECD countries in terms of the proportion of population served by sewage treatment (fig. 7.1A). Topping the list was the Netherlands where 98% of the population has sewage treatment.



Source: 2002 - OECD 2005
1992 - OECD 1995b

Figure 7.1: Ranking Canada's 2002 proportion of the population with sewage treatment (A) and change in proportion of the population with sewage treatment from 1992 to 2002 (B) among OECD member countries

Canada increased the percent of the population served by municipal sewage treatment by 14% from 1992 to 2002, well below the OECD average change of 119% (fig. 7.1B). It is important to keep in mind, however, that the percentage change is relatively low in Canada because a significant portion of the Canadian population was already served by municipal sewage treatment. Nonetheless, there are still significant deficiencies in Canada's sewage treatment system. Three provincial capitals—Victoria, Halifax, and St. John's—continue to pump raw sewage directly into the ocean (Boyd 2001). Even in regions with the most effective treatment, faulty sewage infrastructure combined with exceptionally heavy rains can result in sewage wastewater by-passing the treatment facility and flowing directly into the receiving environment through sewer overflows (Canada, Environment Canada 1996). The OECD estimates that based on current plans, it will take another 20 years before Canada's sewage system needs are met (OECD 2004: 64).

CHAPTER 8:
PRODUCING HEALTHY FOOD

> Food security exists when all people at all times have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life.
>
> World Food Summit, Rome, 1996[1]

Goal

Agriculture in Canada provides nutritious, healthy foods for Canadians as well as people around the world, while safeguarding the land, water, and biodiversity.

Background

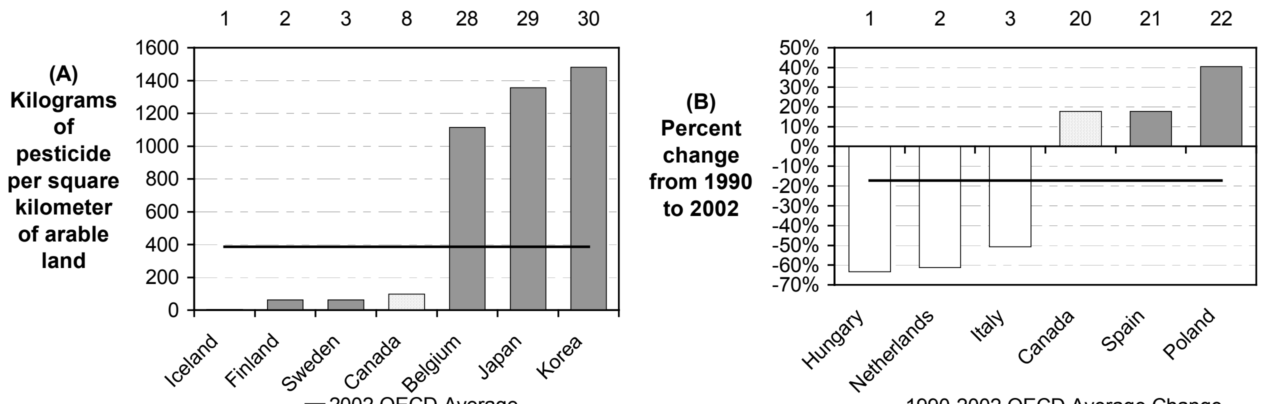
Pesticide contamination, dwindling water tables, surface and groundwater contamination, soil erosion, and uncertainty of impacts of genetically modified foods are some of the environmental issues associated with agriculture (Evans 1998; Chambers et al. 2001). Water supply can become contaminated by pesticides and agricultural waste, and inundated with fertilizer compounds such as nitrogen and phosphorous, which increase eutrophication and damage aquatic ecosystem. The use of genetically modified organisms is also increasing, despite many uncertainties regarding their impacts on human health and the environment.

8.1 PESTICIDE USE

Canada has over 7,000 pesticide products registered, 90% of which are used in agriculture (Boyd 2004). Over 60 of the pesticides used in Canada are banned by other countries due to their environmental and health impacts. Canada uses 96.6 kilograms of pesticides per square kilometer of arable land, about one-quarter the OECD average of 386, but more than 25 times higher than Iceland's pesticide application rate of 3.9, the OECD's lowest. Overall, Canada ranks 8th of 30 OECD countries for kilograms of pesticides per square kilometer of arable land (fig. 8.1A). The largest pesticide application rate in the OECD was 1,480 kg per square kilometer (Korea).

Between 1990 and 2002, Canada increased its kilograms of pesticides per square kilometer of arable land by 17.8%, while the OECD average pesticide application rate decreased by 17% (fig. 8.1B). Canada ranked 20th of 22 OECD countries for this change in pesticide application rate, with Hungary achieving the OECD's best performance through a 63% decrease, and Poland recording the OECD's worst performance by increasing pesticide use by 40%.

[1] As quoted in Boyd 2004: 25



Source: OECD 2005

Figure 8.1: Ranking Canada's 2002 pesticide application rate (A) and change in pesticide application rate from 1990 to 2002 (B) among OECD member countries

8.2 FERTILIZER USE

In 2001, Canada used 5.81 tonnes of fertilizer[2] per square kilometer of arable land, about 25% of the OECD average of 23 (fig. 8.2A). Canada ranks 2nd of 29 OECD countries for fertilizer use. The OECD best performer, Australia, used only about 4.9 tonnes per square kilometer, while the worst OCED performer, New Zealand, applied fertilizer at a rate of 166 tonnes per square kilometer.

Canada increased fertilizer use, from 1990 to 2001, by 16% from 5.01 to 5.81 tonnes per square kilometer of arable land, while the OECD averaged an 11% decrease**.** The largest reduction was recorded by the Slovak Republic, which reduced fertilizer use by 76%. Only three OECD countries had a higher increase in fertilizer application rates. Consequently, Canada ranked 26th of 29 countries in change in fertilizer use (fig. 8.2B).

[2] Total apparent consumption quantities that included nitrogen, phosphorous, and potassium fertilizers were used for this indicator.

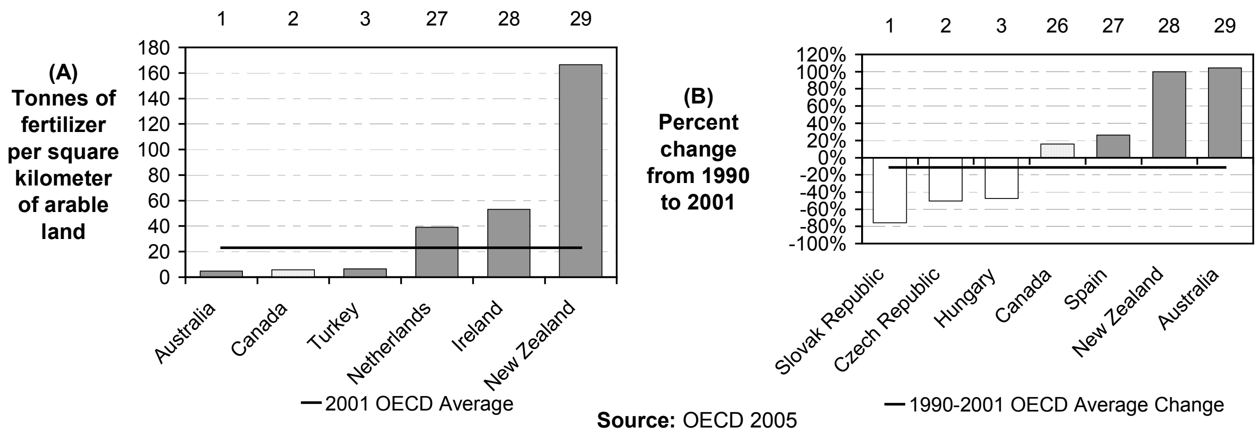


Figure 8.2: Ranking Canada's 2001 fertilizer application rate (A) and change in fertilizer application rate from 1990 to 2001 (B) among OECD member countries

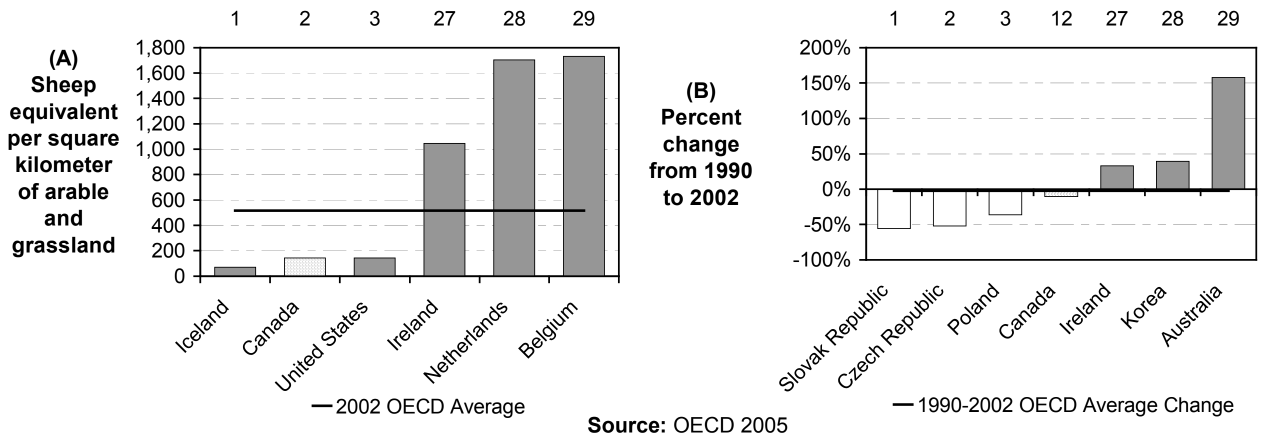
Note: Total apparent consumption quantities that included nitrogen, phosphorous, and potassium fertilizers were used for this indicator.

8.3 LIVESTOCK

Meat production has a high environmental impact. Intensive livestock operations produce an excessive amount of manure—132 billion kilograms of manure per year in Canada—, as well as require vast volumes of water, energy, and other resources to artificially sustain the operations (Canada, Statistics Canada 2001; Boyd 2004). Consequently, the OECD uses livestock as one of its environmental indicators. Livestock is measured in head of sheep equivalent livestock (a weighted summation of: cattle; sheep and goats; horses, mules, and asses; and pigs) per unit of arable and grassland to allow for comparison between countries. Arable and grassland areas were combined when calculating this indicator in an effort to capture the carrying capacity of the land base that might potentially be used to support the livestock

Canada has 141.4 head of sheep equivalent livestock per square kilometer of arable and grassland compared to the OECD average of 515.3. Canada ranked 2nd of 29 OECD countries, while Iceland ranked 1st with only 69 head of sheep equivalent livestock per square kilometer and Belgium ranked last with 1,732.6 (fig. 8.3A).

From 1990 to 2002, OECD countries produced varying results with reducing their respective livestock levels, averaging a 2.2% reduction. Canada ranked 12th of 29 OECD countries with a 10% reduction in levels of sheep equivalent livestock (fig. 8.3B). The Slovak Republic was 1st with a 55% decrease, while Australia ranked last with livestock levels increasing by over 150%.



Source: OECD 2005

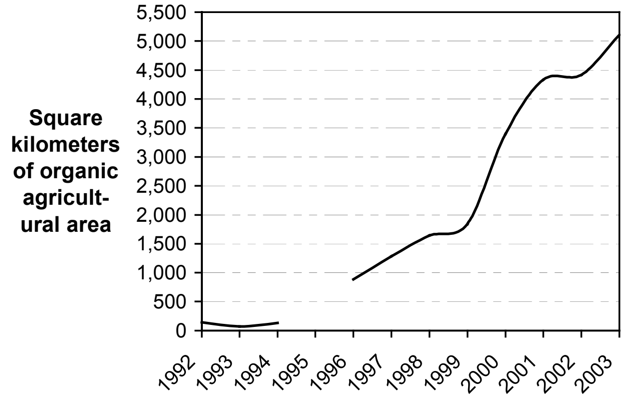
Figure 8.3: Ranking Canada's 2002 livestock levels (A) and change in livestock levels from 1990 to 2002 (B) among OECD member countries

Note: The OECD Environmental Data Compendium contains time-series information on numbers of cattle; sheep and goats; horses, mules, and asses; and pigs for each OECD member country. Because the magnitude of many (if not all) environmental impacts of livestock depend upon the size of the animal, the larger animals (cattle, horses, mules, and asses) were converted to sheep equivalent livestock using factors calculated from 'animal unit equivalents' contained in the United States Department of Agriculture National Resource Conservation Service's *National Range and Pasture Handbook* (2003: 6-9). <Available online: www.glti,nrcs.gov/technical/publications/nrph.html; accessed 19 May 2005.> This indicator assumes cows are equal to five sheep, and horses, mules and asses are equal to 6.25 sheep. A conversion factor for pigs could not be located but because commodity pigs are generally the same size as sheep, the two were assumed equivalent for the purposes of calculating this indicator.

8.4 ORGANIC AGRICULTURE

To mitigate environmental concerns, many farmers are seeking alternative means of managing pests, and eliminating all synthetic pesticides and fertilizers by practicing organic agriculture (Boyd 2004). Organic agriculture is defined as "a holistic system of production management designed to optimize the productivity and fitness of diverse communities within the agro-ecosystem, including soil organisms, plants, livestock, and people" (Macey 2004: 2).

The total area of organic agriculture increased from 4,300 square kilometers to 5,100 in 2003, an 18% increase from 2001 (fig. 8.4). In 2001, nearly 3.5% of agricultural land in Canada was considered organic. While this number is relatively small, organic agriculture is increasing rapidly as farmers respond to growing market demand for organic products (Macey 2004). Data limitations preclude comparison of organic farming in Canada with other OECD countries.



Source: 1992 to 1994, 1997 to 2000, 2002, and 2003 - Macey 2004
1996 and 2001 - Statistics Canada, Census of Agriculture Data

Figure 8.4: Canadian square kilometers of organic agricultural area from 1992 to 2003

Note: Much of the data is based upon reported estimates by producers rather than independently verfified data

CHAPTER 9:
PROTECTING AND CONSERVING NATURE

Goal

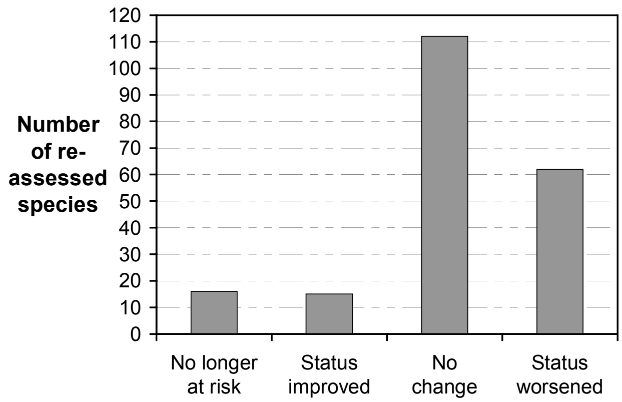
Canada becomes globally renowned for our leadership in conserving, protecting, and restoring the health and diversity of our ecosystem, the magic of our parks and wilderness areas, and the natural beauty of our nation.

9.1 SPECIES AT RISK

One indicator for measuring the health of a country's biodiversity is the number of species at risk of becoming extinct in the wild. However, an important qualification in using species at risk data needs to be emphasized. Species at risk estimates are based on completing studies of individual species; the more species studied, the higher the number of species at risk. For example, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) estimates that the number of species at risk[1] in Canada grew from 17 in 1978 to 467 in 2004 (COSEWIC 2004). However, the increased number of species at risk reflects in part the pace at which COSEWIC can study and designate species, rather than the pace at which species may be going extinct. Also, the estimates significantly understate the number of species at risk because the estimates are based on a review of only 650 species of the estimated 137,500 wild species in Canada (OECD 2004: 76).

A better indicator of trends in species at risk is the change in status for the same group of species over time. This was recently done through a reassessment of 205 species at risk between 1985 and 2004 (fig. 9.1). Of these species, 16 are no longer at risk, 15 have been placed in a lower-risk category, 112 have shown no change in their status, and 62 have been placed in a higher-risk category (Canada, Environment Canada 2003). The number of species at risk whose status has either shown no change or has deteriorated is six times greater than the number of species whose status has improved. Although some successes in improving the status of some of the species at risk have been achieved, it appears that overall biodiversity is deteriorating.

[1] Species at risk includes species designated by COSEWIC as extinct, extirpated, endangered, threatened, or of special concern.



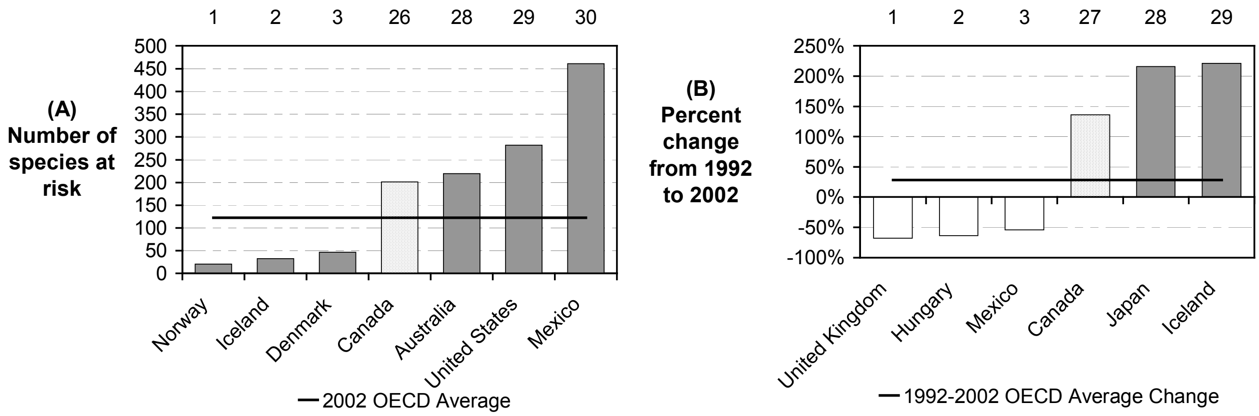
Source: Canada, Environment Canada 2003

Figure 9.1: Canadian change in status of reassessed species at risk from 1985 to 2002

Notes:
(a) The data are based on species reassessments conducted by COSEWIC. Reassessments based on existing reports were not included. Existing reports were reevaluated using quantitative criteria and not based on new information.
(b) Changes in status (i.e., a species placed in a lower-risk or higher-risk category) could be the result of new information gathered rather than an actual improvement or deterioration in the status of species.

In 2002, Canada ranked 26th of 30 OECD countries for number of species at risk, well above the OECD average and more than 23 times greater than Norway, which had the lowest number of species at risk. However, Canada ranked much better in terms of percent of species at risk: 8th of 30 countries and well below the OECD average (fig. 9.2A and 9.3A). The reason for the better ranking in percent of species at risk is that Canada has more species due to its abundant biodiversity. Mammals and birds account for approximately 30% each of the species at risk, while fish account for the remaining 40 %.

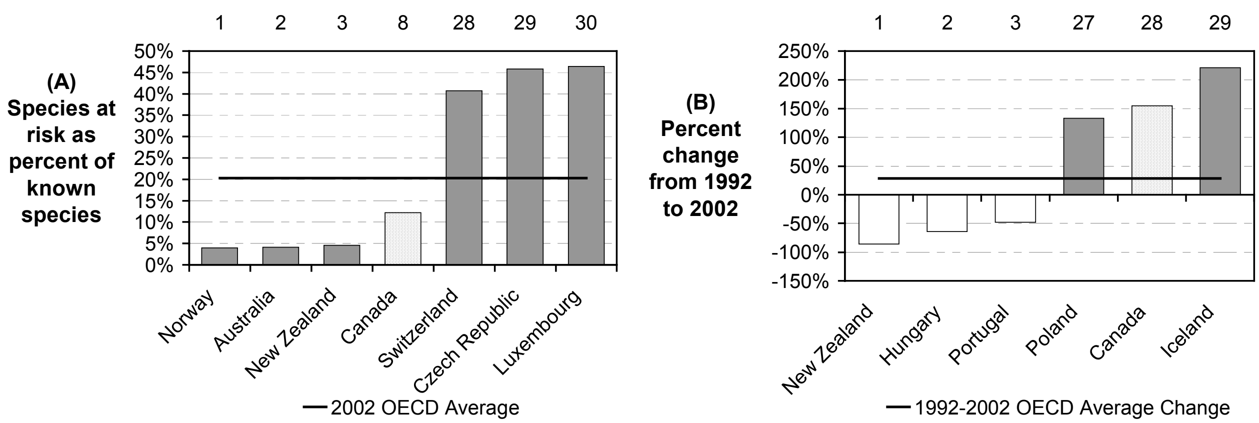
From 1992 to 2002, only two OECD countries—Japan and Iceland—had a greater rate of increase in its respective **number** of species at risk than Canada (fig. 9.2B), and only one OECD country—Iceland—had a greater increase in the **percent** of species at risk (fig. 9.3B). For this performance, Canada ranked 27th of 29 for numbers at risk (fig. 9.2B) and 28th of 29 for percent at risk (fig. 9.3B). These increasing Canadian rates of number of and percent of species being placed at risk are each about five times the OECD average. Compared to these large rates of increase, the OECD best performers managed to decrease total number of species at risk (the U.K. decreased by over 67%) and percent of species at risk (New Zealand decreased by over 87%). Again it should be cautioned that species at risk and the rate of change in species at risk in Canada and other OECD countries reflect in part the rate of study of species, not the underlying trend in species health. For example, the large decrease in percent of species at risk in New Zealand is due to the increase in the number of species identified, not a decrease in the number of species at risk. Therefore, while it is useful to compare species at risk data, comparison and trends should be viewed with caution.



Source: 2002 - OECD 2005
1992 - OECD 1995a, 1995b

Figure 9.2: Ranking Canada's 2002 number of species at risk (A) and change in number of species at risk from 1992 to 2002 (B) among OECD member countries

Note: Seven OECD countries exclude already extinct species from their respective at risk totals: Belgium, Denmark, Finland, Korea, Mexico, Netherlands, and Switzerland.



Source: 2002 - OECD 2005
1992 - OECD 1995a, 1995b

Figure 9.3: Ranking Canada's 2002 proportion of species at risk (A) and change in proportion of species at risk from 1992 to 2002 (B) among OECD member countries

Note: Seven OECD countries exclude already extinct species from their respective at risk totals: Belgium, Denmark, Finland, Korea, Mexico, Netherlands, and Switzerland.

9.2 PROTECTED AREAS

A protected area is an area of land or sea dedicated to the protection and maintenance of biological diversity, as well as natural and cultural resources, managed through legal or other effective means (IUCN 1994). As this definition suggests, protected areas restrict activities that cause ecological damage and also serve to protect important cultural, recreation, and natural features. Protected areas are an important component of a strategy to maintain biodiversity and ecosystem function.

A commonly used indicator is the percent of the total land base that is designated as protected by a jurisdiction. A key consideration in using this indicator is the definition of a protected area. The integrity of protected areas is affected by internal threats such as exotic species, recreational activities, and other human activities, as well as external threats such as fragmentation and development (Canada, Parks Canada 1998). Management policy for protected areas is therefore key to determining the effectiveness of protection. The World Conservation Union (IUCN) classifies protected areas based on management intent. In general, categories I-III protected areas are those that are managed for conservation, wilderness, and ecosystem protection and allow only minor amounts of recreation.[2] Protected areas classified as IV-VI have less strict management guidelines that may allow sustainable resource use. Higher amounts of protected areas in categories I-III is clearly desirable for establishing strong and effective reserves that are capable of preserving ecological integrity.

It should be noted that protected areas change over time as new areas are created, boundaries are shifted, or as sites are impacted by development or natural disasters. Such circumstances complicate the interpretation of protected area estimates (OECD 2004). In addition, it can be difficult to obtain consistent estimates due to different ways of classifying the size of the protected areas or the land base (i.e., including or excluding marine and freshwater components), and inconsistent application of management categories (i.e., IUCN classes).

Another consideration for protected areas is ensuring that preserved areas are valuable environments that adequately represent the full range of ecosystem (World Wildlife Fund 2000). A goal that was unanimously endorsed by the House of Commons in Canada is to protect, in its natural state, a representative sample of each of the country's natural regions in both the terrestrial and marine environments (Canada, Environment Canada 1996).

Canada has a special role to play in world protection because it contains 20% of the world’s remaining natural areas (OECD 2004: 80). As of 2002, approximately 9.9% of Canada’s 998 million hectares of terrestrial land were protected according to the IUCN classes I-VI definition of a protected area (fig. 9.4A). This proportion is well below the OECD average of 15% and Denmark’s 37%, which represents the highest proportion of protected area among OECD countries. Overall, Canada ranks 16th of 30 OECD countries in proportion of its land base that is protected.

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[2] For a complete summary of the categories, see www.unep-wcmc.org/index.html?http://www.unep-wcmc.org/protected_areas/categories/~main; accessed 1 March 2005.

In comparing protected area rankings, it is important to note that although Denmark, Austria, and Germany have the highest proportion of their land base protected, little of their protective areas are in stricter IUCN classes I-III. The respective proportions in IUCN classes I-III are: Denmark (1%), Austria (2%), and Germany (7%). Canada, on the other hand, has 56% of its protected area in classes I-III.

In the last 10 years, Canada has increased its major protected areas (IUCN classes I-VI) by 11% (from 8.9% to 9.9%), which is well below the average increase in protected areas for all OECD countries of 61% (fig. 9.4B). In terms of terrestrial representation, only 29 of 39 regions, and 113 of 194 terrestrial ecoregions are currently represented in the national park system (OECD 2004: 83). Overall, Canada ranked 21st of 25 OECD countries in increase in protected areas. Turkey recorded the largest increase, almost a four-fold increase in protected areas (from 1.1% to 4.1%), the largest increase of any OECD country. However, it should be noted that Turkey still has among the lowest proportion of its land base protected.

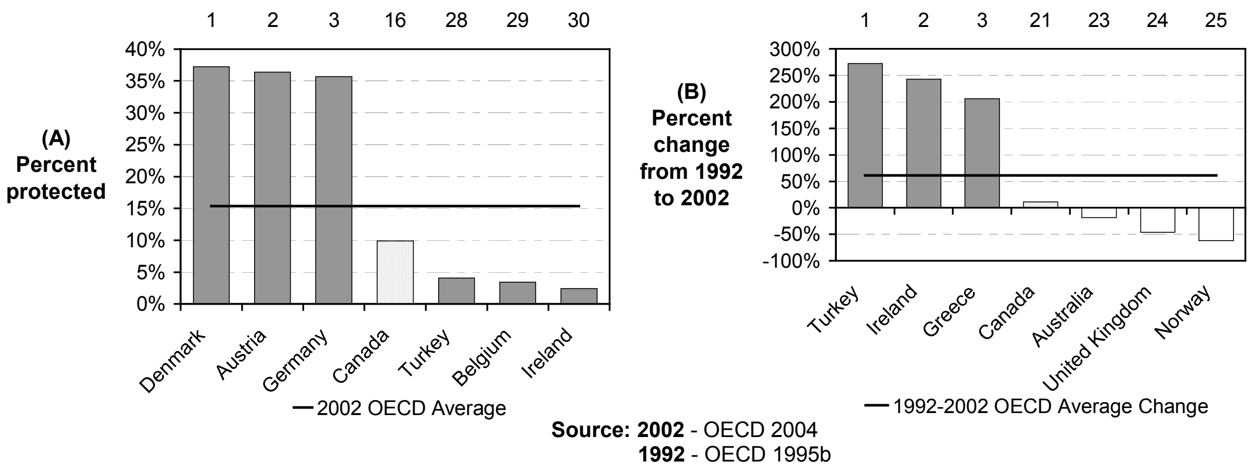


Figure 9.4: Ranking Canada's 2002 proportion of protected area (A) and change in proportion of protected are from 1992 to 2002 (B) among OECD member countries

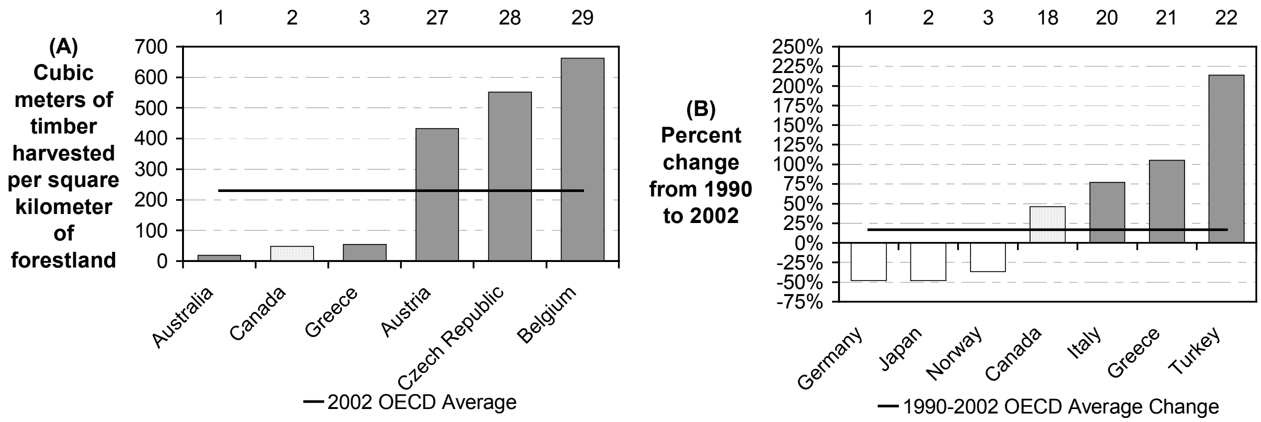
Another component of protected areas is the marine environment. Canada has the longest coastline in the world. While a number of the terrestrial parks have small components of marine waters, very few marine protected areas have been established in Canada. Jamieson and Levings (2001) show that less than 1% of Canada's vast 5.5 million square kilometers of oceans have been protected by provincial or federal legislation. Some marine areas also receive some degree of protection through designation as UNESCO Biosphere Reserves, Ramsar Wetlands of International Importance, National Whale Sanctuaries, and municipal or regional parks; however, these marine protected areas were not included in the estimate provided by Jamieson and Levings (2001). In terms of marine representation, 2 of 29 marine regions are currently represented in the national park system and efforts are underway to establish parks in 3 more areas (Canada, Parks Canada 2003). Additional regions are partly represented because the boundaries of several coastal parks have been drawn to include adjoining marine waters (Canada, Parks Canada 2003).

9.3 FOREST USE

Canadian forests cover over 45% of Canada's land base and comprise 10% of the world's total forested area. Just over one-half of Canada's forests are defined as commercial forests capable of producing commercial species and just over one-quarter is managed primarily for timber production, which is a significant component of the Canadian economy (OECD 2004: 85). Forests also perform important ecological functions including providing habitat for two-thirds of Canada's wildlife, clean air, carbon sequestration, clean water, and flood control. Only 6.8% of Canadian forests are designated as protected under IUCN classes I-VI (OECD 2004: 85).

The OECD uses two indicators to measure stress on forests: volume of timber harvested and volume of timber harvested to the forest growth ratio (OECD 2004). The denominator used for volume of timber harvest to compare countries is the forested land area. The assumption is that the higher proportion of the forest land base being harvested, the greater the stress on the environment. Harvest to growth ratios attempt to measure the sustainability of the timber harvesting rate. Harvest to growth ratios above indicate that forests are being harvested at a faster rate than they are regenerating. However, it should be cautioned that a ratio below one does not necessarily indicate that forest resources are being sustained or enhanced. Forest resources may be depleted by nonharvesting events such as fire. Moreover, the forest being harvested may be ecologically valuable old growth forest that is not adequately replaced by second growth forests or be harvested in a manner that has more environmental impacts.

In 2002, Canada harvested 200,326,000 m^3 of timber, or 48 m^3 of timber per square kilometer of forestland, annually (fig. 9.5A). This harvest rate is about one-fifth the OECD average of 229.5 m^3 per square kilometer. Canada ranked 2nd out of 29 OECD countries in timber harvest rate, reflecting the large volume of forested land base in Canada relative to many other OECD countries. The OECD best performer, the Netherlands, harvested just 19 m^3 per square kilometer of forestland, while the OECD worst performer, Belgium, harvested 662.7 m^3 per square kilometer.



Source: 2002 - OECD 2005
1990 - OECD 1993

Figure 9.5: Ranking Canada's 2002 timber harvest rate (A) and change in timber harvest rate from 1990 to 2002 (B) among OECD member countries

The total volume of timber harvested in Canada increased by 35% between 1990 and 2002, while the volume of timber harvested per square kilometer of forestland increased by 46.3% (fig. 9.5B). Canada's timber harvest rate increase was almost three times higher than the OECD average increase of 16.7%, a performance for which Canada was ranked 18th of 22 OECD countries. The OECD best performer at reducing timber harvest rates, Germany, achieved a nearly 50% decrease. Although its volume of timber harvested increased, it is notable that Canada's forested area remained fairly constant over the past decade at 417.6 million hectares, of which 70% has never been harvested (OECD 2004: 85). It should also be noted that most of Canadian timber is still harvested by clear cutting (OECD 2004: 85).

Canada had a timber harvest to forest growth ratio of 0.4 in 2002, slightly lower than the OECD average of 0.55 (fig. 9.6A). Canada ranked 5th compared to the 29 OECD countries evaluated, with Korea achieving the OECD lowest harvest to growth ratio of 0.1. While Canada performs relatively well, it is important to emphasize that Canada's harvest includes irreplaceable old growth forests of high ecological value. Therefore, even though the rate of harvesting is below the growth rate, harvesting in Canada can do more environmental damage than other countries. In the last decade, the harvest to growth ratio in Canada decreased by 43% compared to the OECD average decrease of 5% (fig. 9.6B). As a result, Canada is tied for 2nd with Germany behind only Turkey, which decreased its harvest to growth ratio by 50%.

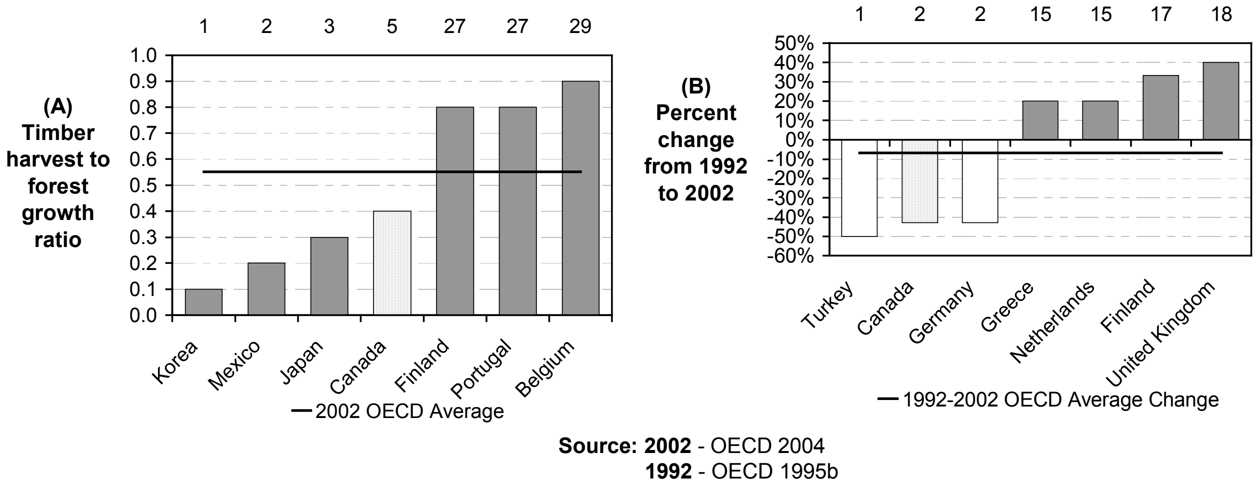


Figure 9.6: Ranking Canada's 2002 timber harvest to forest growth ratio (A) and change in timber harvest to forest growth ratio from 1990 to 2003 (B) among OECD member countries

9.4 FISHERIES

With over five million square kilometers of territorial seas and the longest coastline of any nation, Canada's aquatic environment supports a wealth of marine biodiversity. One in four known species of animals, plants, and microbiota in Canada is marine (approximately 17,750 species) (McAllister 2000). Oceans contribute to Canada's economy, providing food, medicine, industrial products, and tourism opportunities; in 1996 the oceans sector generated an estimated $20 billion of Canada's gross domestic product[3]. Furthermore, oceans provide valuable ecological services such as producing oxygen, absorbing carbon dioxide, and recycling water.

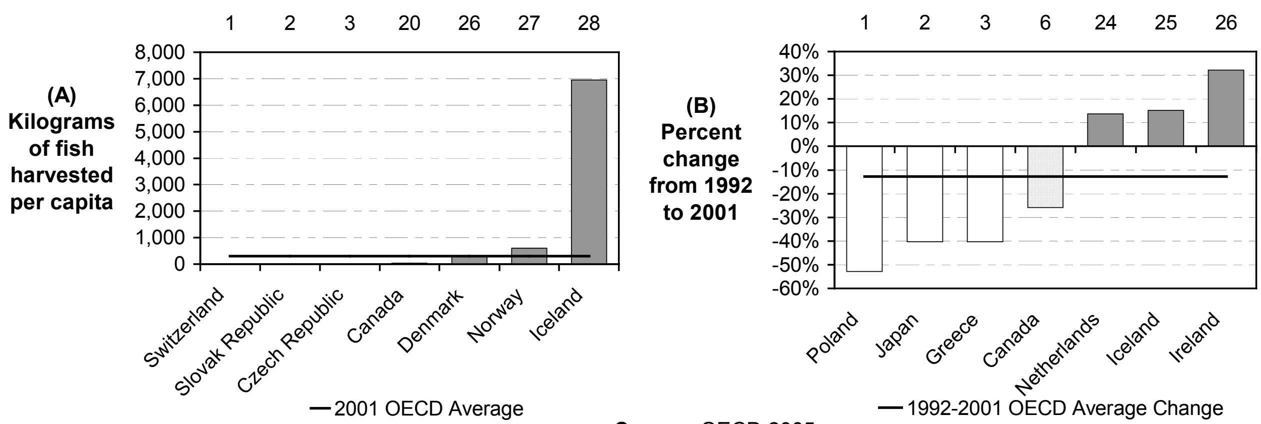
Measuring sustainability in fisheries management is challenging. An ideal indicator should measure fisheries harvest relative to the sustainable fisheries catch. The only data available from the OECD on fisheries management are fish harvests by country, which are reported in absolute quantities as well as percent of world catch. There is no data on sustainable fisheries catch. In the absence of a better indicator, wild fish harvested per capita, which is also used in the Boyd study (2001:28), and fish harvest as percent of world harvest are used to indicate pressure on fish populations and on marine and freshwater ecosystem. Trends in fish harvest can also be an indicator of sustainability. Declines in fish catches are predominantly due to previous overfishing, pollution, habitat loss, climate change, and introduction of exotic species. Therefore, declining fish catches may indicate unsustainable harvest rates (Boyd 2001: 28).

Canada harvested 1,050,000 tonnes of fish in 2001, for a per capita harvest rate of 33.8 kilograms, ranking 20th of 28 OECD countries (fig. 9.7A). From 1992 to 2001, Canada decreased

[3] Canada. Department of Fisheries and Oceans. 2001. Sustainable Development Strategy 2001-2003. <Online: www.dfo-mpo.gc.ca/sds-sdd/brochure_e.htm; accessed 24 March 2005>

its per capita fish harvest by 26%, from 45.5 kg per capita to 33.8 kg per capita (fig. 9.7B). This reduction was more than twice the OECD average reduction. Canada recorded the 6th largest reduction in per capita fish harvest of 26 OECD countries.

The reduction in Canadian fish harvests is due to declining salmon stocks and the collapse of the cod fisheries, which resulted in a decline in the total allowable catch for cod from just over 400,000 tonnes in 1990 to close a ban in cod fishing in major stock areas including the Gulf of St. Lawrence and northeast Newfoundland and Labrador. According to the OECD, the crisis in fisheries encouraged Canada to apply a more precautionary approach, and selective catch strategies to help move closer to environmental and economic sustainability (OECD 2004:184). The significant decline in fish harvests therefore indicates that previous fishing levels were not sustainable.



Source: OECD 2005

Figure 9.7: Ranking Canada's 2001 per capita fish harvest (A) and change in per capita fish harvest from 1992 to 2001 (B) among OECD member countries

In comparing the percent of world fish catch, Canada ranks 15th of 23 OECD countries (fig. 9.8A). With 1% of the world catch, Canada is slightly less than the OECD average world catch of 1.2%. Greece, the OECD country with the lowest fish harvest, consumed only 0.1% of the world catch, and Japan the OECD country with highest fish harvest, caught 5.3% of the world's fish.

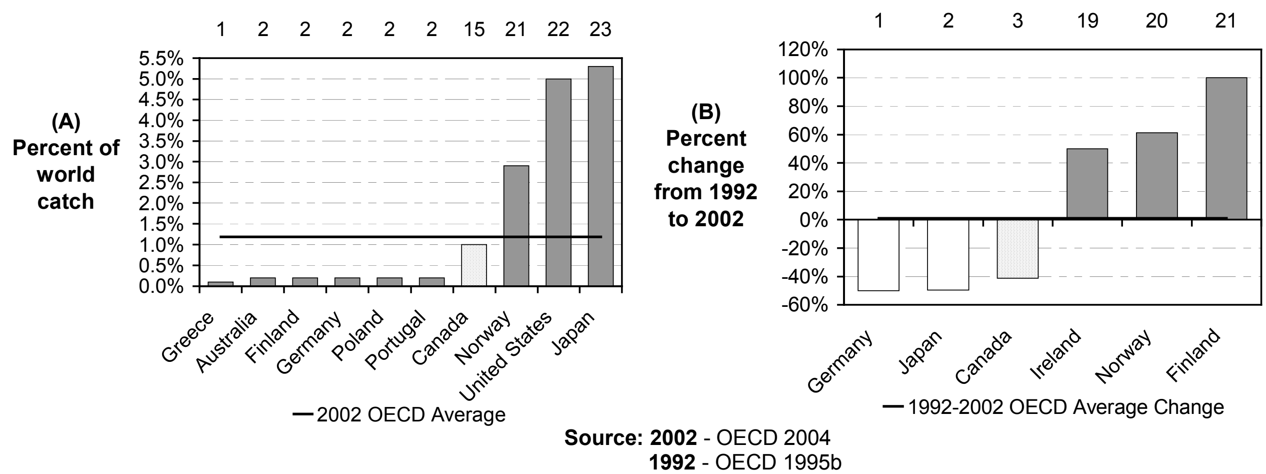


Figure 9.8: Ranking Canada's 2002 fisheries as a proportion of world catch (A) and change in fisheries as proportion of world catch from 1992 to 2002 (B) among OECD member countries

Due to declines in response to the collapse of the cod fisheries and poor Pacific salmon returns, the Canadian portion of the world catch declined considerably since 1992. Canada's percent of the world catch declined from 1.7% to 1%, for a 41% decrease, a substantially better result than the OECD average increase of about 1% (fig. 9.8B). For this performance, Canada ranks 3rd of 21 OECD countries, only slightly behind Germany (-50%) and Japan (-49.5%).

9.5 ECOSYSTEM-BASED MANAGEMENT

Protected areas have traditionally been a cornerstone of conservation (Noss 2000). However, most reserves are too small or disconnected to be viable, especially for protecting widely distributed species such as migratory animals (i.e., salmon or birds) or large carnivores (i.e., grizzly bears) (Noss 2000). Achieving conservation objectives is therefore contingent on sustainable management of areas outside of protected zones (Noss 2000).

One strategy that is often promoted for effective management of public resources is ecosystem-based management (EBM). A variety of definitions of EBM have been proposed in the literature (see CIT 2004 for a review) (Grumbine 1997). Despite the variety of definitions, a relatively consistent set of elements describing EBM includes: system thinking, deeper understanding of the complexity and dynamism of ecological and social system, more extensive consideration of different spatial and temporal scales, ecologically derived boundaries, adaptive management to deal with uncertainty, and collaborative decision making (Yaffee 1999). Stanley (1995) presents two classes of ecosystem management: one that emphasizes human-use aspects more than biocentric ones, and one that shifts from anthropogenic values towards biocentric values. Yaffee (1999) suggests three 'levels' of ecosystem management existing along a continuum of resource management paradigms. Perhaps several of the challenges identified with inconsistent application of the EBM concept can be mitigated by recognizing that progress comes more from moving along the continuum, as opposed to achieving a single state of ecosystem management (Yaffee 1999).

Boyd (2004) suggests that monitoring progress in implementing EBM, which can be measured by the proportion of terrestrial and marine ecosystem in which ecosystem-based management has been implemented, is an important component of tracking progress towards conserving, protecting, and restoring nature. However, tracking EBM definitions will require development of clear criteria that can be used to evaluate whether a specific program should be considered ecosystem-based management. To date, no consistent data are available on the extent of EBM in Canada.

CHAPTER 10:
BUILDING SUSTAINABLE CITIES

Goal

The goal of moving towards more sustainable cities suggests a continuing maintenance, adaptation, renewal, and development of a city's physical structure and system to ensure a satisfactory human environment with minimal demands on resources and minimal adverse affects on the natural environment (Stren et al. 1992).

Background

Supporting Canada's urban communities to become more sustainable is a key element of the federal government's efforts to meet its climate change commitments under the *Kyoto Protocol* (McCormick Rankin Corporation 2002). Reducing pollution and investing in "green" technologies and energy efficiencies are critical steps to creating more sustainable cities.

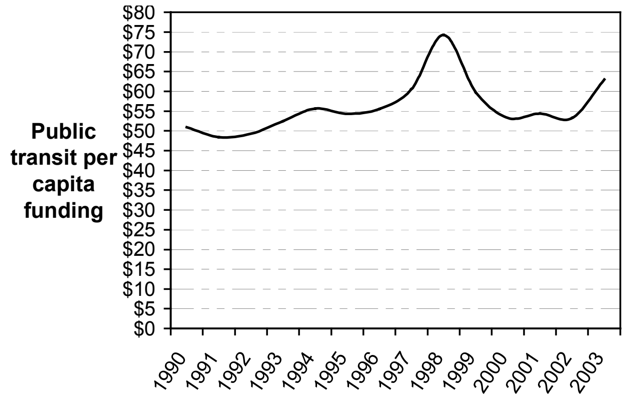
A fundamental component of sustainable cities is reducing reliance on personal automobiles through greater use of public transit. Increased use of public transit will significantly reduce environmental impacts associated with automobile use including air emissions (nitrogen oxides, carbon monoxide, volatile organic compounds, and greenhouse gases), oil contamination, and land development. Three key indicators are used to assess Canada's progress towards a greener transportation system: funding for public transit, distance traveled in road vehicles, and the extent of public transit use. A fourth indicator for determining the extent to which cities are moving towards (or away from) sustainability is urbanization of agricultural land.

10.1 GREEN INFRASTRUCTURE: FUNDING FOR PUBLIC TRANSIT

For the purposes of this report, green infrastructure is defined as the basic facilities, services, and installations needed for urban public transportation. Due to data limitations, figures in this analysis do not include funding towards alternative transportation options, such as bicycle lanes, walking paths, or multi-use trail system.

Data for green infrastructure were obtained from the *1990-2003 Canadian Transit Fact Books*, published by the Canadian Urban Transit Association (CUTA). Both provincial and municipal contributions are included. Contributions include operations and capital funding, and are adjusted for inflation to report expenditures in real dollars.

From 1990 to 2003, Canadian public transit per capita funding increased by almost 24% in real terms from $51 per capita to $63 per capita (fig. 10.1). Public transit funding peaked in 1998 at $74 per capita in real terms. It is not possible to compare transit funding with other OECD countries due to lack of comparative transit funding data.



Source: CUTA 1990 - 2004

Figure 10.1: Canadian per capita public transit funding from 1990 to 2003

Note: Funding data adjusted for inflation based on Statistics Canada Consumer Price Index retrieved from CANSIM.

10.2 DISTANCE TRAVELED

The impact of vehicles on the environment is strongly correlated with the amount of vehicle use; therefore, an important indicator of the impact of transportation is the distance traveled.

Canadian and provincial data for the 2000 to 2003[1] period for the distance traveled by road vehicles were obtained from Statistics Canada CANSIM database. The Canadian and provincial road vehicle distance statistics includes all road motor vehicles except motorcycles.

Canadians travel an average of 9.4 thousand vehicle-kilometers per capita, exceeded only by the U.S. (15.8 thousand vehicle-kilometers per capita). The OECD average is 6.7 thousand vehicle-kilometers per capita, 40% lower then Canada. Canada ranks 29th of 30 OECD countries for the per capita distance traveled by road vehicles (fig. 10.2A)

Canadians have increased their distance traveled per capita over the last 11 years by 13% compared to the OECD average increase of 23%. As a result, Canada ranked 10th of 25 OECD countries for increase in distance traveled (fig. 10.2B). Iceland, the OECD best performer, achieved an 8% decrease in per capita distance traveled over the same period.

[1] Canadian and provincial data for distance traveled by road vehicles is only available for these years.

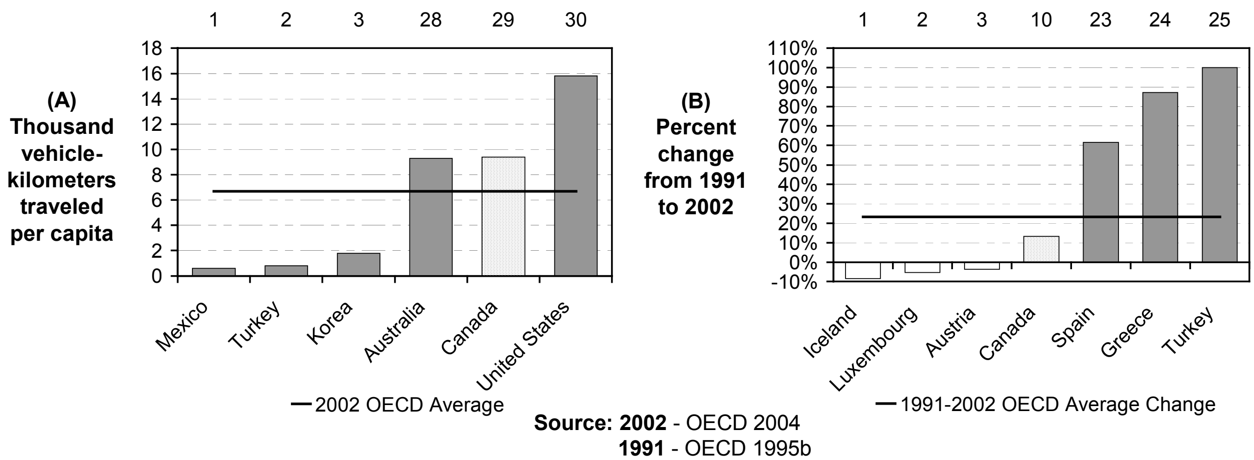


Figure 10.2: Ranking Canada's per capita vehicle-kilometers traveled (A) and change in per capita vehicle-kilometers traveled from 1991 to 2002 (B) among OECD member countries

10.3 PUBLIC TRANSIT

Data for the Canadian and provincial analysis of urban and suburban public transit were obtained from the *1990-2003 Canadian Transit Fact Books*, published by the Canadian Urban Transit Association.

Between 1990 and 2003, the number of passenger trips on urban and suburban transit per capita in Canada decreased by 26.5% (fig. 10.3).

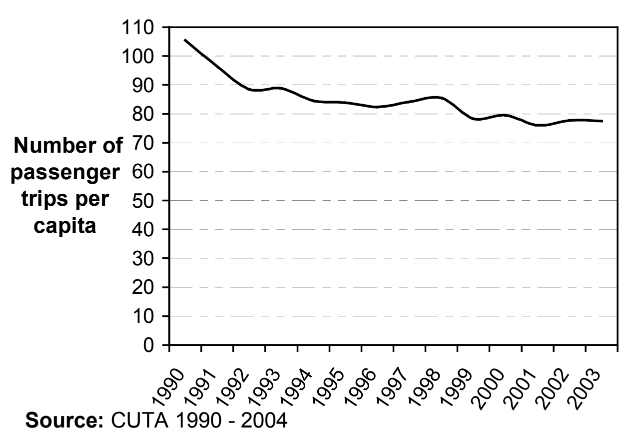


Figure 10.3: Canadian number of urban and suburban transit passengers per capita from 1990 to 2003

10.4 LOSS OF AGRICULTURAL LAND

Between 1971 and 1991, urbanization in Canada consumed about 12,200 square kilometers of arable land.[2] During the same period, Canada's population increased by 6,082,450 people[3] for a rate of loss of agricultural land through urbanization of about two square kilometers per increase of a thousand people. A further 2,150 square kilometers of agricultural area was lost from 1991 to 2001. With a corresponding population increase of 3,014,115 people[4], Canada's rate of loss dropped to 0.7 square kilometers per increase of a thousand people, a 64% decrease in the rate of urban encroachment. Canada's total loss of agricultural land to urban uses since 1971 (14,350 square kilometers) is roughly three times the size of Prince Edward Island.

[2] Hofmann, N. Statistics Canada. Personal communication. 28 February 2005

[3] Statistics Canada. Estimates of Population, Canada, Provinces and Territories. CANSIM II Table 510001

[4] Ibid.

CHAPTER 11: PROMOTING GLOBAL SUSTAINABILITY

Goal

Canada becomes a world leader in Official Development Assistance by promoting ecologically sound and socially sustainable development around the globe. To do so, Canadians must push government toward a greater International Assistance Envelope and ensure involved agencies implement environmentally suitable and culturally sensitive development programs.

Background

Official Development Assistance (ODA), sometimes referred to as foreign aid, is a sum of monies transferred from one nation's governments and businesses to developing countries in the form of loans, grants, technical assistance, or general aid. In order for these financial flows to be considered ODA, they must be

(a) undertaken by the official sector,
(b) with promotion of economic development and welfare as the main objective, [and]
(c) at concessional financial terms [if a loan, having a grant element of at least 25%].[1]

Grants and loans for military purposes can not be considered ODA. In most circumstances, ODA is calculated as a percent of a given country's gross national income (GNI).

The importance of ODA for developing nations is obvious. Multilateral aid to developing countries assisted eliminating small pox, facilitated the installation of responsible democratic governments, and increased per capita incomes.[2] ODA promoted sustainable development by encouraging local ownership, building social capital and partnerships among individuals, and ensuring projects meet first world environmental standards. For donor nations, it builds transnational connections, provides educational opportunities, and maintains a strong voice in international affairs.

11.1 OFFICIAL DEVELOPMENT ASSISTANCE

In principal, the ODA indicator represents a wealthy country's commitment to the developing world. The generally accepted goal is that industrialized nations should contribute at least 0.7% of their GNI to foreign aid.[3] However, the world's wealthiest countries continually fail to meet this level of contribution. In fact, Canada's contribution (0.28%) is below the OECD average of

[1] See OECD Development Cooperation Directorate Glossary; www.oecd.org/glossary/0,2586,en_2649_33721_1965693_1_1_1_1,00.html; accessed 28 February 2005.

[2] See CIDA Development Results; www.acdi-cida.gc.ca/cida_ind.nsf/AllDocIds/CFA2CD60F831096085256F58006B01AF?OpenDocument; accessed 28 February 2005.

[3] Most United Nations member states first adopted this goal in October 1970, on a motion tabled by Canadian Prime Minister and Nobel Laureate Lester B. Pearson. The target of 0.7% has been reaffirmed on several occasions since 1970, most recently at the Monterey Conference on Financing International Development. See *Report of the International Conference on Financing for Development*; www.un.org/esa/ffd/aconf198-11.pdf; accessed 21 May, 2005.

0.35%, a level itself that is only half the recommended rate, and well below the 0.96% contribution by the OECD's highest contributor, Denmark. As a result, Canada ranks 12th out of 27 OECD countries (fig. 11.1A). Poland ranks last contributing only 0.01% of its GNI.

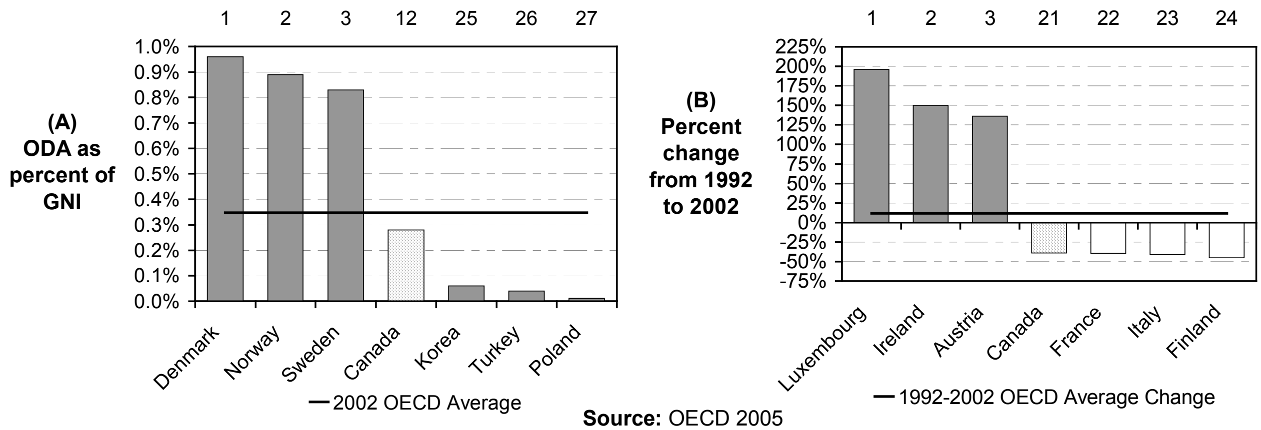


Figure 11.1: Ranking Canada's 2002 Official Development Assistance among OECD member countries

Despite continued promises from Canadian governments to increase ODA, Canada's contributions to foreign aid have dropped significantly. In 2002, Canada's ODA was 0.28% of GNI, a decrease of 39% from the 0.46% of GNI it contributed a decade earlier (fig. 11.1B). On average, OECD countries since 1992 have increased foreign aid by 12%, led by Luxembourg, which increased its ODA by nearly 200%. Canada is ranked 21st of 24 OECD countries for changes in ODA, having only marginally outperformed Finland, the OECD country with the largest decrease in ODA (-45%). However, the 2005 *Canadian Federal Budget* committed to increasing international assistance by $3.4 billion over the next five years with the goal of doubling assistance from 2001 levels by 2010 (Canada, Department of Finance 2005: 21).

CHAPTER 12: ASSESSING CANADA'S ENVIRONMENTAL PERFORMANCE

The primary objective of this report is to provide an assessment of Canada's environmental performance. As discussed in chapter 2, environmental performance can be evaluated by three conceptually distinct methods: objectives-based performance, time-series performance, and cross-sectional performance. Although the objectives based performance is the preferred method for analysis, it can not be used because socially optimal objectives have not been established. Therefore, the cross-sectional performance method was chosen for this study because it is superior to the time-series approach because it provides a benchmark reference based on other the performance of other countries to assess Canada, and the data necessary to complete a cross-sectional analysis are available.

The cross-sectional evaluation used in this study is based on two distinct components: environmental performance and environmental improvement. Environmental performance evaluates current performance and environmental improvement evaluates the change in environmental performance over time.

12.1 CANADA'S ENVIRONMENTAL PERFORMANCE

Canada's current environmental performance is assessed based on two measures:

- **Environmental Performance Rank (EPR),** defined as Canada's rank order relative to OECD countries for each indicator.
- **Environmental Performance Grade (EPG)**, defined as Canada's performance relative to the OECD best performance for each indicator.

Results of the cross-sectional comparisons of Canada's environmental performance are summarized in tables 12.1 and 12.2. Table 12.1 indicates that Canada's composite EPR is 28th out of 30 countries. Only Belgium and the United States have worse ranks. Table 12.2 indicates that Canada's composite EPG is 26.7%, which is marginally above the OECD average composite EPG of 26.5%.

Perhaps more important than the composite performance, is the disaggregated performance by indicator. The results show that Canada's grade is below the OECD average EPG for 17 of 29 indicators. The indicators where Canada is above the OECD average are: renewable energy (including hydro), recycling, sewage treatment, pesticide use, fertilizer use, livestock levels, percent of species at risk, timber harvest per square kilometer of forestland, timber harvest to forest growth ratio, and fisheries harvest rates (per capita and percent of world catch). Canada also tied the OECD average EPG for nuclear waste. Canada received a passing grade (greater than 50%) in only 5 of 29 indicators: renewable energy (including hydro), municipal waste generation, recycling, sewage treatment, and fertilizer use. **However, Canada does not lead the OECD in any of the 29 indicators.**

Table 12.1: Environmental Performance Rank for OECD countries, 1992, 1996, and 2002

COUNTRY	2002 OECD RANK	1996 OECD RANK	1992 OECD RANK
Turkey	1	3	1
Switzerland	2	1	11
Denmark	3	8	10
Poland	4	14	2
Slovak Republic	5	No data	27
Germany	6	6	25
Austria	7	4	9
Sweden	8	10	6
Italy	9	18	8
Netherlands	10	5	19
Portugal	11	12	4
Czech Republic	12	11	26
Mexico	13	2	5
Norway	14	17	13
Hungary	14	9	15
Japan	16	21	14
Finland	17	20	12
France	18	23	22
United Kingdom	18	13	24
Greece	20	16	3
Spain	21	19	7
Luxembourg	22	22	20
Korea	23	7	21
Iceland	24	26	23
New Zealand	25	24	17
Australia	25	27	16
Ireland	27	15	18
Canada	**28**	**28**	**28**
Belgium	29	25	29
United States	30	29	30

Note: A country's rank is based on the average rank for all environmental indicators. The number of countries ranked for each indicator may vary depending on availability of data. Therefore, the number of countries has been normalized for each indicator by calculating the average rank per indicator based on the countries percentile rank for the countries for which data exists times the total number of OECD countries (30). Environmental rank by year is not exactly comparable because the number and type of indicators varies by year. (see appendix B).

Table 12.2: Canada's 2002 environmental performance relative to OECD

CHALLENGE	INDICATOR	RANK	EPG	OECD AVERAGE EPG
Environmental Efficiency	1. Energy Consumption (toe/cap)	28th of 30	13.3%	24.1%
	2. Energy Intensity (toe/US$1,000 GDP)	29th of 30	45.5%	65.6%
	3. Water Consumption (m^3/cap)	29th of 30	9.2%	21.2%
	4. Environmental Pricing (environmental taxes as % of GDP)	28th of 29	27.7%	53.9%
Clean Energy	5. GHG Emissions (tonnes CO_2 equiv/cap)	26th of 29	15.5%	27.8%
	6. Renewable Energy including Hydro (as % of electricity)	5th of 29	59.8%	24.8%
	7. Renewable Energy excluding Hydro (as % of electricity)	18th of 30	8.3%	19.9%
Waste & Pollution	8. Sulfur Oxides (kg/cap)	27th of 28	3.4%	10.1%
	9. Nitrogen Oxides (kg/cap)	26th of 28	15.8%	35.4%
	10. VOCs (nonmethane) (kg/cap)	29th of 29	12.9%	37.5%
	11. Carbon Monoxide (kg/cap)	28th of 28	8.7%	26.4%
	12. Ozone-Depleting Substances (kg/1,000 people)	12th of 14	4.0%	6.7%
	13. Municipal Waste (kg/cap)	19th of 28	61.2%	65.5%
	14. Recycling of Municipal Waste (% of municipal waste)	9th of 30	52.7%	36.5%
	15. Nuclear Waste (kg/1,000 people)	30th of 30	0.0%	0.0%
	16. PAC Expenditures (% of GDP)	13th of 25	45.8%	52.2%
Water Quality	17. Municipal Sewage Treatment (% population with treatment)	14th of 28	73.1%	68.1%
Healthy Food	18. Pesticide Use (kg/km^2 arable land)	8th of 30	4.0%	1.0%
	19. Fertilizer Use ($tonnes/km^2$ arable land)	2nd of 29	83.8%	21.1%
	20. Livestock (sheep $equiv/km^2$ arable and grassland)	2nd of 29	48.8%	13.4%
Nature	21. Number of Species at Risk	26th of 30	10.0%	16.4%
	22. Percent of Species at Risk	8th of 30	32.5%	19.6%
	23. Protected Areas (as % of land base)	16th of 30	26.6%	41.3%
	24. Timber Harvest (m^3/km^2 forestland)	2nd of 29	39.9%	8.3%
	25. Timber Harvest-Forest Growth Ratio	5th of 29	25.0%	18.1%
	26. Per Capita Capture Fisheries (kg/cap)	20th of 28	0.8%	0.1%
	27. Fisheries as Percent of World Catch	15th of 23	10.0%	8.4%
Sustainable Cities	28. Distance Traveled (1,000 vehicle-km/cap)	29th of 30	6.4%	9.0%
Global Sustainability	29. Official Development Assistance (% of GNI)	12th of 27	29.2%	36.1%
	Overall Average	**28th of 30**	**26.7%**	**26.5%**

12.2 CANADA'S ENVIRONMENTAL IMPROVEMENT

The next step in evaluating Canada's environmental performance is to determine if Canada's environmental performance improved. To assess environmental trends, the percent change for each environmental indicator is calculated over the period 1992 to 2002, except for environmental pricing (1995 to 2001), GHG emissions (1990 to 2002), ODSs (1992 to 2000), municipal waste (1992 to 1997), fertilizer use (1992 to 2001), pesticide use (1990 to 2002), and distance traveled by road vehicles (1991 to 2002). No time-series data are available for one of the 29 indicators: PAC expenditures.

Results summarized in table 12.3 show that Canada recorded an improvement in 17 out of 28 indicators. However, Canada's rate of improvement exceeded the average OECD rate of improvement for only 11 indicators. Canada led the OECD rate of improvement for only one indicator: generation of nuclear waste. Again, it should be cautioned that the rate of improvement depends very much on the base year values. Consequently, improvement by itself does not indicate satisfactory performance.

Canada's environmental trends can also be assessed by calculating the EPR and the EPG for 1992 and comparing them to the results for 2002. The results for 1992 summarized in table 12.4 show that Canada's EPR remained unchanged at 28th out of 30 countries from 1992 to 2002. Canada's EPG actually deteriorated slightly from 28.7% to 26.7%. The deterioration in Canada's EPG illustrates that Canada fell slightly further behind the OECD best performers.

Canada's failure to improve its environmental performance faster than the OECD average is surprising. Countries like Canada, which have inferior environmental performance, should be able to improve at a faster rate than the average OECD country because they can adopt existing best practices and technology used by the best performing countries. The best performing countries face the more difficult challenge of developing new technologies and practices.

Table 12.3: Canada's trends in environmental performance relative to OECD

CHALLENGE	INDICATOR	IMPROVEMENT RANK	TREND: 1992 TO 2002	TREND COMPARED TO OECD AVERAGE
Environmental Efficiency	1. Energy Consumption (toe/cap)	15th of 30	✗	✓
	2. Energy Intensity (toe/US$1,000 GDP)	14th of 30	✓	✓
	3. Water Consumption (m^3/cap)	9th of 23	✓	✓
	4. Environmental Pricing (environmental taxes as % of GDP)	27th of 29	✗	✗
Clean Energy	5. GHG Emissions (tonnes CO_2 equiv/cap)	20th of 28	✗	✗
	6. Renewable Energy (including Hydro)	18th of 29	✗	✗
	7. Renewable Energy (excluding Hydro)	14th of 23	✓	✗
Waste & Pollution	8. Sulfur Oxides (kg/cap)	21st of 27	✓	✗
	9. Nitrogen Oxides (kg/cap)	18th of 28	✓	✗
	10. VOCs (nonmethane) (kg/cap)	18th 28	✓	✗
	11. Carbon Monoxide (kg/cap)	18th of 27	✓	✗
	12. Ozone-Depleting Substances (kg/1,000 people)	7th of 12	✓	✓
	13. Municipal Waste (kg/cap)	2nd of 22	✓	✓
	14. Recycling of Municipal Waste (% of municipal waste)	12th of 18	✓	✗
	15. Nuclear Waste (kg/1,000 people)	1st of 28	✓	✓
	16. PAC Expenditures (% of GDP)	No data	No data	No data
Water Quality	17. Municipal Sewage Treatment	9th of 20	✓	✗
Healthy Food	18. Pesticide Use (kg/km^2 arable land)	20th of 22	✗	✗
	19. Fertilizer Use (tonnes/km^2 arable land)	26th of 29	✗	✗
	20. Livestock (sheep equiv/km^2 arable and grassland)	12th of 29	✓	✓
Nature	21. Number of Species at Risk	27th of 29	✗	✗
	22. Percent of Species at Risk	28th of 29	✗	✗
	23. Protected Areas	21st of 25	✓	✗
	24. Timber Harvest (m^3/km^2 forestland)	18th of 22	✗	✗
	25. Timber Harvest-Forest Growth Ratio	18th of 18	✓	✓
	26. Per Capita Capture Fisheries (kg/cap)	6th of 26	✓	✓
	27. Fisheries as Percent of World Catch	3rd of 21	✓	✓
Sustainable Cities	28. Distance Traveled (1,000 vehicle-km/cap)	10th of 25	✗	✓
Global Sustainability	29. Official Development Assistance (% of GNI)	21st of 24	✗	✗
	Overall Average or Total	**23rd of 30**	**17 of 28**	**11 of 28**

Note: "✓" symbolizes favorable result or comparison; "✗" symbolizes unfavorable result or comparison

Table 12.4: Canada's 1992 environmental performance relative to OECD

CHALLENGE	INDICATOR	RANK	EPG	OECD AVERAGE EPG
Environmental Efficiency	1. Energy Consumption (toe/cap)	28th of 30	12.9%	23.9%
	2. Energy Intensity (toe/US$1,000 GDP)	27th of 30	41.3%	59.9%
	3. Water Consumption (m^3/cap)	22nd of 23	9.0%	24.2%
	4. Environmental Pricing (environmental taxes as % of GDP)	25th of 30	38.6%	59.6%
Clean Energy	5. GHG Emissions (tonnes CO_2 equiv/cap)	25th of 28	26.9%	42.2%
	6. Renewable Energy (including Hydro)	5th of 30	62.5%	25.7%
	7. Renewable Energy (excluding Hydro)	13th of 24	9.9%	23.7%
Waste & Pollution	8. Sulfur Oxides (kg/cap)	27th of 28	4.7%	11.5%
	9. Nitrogen Oxides (kg/cap)	27th of 29	12.9%	26.7%
	10. VOCs (nonmethane) (kg/cap)	28th of 28	8.5%	20.8%
	11. Carbon Monoxide (kg/cap)	26th of 28	7.9%	21.7%
	12. Ozone-Depleting Substances (kg/1,000 people)	10th of 12	16.8%	26.2%
	13. Municipal Waste (kg/cap)	21st of 22	47.0%	69.8%
	14. Recycling of Municipal Waste (% of municipal waste)	5th of 18	37.2%	19.3%
	15. Nuclear Waste (kg/1,000 people)	28th of 28	0.0%	0.0%
	16. PAC Expenditures (% of GDP)	No data	No data	No data
Water Quality	17. Municipal Sewage Treatment	12th of 21	64.3%	62.4%
Healthy Food	18. Pesticide Use (kg/km^2 arable land)	3rd of 22	62.5%	9.1%
	19. Fertilizer Use (tonnes/km^2 arable land)	2nd of 29	47.5%	9.1%
	20. Livestock (sheep equiv/km^2 arable and grassland)	4th of 29	39.6%	11.3%
Nature	21. Number of Species at Risk	13th of 29	11.7%	7.3%
	22. Percent of Species at Risk	3rd of 29	54.3%	12.0%
	23. Protected Areas	13th of 25	27.6%	36.0%
	24. Timber Harvest (m^3/ km^2 forestland)	4th of 22	50.2%	6.8%
	25. Timber Harvest-Forest Growth Ratio	12th of 18	57.1%	62.6%
	26. Per Capita Capture Fisheries (kg/cap)	19th of 26	1.0%	0.1%
	27. Fisheries as Percent of World Catch	18th of 21	5.9%	6.7%
Sustainable Cities	28. Distance Traveled (1,000 vehicle-km/cap)	22nd of 25	4.8%	6.3%
Global Sustainability	29. Official Development Assistance (% of GNI)	7th of 24	39.7%	36.2%
	Overall Average	**28th of 30**	**28.7%**	**25.8%**

12.3 MEETING THE SUSTAINABILITY CHALLENGE

Canada's environmental record can also be assessed by evaluating its performance in meeting the nine sustainability challenges provided in the DSF *Sustainability within a Generation Plan.* The performance in meeting the nine challenges is assessed by calculating the average scores for the indicators used to measure each challenge. The results in table 12.5 show that Canada has a failing grade in eight of the nine challenges, and is below the average OECD grade in four of nine challenges. The only challenge where Canada received a passing grade is protecting water quality. This grade, however, is somewhat misleading because the only available indicator to measure performance on the water quality challenge is municipal sewage treatment. As the discussion in chapter 7 illustrates, other evidence shows that Canada is doing a poor job in protecting water quality.

Table 12.5: Canada's performance addressing sustainability's critical challenges

CHALLENGES	2002		1992	
	CANADA EPG	OECD AVERAGE EPG	CANADA EPG	OECD AVERAGE EPG
Genuine Wealth*	0%	0%	0%	0%
Environmental Efficiency	23.9%	41.2%	25.4%	41.9%
Clean Energy	27.9%	24.2%	33.1%	30.5%
Waste & Pollution	22.7%	30.0%	16.9%	24.5%
Water (sewage treatment)	73.1%	68.1%	64.3%	62.4%
Healthy Food	45.5%	11.8%	49.9%	9.8%
Conserving Nature	20.7%	16.0%	29.7%	18.8%
Sustainable Cities	6.4%	9.0%	4.8%	6.3%
Global Sustainability	29.2%	36.1%	39.7%	36.2%
Overall Average	**26.7%**	**26.5%**	**28.7%**	**25.8%**

*Genuine wealth is measured by whether the country has a comprehensive genuine wealth indicator reported on a regular basis. The grade binary: 10 0% if the country has a genuine wealth indicator or 0% if it does not. The genuine wealth indicator is not included in the calculation of the EPG.

12.4 COMPARING RESULTS OF ENVIRONMENTAL RANKING STUDIES

Three other studies ranking Canada's environmental performance are assessed in appendix B and compared to the findings of this study. The study by Boyd (2001) comes to similar conclusions as this study: Canada ranked 28th of 29 countries. The Conference Board (Canada, CBC 2004), ranked Canada 16th in 2002, 12th in 2003 and 9th in 2004 out of 24 countries. The improvement in rank for Canada from 2002 to 2004 was due to a change in indicators, which had the unintended result of biasing the results in favor of low-density countries such as Canada. The Yale Environmental Sustainability Index (ESI) study (Esty et al. 2005) ranked Canada 6th of 146 countries. However, the Yale ESI measured the potential of countries to manage the environment, in addition to current environmental performance. When the Yale ESI results were disaggregated to focus on environmental performance alone, Canada's ranking dropped to 69th of 146 countries. Although the Conference Board and Yale ESI studies present a more favorable rank for Canada because they use different indicators, the rank for Canada is unsatisfactory in all four ranking studies.

12.5 EXPLAINING CANADA'S ENVIRONMENTAL PERFORMANCE

The precise causes of Canada's poor performance await further study. However, it is likely that Canada's poor performance is due to a combination of factors including geography, climate, resource endowment, economic structure, and poor environmental policy. Geography, climate, and resource endowment are exogenous constraints that can not be altered, while public policy and, to a lesser extent industrial structure, are endogenous factors that can be changed.

Although it is difficult to assess the relative significance of exogenous and endogenous factors, two recent independent evaluations suggest that poor public policy is a major factor explaining Canada's poor environmental performance. The OECD (2004: 15-16) concludes that while Canada made some progress, "sustainable development . . . still largely remains to be translated into practical institutional and market-based integration." The Canadian Commissioner of Environment and Sustainable Development (Canada, Commission of the Environment and Sustainable Development 2004: 77) found that "clearly defined expectations, performance, and results (in environmental policy) are weak or missing," and there are "no consequences for not achieving goals." The commissioner (Canada, Commission of the Environment and Sustainable Development 2004: 4) further concluded that:

> Audits in 1998 and 2000 found slow and unsatisfactory progress in implementing a Cabinet directive to departments—first issued in 1990—to undertake strategic environmental assessments. The overall results of our audit this year suggest that most departments still have not made serious efforts to apply the directive. Thus, there is no assurance that decision makers have the information they need to take the environment into account when shaping Canada's future in important areas such as aquaculture, agriculture, and taxation.

The impact of public policy on environmental performance is also demonstrated by the successful examples of environmental policy in areas such as sulfur oxides and ozone-depleting substances, where Canada recorded reductions of 31% and 93% respectively. Another successful policy was the ability of British Columbia to double protected areas from 6% to about 13% of the land base over a ten-year period.

These success stories in environmental policy have common attributes. First measurable targets were set and a detailed plan was developed to achieve targets and milestones by specific dates. A comprehensive monitoring program with regular public reporting requirements was used to measure progress. The plan and targets had a strong legal foundation and mitigative action was taken if targets were not met. Finally, relevant stakeholders collaboratively managed each process. The success stories show what Canada is capable of achieving if the desire exists to succeed.

The importance of public policy versus exogenous variables can also be illustrated comparing higher ranked countries to Canada. Countries ranked in the top ten can be placed into two categories: low income and high income. The four low-income countries—Turkey, Poland, Hungary, and Slovak Republic—each have per capita incomes more than 50% below Canada's. These four countries rank in the top ten because per capita pollution emissions are low due to small per capita economic output. The six high-income countries—Switzerland, Denmark, Germany, Austria, Sweden, and the Netherlands—each have per capita incomes, manufacturing intensity (industrial production as percent of GDP), and road travel rates (kilometer per capita) similar to Canada (OECD 2004: 204-5). Therefore, differences in per capita incomes, economic structure, and distance traveled can not explain differences in environmental performance. This is also confirmed by a more detailed analysis comparing Canada and Sweden by Boyd (2003).

The most logical explanation for the large difference in environmental performance between the high-income OECD countries and Canada appears to be public policy. Examining one indicator of environmental policy intensity supports this conclusion: environmental pricing. As a percent of GDP, environmental taxes collected in the six highly ranked high-income countries were, on average, more than double the rate applied in Canada. Even Japan, which has the lowest environmental tax rate of these six countries, has a rate of environmental taxation one-third higher than Canada. Although more analysis on the differences in environmental performance is warranted, weak environmental policy appears to be a major factor explaining Canada's poor performance.

CHAPTER 13:
CONCLUSIONS AND RECOMMENDATIONS

13.1 CONCLUSIONS

1. Canadian environmental policy has been evaluated on the basis of a comprehensive set of environmental indicators using different measures of comparison. The results for all evaluative measures show that Canada's environmental performance is poor.
   - Canada's current environmental performance is the third worst of any OECD country (28^{th} out of 30).
   - Canada's environmental performance is worse than the OECD average for 17 of 29 indicators.
   - Canada's environmental performance is worse than the OECD best performing country for all 29 indicators.
   - Canada's Environmental Performance Grade (EPG) is only 26.7%.

2. Environmental trend line analysis shows equally poor results. While Canada's improvement in 17 of 28 indicators over the last decade (1992-2002) is encouraging, Canada's rate of improvement lags behind the average rate of improvement for OECD countries. The comparative trend line analysis for 1992 to 2002 shows that:
   - Canada's rate of improvement is below the OECD average rate of improvement for 17 of 28 indicators.
   - Canada's rate of improvement is below the OECD best rate of improvement for 27 of 28 indicators.
   - Canada's relative position remained unchanged at 28^{th} of 30 countries, but Canada's EPG actually deteriorated slightly from 28.7% to 26.7%.

3. Canada's poor performance is likely due to a combination of factors including geography, climate, resource endowment, economic structure and poor environmental policy. Some factors are exogenous constraints that can not easily be altered and some factors are endogenous constraints that can be mitigated by improved policy.

4. The causes of Canada's poor environmental performance await further study. However, independent evaluations by the OECD and the Canadian Commissioner of Environment and Sustainable Development indicate that poor public policy is a major factor explaining Canada's poor environmental performance.

5. The role of public policy is also illustrated by success stories in Canada in areas such as sulfur oxides and ODS reductions. These success stories show that significant improvements are possible with the right public policy.

6. The role of public policy is further illustrated by the superior environmental performance of high-income countries such as Switzerland, Denmark, Germany, Austria, Sweden, and the

Netherlands, which have superior environmental records than Canada despite having many characteristics such as income levels and industrial structure in common.

7. Based on these findings, it is urgent that Canada completes a comprehensive review of its environmental policies. Given Canada's capacity, there is simply no justification for Canada's poor environmental performance.

13.2 RECOMMENDATIONS

8. Regular reporting of environmental monitoring results based on a comprehensive environmental sustainability reporting system (ESR) is essential to track Canada's environmental performance and assess effectiveness of environmental policies. Although Canada is making progress in environmental reporting and monitoring with initiatives such as the National Air Pollutants Surveillance System, the National Pollutant Release Inventory, and national water quality monitoring, Canada currently does not have an ESR to provide the public and policy makers with tracking of Canada's environmental performance. Therefore, it is recommended that Canada adopt a comprehensive ESR that tracks Canada's environmental performance on an annual basis.

9. In undertaking this study it was found that there are important environmental data gaps concerning Canada and the provinces that make it difficult to track environmental performance. Key data gaps that need to be addressed include: raw materials consumption, air quality, water quality, pesticide use, species at risk, biodiversity, ecosystem-based management practices, natural assets valuation, and human health impacts of pollution.

10. The credibility and effectiveness of an ESR is contingent on the process having a legislated authority and an independent, collaborative management structure. Therefore, it is recommended that either a new independent ESR agency be created (or the mandate of the existing Commissioner of the Environment and Sustainable Development be changed) with the following mandate:
    a. The ESR function is specified in legislation.
    b. The ESR statute contains a clear mandate that obligates the ESR agency to
        - complete a comprehensive assessment of Canada's environmental performance and environmental policies on an annual basis;
        - set goals, measurable objectives, and targets with timelines for Canadian environmental policy in the nine sustainability categories outlined in this report,
        - recommend policies for achieving environmental goals and objectives, which include a plan that clearly shows when and how the goals, objectives, and targets will be met; and;
        - report the results of the above assessment of Canada's environmental record in an annual public report to the Canadian Parliament.
    c. The ESR agency has a multistakeholder Board of Directors compromised of representatives from government, industry, First Nations, and nongovernmental organizations.

11. This report has completed a strategic scan that shows that Canada's environmental performance significantly lags the performance of most OECD countries. It is recommended that more analysis be undertaken to assess the reasons for differences in environmental performance and to identify keys to the success of the best performing jurisdictions. The best practices assessment should then be used to evaluate Canadian environmental policy and identify changes required to improve Canada's environmental performance.

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APPENDIX A: DESCRIPTION OF ENVIRONMENTAL MONITORING SYSTEMS

INTRODUCTION

The purpose of this appendix is to describe the ESR studies that were reviewed as part of this project. The development of the ESR methodology used in this study is described in appendix B.

A.1 OECD ENVIRONMENTAL REPORTING SYSTEM

The OECD tracks member countries' environmental performances and progress towards sustainable development. The objective of the OECD is to report member countries' environmental performances by using a common framework of environmental indicators. Such indicators help inform the public about key issues of common concern to OECD countries. (OECD 2003a).

The criteria used by the OECD to choose its indicators include policy relevance, analytical soundness, and measurability. In addition to these criteria, the OECD used the Pressure-State-Response (PSR) model, which highlights cause-and-effect relationships between humans and the environment. The concept of PSR is that humans exert **pressure** on the environment, which affects the quality and quantity (**state)** of natural resources. Society **responds** to these changes by implementing environmental, economic, and sectoral policies (OECD 2003a).

The OECD has published a compendium summarizing environmental indicators for member countries on a biannual basis since 1985. The OECD also publishes separate reports evaluating the environmental performance for each member country, with two reviews completed for Canada (OECD 1995b, 2004). The most recent review evaluated Canada's environmental performance based on the following six categories.

1. Air management
2. Water management
3. Nature and biodiversity management
4. Environmental-economic interface
5. Environmental-social interface
6. Sector integration – chemicals

OECD indicators are updated on a regular basis and may change as scientific knowledge, policy concerns, and data availability progress (OECD 2003a). The indicators currently used by the OECD are summarized in table A.1.

Table A.1: Indictors for the OEDC *Environmental Performance Review – Canada*

CATEGORY	INDICATOR	MEASUREMENT
Air Pollution	Sulfur oxides	kg/capita kg/US$1,000 GDP
	Nitrogen oxides	kg/capita kg/US$1,000 GDP
	VOCs	kg/capita
	Carbon monoxide	kg/capita
Agriculture	Pesticide use	Tonnes/km^2 of arable land
	Nitrogenous fertilizer use	Tonnes/km^2 of arable land
	Livestock population	# of sheep equivalents/capita
Surface Water Use	Water consumption	% of gross annual availability Cubic meters/capita
Climate Change	GHG emissions	Tonnes of CO_2 equivalents/capita Tonnes/US$1,000 GDP
Transportation	Road vehicles	#/capita
	Vehicle distance traveled	Vehicle-km/capita
Waste	Public sewage treatment	% of population with sewage treatment
	Municipal waste	kg/capita
	Industrial waste	kg/US$1,000 GDP
	Nuclear waste	kg/capita
	Pollution abatement	PAC expenditures as % of GDP
	Environmental taxes	Revenue as % of GDP
Energy Use	Energy efficiency	toe/US$1,000 GDP toe/capita
	Energy supply source	% by type (oil, gas, nuclear, renewable)
Protected Areas/ Forested Areas	Protected area status	% of land base protected
	Forests	% of land area forested Harvest to growth ratio Harvest
	Tropical wood imports	US$/capita
Threatened Species	Mammals	% of known species
	Birds	% of known species
	Fish	% of known species
	Fisheries	% of world catch
Population	Population	% growth
Official Development Assistance	Development assistance	Development assistance as % of GNI

A.2 CANADA VS. THE OECD: AN ENVIRONMENTAL COMPARISON

The purpose of *Canada vs. the OECD: an Environmental Comparison* is to assess Canada's environmental track record (Boyd 2001). The methodology used in this study is based on a time-series analysis and a cross-sectional comparison of Canada's environmental performance, using the OECD environmental indicators (table A.1). The time-series analysis reports the percent change in each indicator over two decades (1980-1999). The cross-sectional comparison ranks Canada's environmental performance for each indicator relative to other member nations of the OECD for the most recent year. The OECD countries are ranked from best to worst for each indicator. An overall average rank for each country is also calculated based on the arithmetic mean of the rank for each of the indicators.

A.3 ALBERTA GPI ACCOUNTING PROJECT

The Alberta Genuine Progress Indicator Accounting Project (AGPI) provides a framework to measure sustainability. The goal of the AGPI is to provide citizens and decision makers with a comprehensive measure of progress towards achieving economic, social, and environmental sustainability. The AGPI is based on an integration of four indexes: the Genuine Progress Indicator (GPI) developed in the U.S., the Index for Sustainable Economic Welfare, the United Nations Human Development Index, and the Edmonton Social Health Index (table A.2) (Anielski 2001).

The calculation of the AGPI involves three components. First, the GPI provides data for each of over 50 sustainability and quality of life indicators. Second, the GPI balance sheet records current and historical conditions of all capital assets, liabilities, and net worth. This information is provided in physical, qualitative, or monetary terms. Third, a GPI income statement provides a cost-benefit analysis of the economic, social, and environmental indicators compared to the gross domestic product (GDP). This step results in a GPI estimate of net sustainable income to determine total monetary costs and benefits associated with management or consumption of all forms of capital (Anielski 2001). The GPI methodology was applied to Alberta using data from 1961 to 1999.

A.4 THE GPI ATLANTIC NATURAL RESOURCE AND ENVIRONMENTAL ACCOUNTS

The GPI Atlantic Natural Resource and Environmental Accounts (GPI Atlantic) was founded in 1997 to develop a more comprehensive measure of societal well-being. The GPI Atlantic framework is based on following four core principles:

- integration of sustainability as an overarching theme,
- utilization of investment oriented accounting approaches that recognize natural resources as capital assets subject to depreciation and requiring potential reinvestment,
- application of the precautionary principle to economic valuation methods, and
- recognition of resource accounting and sustainability measures as a first step toward incorporating full cost accounting into existing financial and taxation structures, as well as eventually into market price mechanisms (Colman 2001b: 2).

Table A.2: Alberta GPI Indicators

CATEGORY	INDICATOR	MEASUREMENT
Economy	Economic growth	GDP
	Economic diversity	Index where 1.0 represents Alberta's diversity as equal to federal diversity
	Balance of trade	% of total exports contributed by each industry or commodity group
	Real disposable income	CDN$/capita
	Personal consumption expenditures	GDP/capita
	Taxes	CDN$ paid in taxes/capita
	Debt	Total CDN$ value of household, government, business, farm debt/capita
	Savings rate	CND$ savings/capita
	Household infrastructure	CDN$ value of household infrastructure
	Public infrastructure	Net capital stock of public infrastructure
Society	Poverty	% living below low-income cutoff
	Income Inequality	Gini coefficient of income inequality
	Paid work time	# of hours of paid work
	Unemployment rate	# of people unemployed
	Underemployment rate	# of people underemployed
	Parenting and eldercare time	Hrs/person
	Leisure time	Hrs of free time
	Volunteer time	Hrs of unpaid work
	Commuting time	# of registered vehicles
	Family breakdown	# of marriages/divorces
	Crime	# of incidents/100,000 people
	Democracy	% participation of registered voters
	Intellectual/knowledge capital	% of population 15 yrs+ with some level of post secondary education
	Life expectancy	Years
	Infant mortality	# of deaths/1,000 births
	Premature mortality	Person-years of life lost/100,000 people
	Suicide	# of suicides/100,000 people
	Auto crashes	# of people killed/100,000 people
	Substance abuse	% of youth with drug abuse offences
	Gambling	CDN$ spent gambling
	Obesity	Body mass indices

Environment	Ecological footprint	Hectares/capita
	Ecosystem health	Forest fragmentation index
	Parks and Protected Areas	Area protected in km^2
	Energy demand	Primary energy demand/CDN$ millions of GDP
	GHG emissions	Million tonnes of GHG emissions
	Carbon budget deficit	Million tonnes of carbon equivalent
	Nonrenewable conventional oil/gas reserve	Closing stock/annual production
	Oilsands reserve life	Closing stock/annual production
	Renewable energy	Not yet determined
	Agriculture sustainability: Irrigation use	# of acres Volume of water/irrigated acre
	Agriculture sustainability: Soil erosion	% of land at risk % of cultivated land
	Agriculture sustainability: Dryland salinity	Extent of average visible salinity in acres
	Agriculture sustainability: Organic soil loss	kg/hectare
	Organic agriculture	# of certified producers
	Timber sustainability	Total growth volume to total depletions ratio
	Wetlands	% lost/remaining
	Peatlands	Tonnes harvested
	Fish & wildlife species' health	Tonnes of commercially harvested fish # of red and blue listed species
	Air quality	% of increased risk of death
	Water quality	% of population with sewage treatment
	Hazardous waste production	Tonnes
	Landfill waste production	Tonnes waste disposed Tonnes waste disposed/capita

The GPI links the economy with social and environmental variables to create a more comprehensive measurement tool. The GPI accounts for the value of human, social, and natural capital in addition to conventional measures of economic capital. The index also assigns value to assets like population health, educational attainment, community safety, voluntary work, and environmental quality.[1] The GPI Atlantic framework has 22 components distributed across five general categories (table A.3).

Table A.3: The GPI Atlantic Indicators

CATEGORY	INDICATOR
Time Use	Economic value of civic and voluntary work
	Economic value of unpaid housework and child care
	Work hours
	Value of leisure time
Natural Capital	Soils and agriculture
	Forests
	Marine environment/fisheries
	Energy
Environmental Quality	GHG emissions
	Sustainable transportation
	Ecological footprint analysis
	Air quality
	Water quality
	Solid waste
Socioeconomic	Income distribution
	Debt, external borrowing, and capital movements
	Valuations of durability
	Composite livelihood security index
Social Capital	Population health
	Educational attainment
	Costs of crime
	Human freedom index

Source: GPI Atlantic website. www.gpiatlantic.org/; accessed 22 June 2005.

Application of the GPI is still in progress. Separate reports will be completed on each indicator instead of integrating all information into a single, aggregate number. The final result will be an index consisting of the 22 components applied to a region of Nova Scotia. It is intended that the "full cost accounting" method applied by this pilot project will provide a starting point for future applications at various levels of government.[2]

[1] GPI Atlantic website. www.gpiatlantic.org/; accessed 22 June 2005.

[2] Ibid.

A.5 ENVIRONMENTAL TRENDS IN BRITISH COLUMBIA

The B.C. provincial government began publishing a report summarizing environmental trends in 1998. To date, three reports have been published (B.C. 2002). The reporting of environmental trends in B.C. is based on six themes: biodiversity, water, stewardship, human health and the environment, toxic contaminants, and climate change. The report uses 16 indicators that incorporate 64 separate measurements (table A.4).

The environmental trends reports chose indicators on the basis of the following criteria:

- representative,
- sensitive to environmental change,
- relevant to public policy, and
- easy to understand by a nontechnical audience (B.C. 2002).

Each report outlines the current status for each indicator for British Columbia, the importance of measuring the indicator, and actions taken to improve the current trend. Information is also provided on specific provincial goals as well as on future environmental initiatives. No attempt is made to aggregate the indicators into a single index to measure the overall state of environment.

A.6 NATIONAL ROUND TABLE ON THE ENVIRONMENT AND THE ECONOMY

The National Round Table on the Environment and the Economy (NTREE) created the Environmental Sustainable Development Initiative (ESDI), a three-year multistakeholder program to develop sustainability indicators for Canada. The purpose of the indicators is to measure Canada's progress toward achieving sustainability (Canada, NRTEE 2003). A framework was established based on the concept of economic capital to link current macroeconomic indicators with proposed new indicators. The rationale for this framework is that types of capital not normally included in economic accounts, such as environmental assets that provide quality-of-life "services", are as important to the future economy as more traditional forms of capital, such as factories and machinery. From this premise, it was decided that a way to track all the capital needed by future generations to sustain a healthy society and economy should be developed (Canada, NRTEE 2003).

The indicators were developed by a 30-member steering committee that included nongovernmental organizations, academics, government officials, business, and financial organizations. The steering committee worked closely with Statistics Canada and Environment Canada. Criteria used to evaluate alternative indicators included:

- transparency,
- clarity,
- scientifically credibility, and
- understandability by a nontechnical audience (Canada, NRTEE 2003).

The ESDI steering committee's assessed the possibility of creating a single aggregate indicator. The creation of a single indicator was rejected because the units measuring capital in the separate indicators were not comparable and, therefore, could not be combined into a single measure (Canada, NRTEE 2003).

Table A.4: Environmental trends in British Columbia 2002 indicators

CATEGORY	INDICATOR	MEASUREMENT
Air Pollution	Particulate matter (PM_{10})	% of communities exposed to health risks from PM_{10} for more than 18 days annually % of the time that PM_{10} concentration is greater then 50 ug/m^3
	Ground-level ozone	Average daily 8-hr maximum ozone concentration in parts per billion weighted by population living in affected areas
Other Health and Environmental Indicators	Mercury concentration in fish	Mean mercury concentration in parts per billion wet weight for bull trout and lake trout
	Landscape pesticide use	Tonnes of active ingredient
	Ultraviolet radiation exposure	# of days in each category 1. extreme – 15 min or less to burn 2. high – about 20 min to burn 3. moderate – about 30 min to burn 4. low – more than 1hr to burn
Surface Water Quality	Water quality	Provincial water quality index – # of monitoring stations/category (excellent, good, fair, borderline, poor)
	Stream crossings	#of crossings/km of stream
Surface Water Use	Water allocation restrictions	% of licensed stream length that has water allocation restrictions by decade
	Municipal water use	m^3/capita
Groundwater	Declining groundwater levels	% of observation wells with declining water levels primarily due to human activities
Toxic Contaminants	On-site toxic substance releases	Tonnes
	Absorbable organic halides discharged in pulp and paper effluent	Tonnes/day
Persistent Chemicals	Organochlorines	Concentration in mg/kg of organochlorines in great blue heron eggs
	Dioxins and furans	Parts per trillion in harbor seals Average combined Dixon and Furan levels in digestive gland of Dungeness crab toxic equivalents (picograms/gram)
	PCBs	Parts per million in harbor seals
Climate Change	GHG emissions	Tonnes CO_2 equivalent/capita
	Temperature change	Change in ambient average temperature over the last century
	Fraser River annual flow	Date of one-third of Fraser River annual flow
	Fraser River temperature	Average Fraser River temperature
Transportation	Total vehicles	# of vehicles sold
	Road vehicles	#/capita

Waste	Sewage treatment	% of population with secondary or tertiary wastewater treatment plants (%)
	Mining waste	# Metal leaching/acid rock drainage mine sites
	Municipal solid waste	Municipal per capita solid waste disposal and recycling rates
	Waste oil	Waste oil re-refined
	Lead acid batteries	# of lead acid battery units recycled
Energy Use	Conventional energy consumption	Conventional energy consumption
	Conventional energy intensity	Consumption/GDP
Linking Environment and Economy	Organic farming	# of certified organic producers and processors
	Provincial park revenue	GDP generated by provincial parks
	Environment industry employment	# of positions
Protected Areas/ Forest Areas	Protected areas	% of land base protected
	Protected ecosections	% of ecosections protected
	Size of protected areas	# of protected areas by size in hectares
	Forest protected areas	% of total provincial forested area)
	High-elevation forest	% of total high-elevation forested area
	Low-elevation forest	% of total low-elevation forested area
Species at Risk	Red-listed species	% of known species that are threatened or endangered, or are candidates for such designations
	Red- and blue-listed species	# of red and blue listed species in each ecological region
Habitat	Road density	km of road/km^2 of watershed area
	Coastal estuary use	Area licensed or managed for conservation use
Fisheries	Steel head conservation risk	Categorized as healthy, conservation concern, extreme conservation concern, or no steelhead
	Bulltrout conservation risk	Categorized as presumed healthy, conservation risk unknown, presumed conservation risk, or no historical presence
	White sturgeon age distribution	% of juveniles, sub-adults, and adults

Based on its analysis, the ESDI steering committee recommended six indicators (table A.5). The ESDI steering committee recommended that Statistics Canada publish these six indicators annually, and that the indicators be incorporated into the federal budget statement by the Department of Finance (Canada, NRTEE 2003). To date, actions have not been taken to implement these recommendations.

Table A.5: National Round Table on the Environment and the Economy indicators

CATEGORY	INDICATOR	MEASUREMENT
Air Quality	Ground-level ozone	Average daily 8-hr maximum ozone concentration in parts per billion weighted by population living in affected areas
Fresh Water Quality	Water quality	Provincial water quality index – # of monitoring stations/category (excellent, good, fair, borderline, poor)
GHG Emissions	GHG emissions	All GHG (CO_2, CH_4, N_2O) sources in tonnes CO_2 equivalents
Forest Cover	Crown closure	Changes in area with a crown closure of greater than 10%
Extent of Wetlands	Wetlands	% area of wetlands over time

A.7 SUSTAINABILITY WITHIN A GENERATION

The report, *Sustainability within a Generation* (Boyd 2004), was commissioned by the David Suzuki Foundation to provide a policy framework for achieving sustainability in Canada. The report includes a vision statement, goals, and specific policy recommendations to achieve a sustainable future.

The primary objective of the report is to outline a plan to achieve sustainability and increase genuine wealth for Canadians. The path to sustainability outlined in the report is based on the following nine goals (Boyd 2004).

1. Generating genuine wealth
2. Improving environmental efficiency
3. Shifting to clean energy
4. Reducing waste and pollution
5. Protecting water quality
6. Producing healthy food
7. Conserving and protecting nature
8. Building sustainable cities
9. Promoting global sustainability

Measurement of progress in meeting these goals is based on specific environmental indicators. The report references potential indicators but does not provide a comprehensive set of indicators to measure sustainability. The report provides a conceptual framework for developing an ESR.

For each of the goals, the report presents the Canadian context of the problem and sets targets and timelines to achieve sustainability within a generation. Interim objectives are included to enable Canadian's to monitor progress toward the goals. The report also provides policy recommendations that need to be implemented for Canada to achieve sustainability within a generation (Boyd 2004).

A.8 2004 STATE OF THE FRASER BASIN REPORT

The vision of the Fraser Basin Council of British Columbia (FBC) is to build a community where "social well-being is supported by a vibrant economy and sustained by a healthy environment" (FBC 2004). FBC works with stakeholders from the basin, including community groups, government, First Nations, business, academics, and labor groups. As part of their mandate, FBC measures progress toward sustainability in the Fraser Basin and publishes results in an annual report (FBC 2004).

Through the reporting process, FBC seeks to achieve three goals:

- increase public awareness and understanding of key sustainability issues and trends,
- identify critical issues and appropriate responses to improve the region's progress toward sustainability, and
- inform and influence decisions and actions of basin residents in order to advance local progress towards sustainability (FBC 2004: 3).

The indicators used by FBC were developed in consultation with government, the private sector, and community groups. FBC uses 17 indicators to assess social, economic, and environmental aspects of life in the Fraser Basin (table A.6). A link between each indicator and sustainability is provided, along with relevant data outlining current status and trends.

Table A.6: Fraser Basin sustainability indicators

CATEGORY	INDICATOR	MEASUREMENT
Aboriginal and Non-Aboriginal Relations	State of relations	% of responses by category (getting better, no change, getting worse, don't know)
	Level of satisfaction	% of responses by category (very satisfied, neutral, dissatisfied/very dissatisfied, too early to say, no response)
	Treaty process	# of First Nations at different stages of treaty process
	Benefits and challenges of agreements	Not available – indicator information not included in report
Agriculture	Productive land	% change
	Farm income	Net farm income in Fraser Basin ($)
	Soil conservation	% of farms reporting soil conservation practices
	Agricultural land reserve	Change in area protected by Agricultural Land Reserve
Air Quality	Particulate matter (PM_{10})	% of time PM_{10} > 50 $\mu g/m^3$
	$PM_{2.5}$ trends	$\mu g/m^3$
	Ozone trends	Parts per billion
Business and Sustainability	Corporate donors	% of companies surveyed that contributed to either the IMAGINE Campaign or the Matching Gift Campaign
	Real R&D spending to GDP	% of R&D spending
	Environmental industry	# of businesses # of people employed
Community Engagement	Volunteerism and charitable giving	% of population that has volunteered
	Sense of belonging within local community	% of responses by category (very strong, somewhat strong, somewhat weak, very weak, not stated)
	LRMP survey	% of responses that agree/disagree with set of questions
	Confidence in public institutions	Not available – indicator information not included in report
Community Sustainability	Population	% change in population
	Waste disposal	kg per capita waste disposed
Economic Diversification	Economic Indicators	Average % growth of six indicators (employment, sales, manufacturing shipments, international visitors, nonresidential building permits, housing)
	Diversity Index	No unit of measurement
Education	Educational attainment	# of people/level of education
	Student-teacher ratios	% change in ratios
	Apprenticeship enrollment	# of students enrolled
	Adult training	# of adults in training

Energy and Climate Change	Energy use	% use by sector (community/institution/public, residential, total industrial, agricultural, transportation)
	Energy efficiency	% change
	Energy consumption	% by source (hydroelectricity, biomass, natural gas, petroleum)
	Growth in energy use	% change by source (petroleum, natural gas, hydroelectricity, biomass, coal and coke)
	GHG emissions	% by source (waste, agricultural and land use, fugitive emissions, industry, commercial and industrial, residential, transportation)
	Green energy	% by source (wind, biogas and sewage gas, solar photovoltatics, low-impact hydro)
Fish and Wildlife	Escapement	# valid escapement observations
	Chinook run	% of Chinook runs with increased escapement
	Sockeye run	% of sockeye runs showing increasing escapement
	Red- and Blue-listed species	% of known species
	Red- and Blue-listed species by region	# per region
Flood Hazard Management	Population	# of people and buildings located in the flood plain
Forests and Forestry	Ratio of area reforested	No unit of measurement
	Cumulative area certified	# of hectares
	Mountain pine beetle	# of affected hectares
	Forest vulnerability index	No unit of measurement
	Softwood lumber exported	Not available – indicator information not included in report
	Forest health	Not available – indicator information not included in report
Health	Life expectancy	Years
	Low weight births	% by region
	Self-rated health	% of responses by category (poor, fair, good, very good, excellent)
	Age standardized mortality rate	Not available – indicator information not included in report
	Change in age standardized mortality rate	Not available – indicator information not included in report
	Leisure time – physical activity	Not available – indicator information not included in report
Housing	Core housing need	%
	Vacancy	% vacant: apartment/row houses and urban/rural
	Tenure	Ownership/renter
Income and employment	Household income	Average household income
	Income distribution	% of population by household income
	Employment rate	Employment rates by region
	Unemployment rates	Unemployment rates by region

Population	Age distribution	% of Fraser Basin population by age
	Mobility	# of migrants to the region
	Ethnicity	% of population by ethnic origin
	Aboriginal population	# of people
Water Quality and Quantity	Water use	% of total water use by sector)
	Water flow	Average flow in m^3/day
	Water quality	% of samples that achieve of water quality objectives
	Water quality	% of time water quality objectives are met

A.9 CONFERENCE BOARD OF CANADA: PERFORMANCE AND POTENTIAL STUDIES

Since 1999, the Conference Board of Canada (CBC) has published an annual report that evaluates Canada's economic, social, and environmental performance relative to other OECD countries. The evaluation reports on 24 of 30 OECD countries. Five OECD countries were excluded from the analysis (Czech Republic, Hungary, Poland, Slovak Republic, and Turkey) because of lack of reliable data. Luxembourg was also excluded due to its economic union with Belgium (Canada, CBC 2004).

The CBC study uses 110 indicators organized into six categories: economy, innovation, environment, education and skills, health, and society. Twenty-four indicators define the environmental category (see table B.2). CBC used the following three criteria to determine which indicators to analyze (Canada, CBC 2004: 16).

- Is there a general agreement that a movement in the indicator in one direction is better than in the other?
- Are the data available for most of the countries?
- Are the data comparable across countries?

The countries are ranked based on an overall index calculated for each category by summing standardized scores for each of the individual indicators. Standardized scores are calculated using the difference between a country's value and the average value divided by the standard deviation for each indicator. This value is then multiplied by 100. The mean of the standard scores is then calculated for each country per category in order to generate the overall category index. The countries are then ranked from highest to lowest based on the index, and the top 12 countries are selected for further comparison (Canada, CBC 2004).

The performance of the 12 countries is compared by designating the country as a gold, silver, or bronze performer on each indicator. Gold is awarded to the countries that score in the top third, silver to the middle third, and bronze to the bottom third of the 12 countries. In previous years, the countries were ranked as "top, average, or poor performers" based on the same division into thirds. However, this approach was replaced by the current method to reflect that fact that these countries are already the best in the world for that particular category (Canada, CBC 2004).

A.10 YALE ENVIRONMENTAL SUSTAINABILITY INDEX

The Yale Environmental Sustainability Index (ESI) was developed by the Yale Center for Environmental Law and Policy and the Center for International Earth Science Information Network (CIESIN) at Columbia University in collaboration with the World Economic Forum's Global Leaders for Tomorrow Environment Task Force. To date four reports have been published: a Pilot ESI in 2000, and three ESI reports in 2001, 2002, and 2005 (Esty et al. 2005).

The objective of the ESI is to assess a country's potential to protect the environment over coming decades. By "benchmarking" many countries' performances across a broad range of indicators, the ESI identifies leaders and laggards on an issue by issue basis, allowing countries to identify strengths and weaknesses in their environmental performances and best practices. To date, two reports have been published that rank countries based on environmental sustainability (Esty et al. 2002; Esty et al. 2005).

The methodology of ESI is based on comparing countries on the basis of environmental indicators. In the most recent study (Esty et al. 2005), 76 variables are used to assess performance of 146 countries across 21 indicators that are grouped under 7 broad themes or components (see table B.3). Countries were included in the comparative study if there were data for at least 45 of the 76 variables, the country was larger than 5,000 km^2, and had a population greater than 100,000. Variables were chosen on the basis of scientific validity as measures of sustainability.

Data were collected for the 76 variables from a variety of sources. Where data were not available for specific country indicators, statistical techniques were used to estimate the data. To facilitate comparison between countries, denominators or rates such as per unit of GDP, per unit of land, and per capita were used. Data were also "normalized" to eliminate extreme values on the assumption that extreme values were likely data errors.

Aggregating the data into a single ESI involved several steps. First, the data for each variable was transformed into a common index so that the data sets could be aggregated. The index was calculated by taking the difference between each country's value by variable and the mean value of all countries for the same variable and dividing the difference by the standard deviation for the variable values. The index for each indicator was then calculated by averaging the value of all variables relevant to that indicator. The overall ESI for each country was calculated by averaging the ESI values for the 21 indicators.

The ESI study identifies several limitations of the method. First, there are serious data limitations for the 146 countries analyzed. Data varies in coverage and reliability. Second, the impact of each variable on the ESI varies because the number of variables used to estimate indicator values ranges from two to twelve. The twelve variables used to estimate one indicator have significantly less impact on the final ESI than the two variables used to measure other indicators. Third, the ESI assumes equal weights for the 21 indicators in estimating the overall country ESI.

The Yale ESI is discussed in more detail in appendix B.

APPENDIX B: COMPARING THE RESULTS OF RANKING STUDIES

The purpose of this appendix is to compare the results of recent studies that have ranked Canada's environmental performance. Four studies are assessed: this study (SFU-REM), the Boyd study (2001), the Conference Board Study (Canada, CBC 2004), and the Yale Environmental Sustainability Index study (Esty et al. 2005).

B.1 STUDY FINDINGS

The results of the four studies provide different rankings for Canada (table B.1). The Yale ESI provides the highest ranking (6 out of 146), while the SFU-REM and the Boyd studies provide the lowest rank. However, the Yale rank for Canada's environmental performance, which is a subcomponent of the ESI, is 69 out of 146. This lower rank is more consistent with the SFU-REM result. In Conference Board's most recent study (Canada, CBC 2004), Canada is tied at 9th out of 24 countries in the environmental rank. The Conference Board's environmental rank for Canada improved from 16th in 2002 and 12th in 2003 (Canada, CBC 2004: 35). As discussed below, the improvement in the Conference Board rank for Canada is due to changes in the indicators.

Table B.1: Comparison of environmental ranking studies for Canada

	SFU-REM	BOYD	CONFERENCE BOARD	YALE ESI
YEAR	2005	2001	2004	2005
OBJECTIVE	Assess current environmental performance	Assess current environmental performance	Assess current and potential environmental performance	Assess current and potential environmental performance
NUMBER OF INDICATORS	29	25	24	76*
RANKING SYSTEM	Ordinal	Ordinal	Hybrid interval scale	Interval scale
INDICATOR WEIGHTS	Equal weights	Equal weights	Equal weights	Equal/arbitrary weights*
CANADA'S RANK	28	28	2004: 9 2003: 12 2002: 16	Overall: 6 Environmental Performance: 69*
NUMBER OF COUNTRIES	30	29	24	146

* The Yale study uses the term data set to describe what are termed indicators in the other studies. The Yale study groups data sets into indicator categories and gives equal weight to each indicator category. Indicator weights therefore vary arbitrarily by the number of indicators grouped under each indicator category. Yale provides Canada with an overall rank of 6. The average rank for Canada computed by the SFU-REM study team using the Yale study based on the 11 indicators of environmental performance (air quality, biodiversity, land, water quality, reducing air pollution, reducing ecosystem stress, waste and consumption, reducing water stress, natural resource management, eco-efficiency, and greenhouse gas emissions) is 69.

B.2 REASONS FOR DIFFERENT RANKS

1. STUDY OBJECTIVE

The first explanation for the differences in the ranks is that the objectives of the studies vary. The SFU-REM and the Boyd studies are designed to measure **current** environmental performance. The Conference Board and Yale studies are designed to measure **potential** of the countries to manage the environment. Current environmental performance is a subcomponent of the CBC and Yale studies. Consequently, the studies measure different country characteristics.

2. INDICATOR SELECTION FOR THE SFU-REM STUDY

One of the major reasons for differences in ranks is that the studies use different indicators based on their different objectives. The decision on which indicators to use in the SFU-REM study was based on the following steps. First, a list of indicators, summarized in table B.3, was prepared based on indicators used in other major studies. Second, the indicators were assessed on the basis of the following criteria.

- The indicator must provide a meaningful measure of environmental performance.
- The indicator must be generally understandable for a nontechnical audience.
- The data required for the indicator must be reliable, reasonably current, and available on a regular basis.
- The indicator should not directly replicate other indicators.

The results of the assessment of each indicator are summarized in the SFU-REM column in table B.3. The '✓' shows that the indicator was adopted. If the indicator was rejected, the major reason for the rejection is provided. The principal rationales for rejection include: lack of reliable data, lack of relevance to current environmental performance, and direct overlap with other indicators.

The SFU-REM study team lacked the resources to independently assess the reliability of environmental data. Therefore, the decision on data reliability was based on the simpler decision rule of whether the data was collected by the OECD. The OECD undertakes a multiple step due diligence assessment of OECD country environmental data to ensure comparability and accuracy (OECD 2005). Therefore, the indicator was rejected if the data was not published in the *OECD Environmental Compendiums.* Several indicators related to water quality published by the OECD were also rejected because of the limited spatial coverage. A second common reason for rejection was relevance to environmental performance. Many of the indicators in table B.3 measure the quality of governance or social/health risks and outcomes. While these are important indicators, they are not relevant to the objective of the SFU-REM study to measure environmental performance. Third, some indicators were rejected if they directly overlapped with other indicators. Based on this review, 29 indicators were adopted in the SFU-REM study.

3. COMPARISON OF INDICATORS IN RANKING STUDIES

SFU-REM and Boyd Studies

The SFU-REM and Boyd studies have the most indicators in common—23 (see table B.3). Five of the 23 indicators in common use different measurement units: pesticide use, fertilizer use, and recycling. For fertilizer and pesticide use, the SFU-REM study uses tonnes/km^2 arable land and the Boyd study uses tonnes/capita. Timber harvest in the SFU-REM study uses timber harvest per unit of forested land and livestock per unit or agricultural land in replace of the per capita denominators used in the Boyd study. Recycling in the SFU-REM study is based on % of municipal waste and the Boyd study is based on % of paper and glass, which is a subset of municipal waste. These changes in denominators in the SFU-REM study are made to better measure sustainability. The SFU-REM study added seven new indicators not in the Boyd study and dropped three.

SFU-REM and Conference Board Studies

The SFU-REM and Conference Board studies share 9 indicators in common. However, 4 of the 9 indicators shared in common use different measurement units. Three of these differences in measurement units relate to air emissions of sulfur oxides, nitrogen oxides, and volatile organic compounds. The SFU-REM study uses emissions per capita and the Conference Board uses emissions per unit of populated land, which is defined as having a density equal to or above five people per square mile.

The logic of using land area as the denominator for air emissions is that it attempts to measure the potential impact on air quality by calculating the spatial concentration of emissions. However, this is a less effective way of measuring air quality impacts than the direct measure of concentrations of pollutants in the air, which are used as other Conference Board indicators. Large tracts of land on the prairies, for example, provide little help in dispersing pollutants in southern Ontario.

The use of land area as the denominator also significantly biases the results in favor of countries with large land areas such as Canada. The impact of this is illustrated by comparing the results of earlier Conference Board studies (Canada, CBC 2002; 2004) to the current one (Canada, CBC 2004). In the earlier studies the Conference Board measured air emissions per unit of GDP, instead of per unit of land. Canada received among the lowest ratings for air emissions among OECD countries: 24th and 28th out of 30 OECD countries for sulfur oxides and nitrogen oxides emissions per unit of GDP respectively (OECD 2004: 202-3). Ranking air emissions by land area moves Canada into the top ten. This change in unit of measure explains much of the improvement in Canada's ranking from the earlier Conference Board studies in which Canada is ranked in the middle to lower end of OECD countries.

SFU-REM and Yale Studies

The SFU-REM and Yale study share 14 indicators in common, 6 of which use the same measurement unit. However, the sharing of common indicators in the SFU-REM study is swamped by the use of an additional 62 variables in the Yale study not used in the SFU-REM study. Many of these additional variables used in the Yale study are designed to measure potential to manage the environment and therefore are not consistent with the objective of the SFU-REM study, which is designed to measure current environmental performance. The Yale study also includes some social indicators such as death and fertility rates.

Overall, about one-half of the variables in the Yale study measure environmental performance while the other one-half measure potential to manage the environment or social/health performance. The variables measuring environmental performance are grouped into 11 indicator categories. Based on the 11 indicator categories that measure environmental performance, Canada's average rank falls from 6th to 69th (table B.2). It should also be noted that the reducing air pollution indicator uses the same land area denominator as the Conference Board study, which biases the results in Canada's favor. If a per capita or per unit of GDP denominator is used, Canada's air quality rank would fall to at least 139th.

Table B.2: Yale ESI rank for Canada's environmental performance

INDICATOR	CANADA'S RANK
Air quality	27
Biodiversity	42
Land	8
Water quality	5
Reducing air pollution	126
Reducing ecosystem stress	74
Waste and consumption	141
Reducing water stress	50
Natural resource management	97
Eco-efficiency	83
Greenhouse gas emissions	107
Average rank	**69**

4. DATA REFERENCE YEAR

Another difference between the four studies is the currency of the data. The SFU-REM study uses the most recent data for OECD countries: up to 2002 data from the OECD (2005). The Boyd study uses up to 1996 data from the OECD (1999). The Conference Board relies largely on the 2002 Yale study (Esty et al. 2002), which contains data up to 1998. The Yale ESI study uses data predominantly from 2000 to 2004, with some data from the late 1990s. However, the differently year data in the four studies appears to explain little of the variation in results. The Boyd study, which relies on the earliest data, has ranking results for Canada virtually identical to the SFU-REM study, which has the most recent data.

5. RANKING METHOD

The four studies use different methods to rank the countries, which can produce different orderings. The SFU-REM study and the Boyd study use an ordinal ranking system. Each country is ranked in order from 1 to 30 for each indicator and the average rank for the countries is then calculated and used to provide an overall country rank. The advantage of this approach is its simplicity. The disadvantage is that the ordinal scale does not measure the difference between countries. Countries may be close in one indicator and vary far apart on another indicator. The ordinal scale will not capture this difference. The SFU-REM study compensates for this by calculating the EPG, which shows how far a country is behind the best performer.

The Yale study uses an interval ranking system based on an index that measures the difference between countries. The index values are then averaged for each country to produce an overall rank. By basing the rank on the magnitude of the difference between countries, the interval scale can produce a different rank order. The advantage of this approach is that is accounts for the actual differences between countries, instead of the ordinal scale assumption of a constant difference. However, the Yale study somewhat reduces this interval effect by dividing the differences by the standard deviation. The disadvantage of the interval scale is its complexity, which makes it difficult to understand for the general public.

The Conference Board study uses a hybrid system that is not clearly explained in their report (Canada, CBC 2004). The Conference Board calculates an interval index based on the same method as the Yale study for 24 OECD countries. The top 12 countries are then selected for more detailed analysis, how the top 12 are chosen is not clearly indicated. The Conference Board then puts the top 12 countries into three categories for each of the 24 indicators: gold, silver, and bronze. The number of medals are weighted and added to provide the overall ranks. Using the three medal categories eliminates the affect of the absolute differences and ordinal differences in the ranking calculation. Therefore the resulting ranks are difficult to interpret.

6. WEIGHTING METHOD

Two weighting systems are used in the four studies. The SFU-REM study, Boyd study, and Conference Board study all apply equal weights to the indicators. The Yale study applies equal weights to the indicator categories, but implicitly applies arbitrary weights to the individual variables (which are referred to as indicators in the other three studies). The reason for this is that the number of variables in each indicator category varies between 2 and 12 in the Yale study. The weight of a variable in the indicator category with twelve variables is one-sixth of the weight of a variable in an indicator category with two variables. For example, the variable for protected land (% of land based designated as protected) has a weight of 0.4 % in the Yale study compared to fertility, which has a weight of 2.5%. The lower weight for protected areas is based on the decision to place it in the environmental governance category instead of the land category. The protected area indicator has a weight of about 3.3% in the SFU-REM study, equal to the weight of all other indicators. Differential weights will produce different ranking results.

7. SUMMARY

The four studies reviewed have different objectives, methods, and indicators that result in different ranks for Canada. When the study results are assessed on the basis of Canada's current environment performance, the differences in ranking results are significantly reduced. An analysis of the Yale results indicates that Canada's rank in current environmental performance is 69th. When the Conference Board utilized air quality measures based on emissions per unit of GDP instead of per unit of land, and left out governance indicators, Canada's ranking was 12th to 16thth. The Conference Board and the Yale studies therefore rank Canada in the middle to lower middle of the pack on environmental performance, while the SFU-REM and Boyd studies rank Canada at the bottom of the pack. In all four studies, Canada's environmental performance is unsatisfactory.

Table B.3: Comparing environmental indicators in Canadian ranking studies

INDICATOR	SFU-REM	BOYD	CONFERENCE BOARD	YALE ESI
1. Energy consumption (toe/cap)	✓	✓		
2. Energy intensity (toe/US$1,000 GDP)	✓	✓		✓
3. Water consumption (m^3/cap)	✓	✓		
4. Environmental pricing (environmental taxes as % of GDP)	✓			
5. GHG Emissions (tonnes CO_2 equiv/cap)	✓	✓	✓ (CO_2 per capita, per unit of GDP, and absolute)	✓
6. Renewable energy (including hydro)	✓			✓
7. Renewable energy (excluding hydro)	✓			
8. Sulfur oxides (kg/cap)	✓	✓	✓ (per populated land area)	✓ (per populated land area)
9. Nitrogen oxides (kg/cap)	✓	✓	✓ (per populated land area)	✓ (per populated land area)
10. VOCs (nonmethane) (kg/cap)	✓	✓	✓ (per populated land area)	✓ (per populated land area)
11. Carbon monoxide (kg/cap)	✓	✓		
12. Ozone-depleting substances (kg/1,000 people)	✓	✓		
13. Municipal waste (kg/cap)	✓	✓	✓	
14. Recycling of municipal waste (% recycled)	✓	✓ (% paper and glass)		✓ (% paper and glass)
15. Nuclear waste (kg/cap)	✓	✓		
16. PAC expenditures (% of GDP)	✓			
17. Municipal sewage treatment (% population served)	✓	✓		
18. Pesticide use (kg/km^2 arable land)	✓	✓ (per capita)	✓	✓
19. Fertilizer use (tonnes/km^2 arable land)	✓	✓ (per capita)	✓	✓
20. Livestock (sheep equiv/km^2 arable and grassland)	✓	✓ (per capita)		

21. Number of species at risk	✓	✓		
22. Percent of species at risk	✓		✓	✓
23. Protected areas (% of land area)	✓	✓	✓	✓
24. Timber harvest (m^3/km^2 forestland)	✓	✓(per capita)		
25. Timber harvest-forest growth ratio	✓			
26. Per capita capture fisheries (kg/cap)	✓	✓		✓ (harvest to productivity ratio)
27. Fisheries as percent of world catch	✓			
28. Distance traveled (vehicle-km/cap)	✓	✓		✓ (per populated land area)
29. Official Development Assistance (% of GDP)	✓	✓		✓ (index based on contribution to international environmental projects
30. Number of road vehicles (#/cap)	Overlap with distance traveled	✓		
31. Hazardous waste (kg/cap)	Data reliability- current OECD for Canada unavailable	✓	✓ (per unit of GDP)	✓ (tonnes)
32. Population growth	Exogenous variable	✓		✓
33. Urban sulfur dioxide concentration ($\mu g/m^3$)	Data reliability - poor spatial coverage		✓	✓
34. Urban nitrogen dioxide concentration ($\mu g/m^3$)	Data reliability - poor spatial coverage		✓	✓
35. Urban particulate matter ($\mu g/m^3$)	Data reliability - poor spatial coverage		✓	✓
36. Water phosphorus concentration (mg/L of water)	Data reliability - poor spatial coverage		✓	✓
37. Water suspended solids (mg/L of water)	Data reliability - poor spatial coverage		✓	✓
38. Industrial organic pollutants (BOD/km^3 of water)	Data reliability - poor spatial coverage		✓	✓
39. % of country under water stress	Data reliability		✓	✓
40. Internal renewable water per capita	Data reliability		✓	✓
41. Stringency of environmental regulations (survey responses ranking	Data reliability - survey response		✓	✓ (multiple indicators - see below)

from business)				
42. Quality of environmental governance (survey response ranking from business)	Data reliability-survey response		✓	✓ (multiple indicators - see below)
43. % of households using solid fuels	Relevance to OECD countries			✓
44. Threatened ecoregions as % of land	Data reliability			✓
45. Biodiversity (Index)	Data reliability			✓
46. % of land with low anthropogenic effect	Data reliability			✓
47. % of land with high anthropogenic effect	Data reliability			✓
48. Dissolved O_2 concentration in water	Data reliability - poor spatial coverage			✓
49. Electrical connectivity of water	Data- poor spatial coverage			✓
50. Suspended solids in water (mg/L)	Data - poor spatial coverage			✓
51. m^3 of water/cap	Data reliability			✓
52. m^3 of groundwater/cap	Data reliability			✓
53. Coal consumption (TJ/cap)	Overlap- renewable energy and air emissions			✓
54. Change in forest cover	Data reliability			✓
55. % land at risk of acidification	Data reliability			✓
56. Fertility rate	exogenous			✓
57. Ecological footprint/cap	Data reliability			✓
58. % arable land salinized	Relevance to OECD countries			✓
59. % forest area certified for sustainable management	Data reliability			✓
60. Subsidy level (survey response ranking)	Data reliability : survey response			✓
61. Agricultural subsidies	Relevance to environmental performance			✓

62. Death rate from infectious disease	Relevance to environmental performance			✓
63. Child death rate from respiratory disease	Relevance to environmental performance			✓
64. Child death rate	Relevance to environmental performance			✓
65. % of population undernourished	Relevance to environmental performance			✓
66. % of population with access to improved drinking water	Relevance to environmental performance			✓
67. Death rate from floods and storms	Relevance to environmental performance			✓
68. Natural disaster exposure (Index)	Relevance to environmental performance			✓
69. Ratio of gasoline price to world average	Relevance to environmental performance			✓
70. % of variables missing from CGSDI	Environmental governance variable			✓
71. Environmental knowledge creation (scientific publications)	Environmental governance variable			✓
72. IUCN memberships/cap	Environmental governance variable			✓
73. Local agenda initiatives/cap	Environmental governance variable			✓
74. Corruption	Environmental governance variable			✓
75. Rule of law	Environmental governance variable			✓
76. Civil liberties	Environmental governance variable			✓
77. Democracy	Environmental			✓

	governance variable			
78. Dow Jones SGI	Environmental governance variable			✓
79. Ecovalue rating of firms headquartered in country	Environmental governance variable			✓
80. ISO 14001 certified companies/unit of GDP	Environmental governance variable			✓
81. Private sector environmental innovation (business survey response ranking)	Environmental governance variable			✓
82. Participation rate in responsible care program of CMA	Environmental governance variable			✓
83. Innovation index	Environmental governance variable			✓
84. Digital access index	Environmental governance variable			✓
85. Female primary education completion rate	Relevance			✓
86. Gross tertiary enrollment rate	Relevance			✓
87. Researchers/cap	Environmental governance variable			✓
88. Memberships in environmental intergovernmental organizations	Environmental governance variable			✓
89. Participation rate in international environmental agreements	Environmental governance variable			✓
90. Sulfur dioxide exports	Overlap with emissions			✓
91. Imports of polluting goods and raw materials as % of total imports	Data reliability			✓

APPENDIX C:
BACKGROUND DATA FOR OECD COUNTRIES

	POPULATION (2002)	GDP (billions) (2002)	ARABLE LAND (sq. km) (2001)	GRASSLAND (sq. km) (2001)	FORESTLAND (sq. km) (2001)	INDICATORS WITH DATA	
						2002	1992
Canada	31,414,000	873.4	410,760	201,960	4,175,840	29	28
Mexico	101,398,000	815.0	273,000	800,000	646,730	23	18
United States	288,600,000	9,260.0	1,772,590	2,340,000	2,981,350	28	28
Japan	127,435,000	3,169.0	48,300	4,280	251,170	29	28
Korea	47,640,000	718.2	18,760	500	62,970	26	15
Australia	19,663,000	491.4	506,000	1,049,000	1,642,900	27	22
New Zealand	3,939,000	76.6	5,340	138,630	92,550	27	24
Austria	8,139,000	201.1	14,730	19,170	34,330	26	25
Belgium	10,269,000	257.8	8,570	5,350	6,790	27	23
Czech Republic	10,201,000	142.6	33,120	9,660	26,370	28	17
Denmark	5,374,000	141.2	22,880	3,580	5,380	27	26
Finland	5,201,000	125.0	25,870	1,140	230,090	28	26
France	59,482,000	1,416.9	185,470	118,640	170,930	28	27
Germany	82,483,000	1,925.4	120,200	50,130	105,310	28	27
Greece	10,656,000	171.7	38,520	46,500	29,400	28	24
Hungary	10,164,000	121.0	48,040	10,610	17,870	27	19
Iceland	288,000	7.6	1,290	17,710	1,310	26	24
Ireland	3,897,000	117.1	10,790	33,390	6,500	28	22
Italy	58,054,000	1,296.9	96,440	34,180	68,550	27	26
Luxembourg	444,000	19.3	630	650	890	23	21
Netherlands	16,105,000	400.4	10,410	9,020	3,230	28	27
Norway	4,538,000	126.0	8,860	1,610	120,000	27	27
Poland	38,623,000	356.0	144,430	40,810	91,310	29	17
Portugal	10,380,000	168.4	24,730	13,900	33,810	27	26
Slovak Republic	5,379,000,	62.1	15,750	8,650	20,010	27	15
Spain	40,546,000	754.4	179,480	114,500	166,410	28	27
Sweden	8,925,000	220.3	26,970	4,470	302,590	28	27
Switzerland	7,291,000	199.6	4,380	10,860	12,720	28	27
Turkey	69,666,000	420.5	259,860	123,780	207,630	29	25
United Kingdom	60,242,000	1,318.6	57,030	110,080	27,940	28	27

Source: OECD 2005