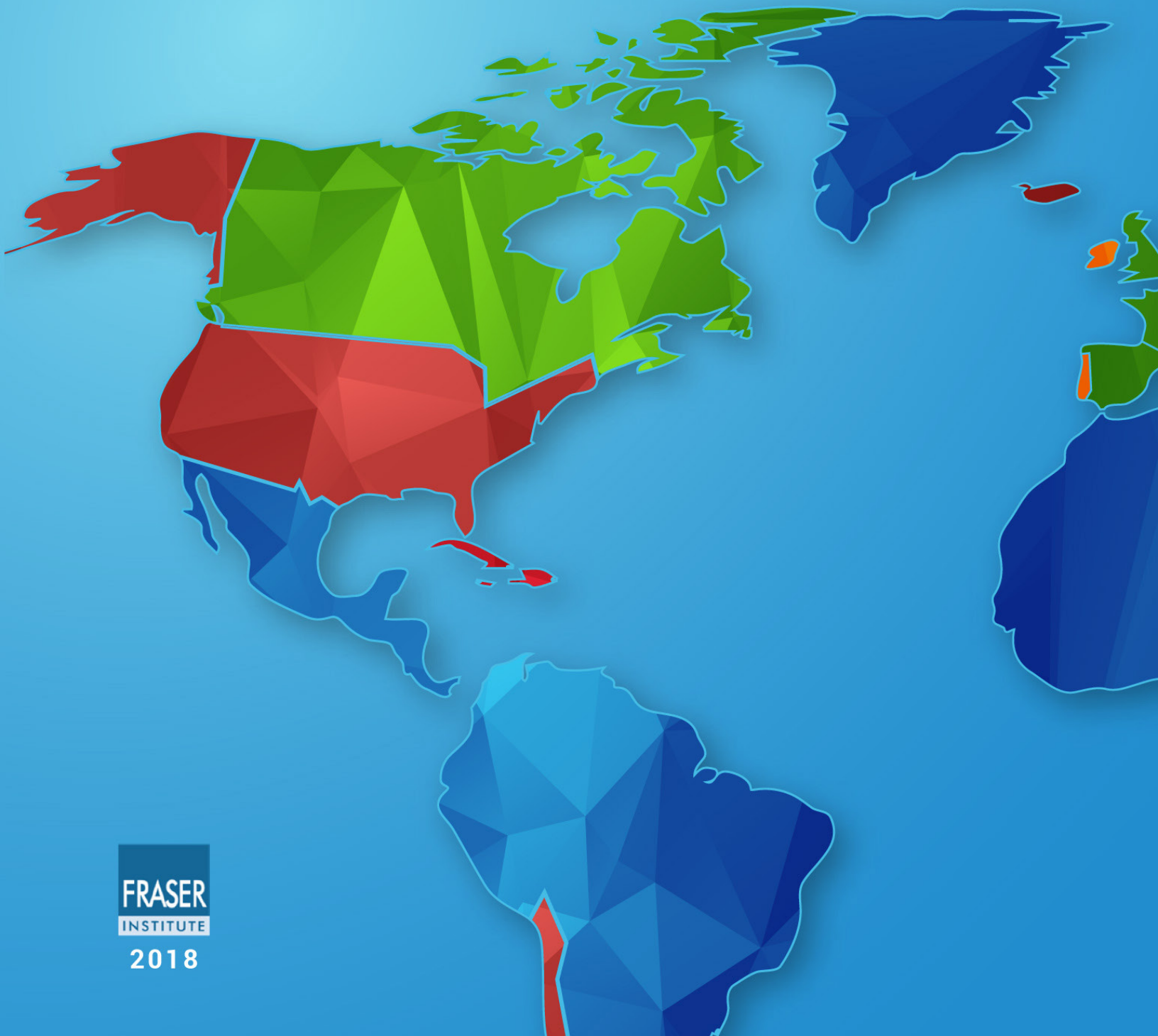
ENVIRONMENTAL RANKING FOR CANADA AND THE OECD

by Ross McKitrick, Elmira Aliakbari, and Ashley Stedman



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Executive Summary

Canadians care about the state of their environment. Over the past few years, several reports have presented Canada as an environmental laggard, ranking it near the bottom of the list of OECD countries. But we regard the methodologies behind these studies as flawed: they unfairly represent Canada's environmental performance in some respects and do not always use the most meaningful and relevant performance measures. We therefore sought to develop an improved and transparent methodology that would allow us to measure and compare environmental performance among OECD countries.

This report presents the Fraser Institute's first edition of *Environmental Ranking for Canada and the OECD*, in which we rank 33 high-income countries across two broad objectives: protecting human health and well-being; and protecting ecosystems. We calculate an overall Index of Environmental Performance, which is a composite measure based on 17 indicators that measure 9 core categories. Under the objective, protecting human health and well-being, we examine air quality, water quality, and greenhouse gases. Under the objective, protecting ecosystems, we consider six core categories: air emissions, water resources, forests, biodiversity, agriculture, and fisheries. In order to construct the index, we assign equal weight to composite indicators of the protection of human health and well-being and to indicators of the protection of ecosystems. The index scores range from zero to 100. A higher index score means a jurisdiction has a stronger environmental performance while a lower index score indicates a weaker environmental performance.

The overall scores range from a low of 34.8 for South Korea to a high of 78.9 for Sweden, with an average of 62.9 across all 33 high-income countries. Canada performs relatively well, obtaining an overall score of 68.5 which places it 10th out of 33 high-income OECD countries. Canada ranks behind Sweden, Norway, New Zealand, France, Finland, Denmark, Switzerland, Spain, and the United Kingdom. In contrast to the studies that used what we consider to be flawed methodologies, our method shows that Canada performs better than the majority of high-income OECD countries on environmental protection.

For air quality (under the objective, protecting human health and well-being), Canada performs well and ranks 9th among the 33 high-income OECD countries, based on the two indicators—average exposure to fine particulate matter and exceedances of fine particulate matter. Iceland is the best performer. For water quality, Canada also performs well and ranks 3rd out 33 countries based on the two indicators that assess the health risks posed by water pollution: access to improved sanitation facilities and access to improved water sources.

For greenhouse gases, Canada ranks 31st for its carbon intensity (CO_2 emissions per unit of GDP) and 24th for its ability to reduce its carbon intensity over a decade. However, it ranks 6th based on low-emitting electricity production, which measures the share of total electricity generated by low emitting sources of energy, that is, renewables and nuclear.

Canada ranks 29th based on its sulphur (SO_X) emissions intensity, which measures SO_X emissions generated per unit of activity, but on this measure nearly all countries have very good scores and there is little difference between Canada and the top-ranked countries. Canada's SO_X emission intensity declined by almost 53% from 2004 levels, which was better than the average reduction across the OECD countries (51.7%).

Canada ranks 23rd for its wastewater treatment rate and 6th for the intensity of use of its water resources. On the latter measure, only Latvia, Norway, Iceland, Luxembourg, and the Slovak Republic perform better than Canada.

Despite preserving its forest cover over a decade, Canada ranks 28th because forest cover has expanded somewhat in many other countries. Chile, with the most significant increase in its forest cover over a decade, is the best performer while Portugal, with the most significant decline in its forest cover, is the poorest.

Canada ranks 10th out of 32 countries for the number of species at risk and 32nd out of 33 countries for the percentage of its terrestrial land designated as protected areas.

Canada has a good record on environmental issues related to agriculture. Canada ranks 3rd on fertilizer use (nitrogen) and 8th on pesticide use. Only Iceland and Australia perform better than Canada and use less fertilizer.

Indicators such as these do not, on their own, imply a need for looser or tighter policies. Even where Canada ranks below the mid-point, recommendations to change environmental policies need to be based on comparisons of costs and benefits. Any particular ranking on any particular scale can be consistent with a country having appropriate environmental standards.

The main implication of this report is that Canada is not an environmental laggard as other reports have claimed. Canadians enjoy high levels of environmental quality in absolute terms and in comparison to our OECD peers. In specific areas where our ranking is low, it is sometimes unavoidable due to our geography or climate, and in other cases it reflects the tight distribution of outcomes among the world's wealthiest nations. In many areas of environmental quality that matter the most to Canadians, we compare favourably to the rest of the OECD and, by implication, the rest of the world.

Introduction

Canada's environmental performance continues to be the subject of much public interest. Several recent reports have presented Canada as an environmental laggard, ranking it near the bottom of the list of OECD countries. A 2016 report by the Conference Board of Canada compared our environmental performance to 15 peer countries, awarding Canada a "D" grade and a ranking of 14th out of 16. A report by the David Suzuki Foundation (DSF) in 2010 concluded that Canada's record was among the worst of developed countries, placing us 24th out of 25 countries. A 2001 study by University of Victoria researcher David Boyd, entitled *Canada vs. the OECD: An Environmental Comparison*, concluded that Canada had a very poor environmental record, ranking 28th out of 29 developed countries.

The Fraser Institute has a long history of data-intensive research on environmental quality in Canada. Its first *Environmental Indicators* report was published in 1997, followed by others such as Brown, Green, Hansen, and Fredricksen (2004), McKitrick (2008), Wood (2013), and McKitrick and Aliakbari (2017). Our familiarity with the subject made us curious about the discrepancy between the dismal results reported above and the public records of air and water quality that show that Canadians generally experience high levels of environmental quality.

Our examination of the reports that have ranked Canada near the bottom of the list of OECD countries led us to conclude that their results are sensitive to faulty assumptions that unfairly penalize Canada's environmental record. For instance, for air quality measures the past reports relied on absolute emissions per capita without accounting for key spatial factors. When comparing air quality among jurisdictions, the key question is not absolute emissions per capita, but the exposure of people and the environment to air pollution. A few large operations in some Canadian provinces may skew the emissions per capita measure upward, but do not translate into actual exposure in urban areas where most people live. Most countries have air quality standards that limit ambient pollution concentrations to what they consider safe levels. Therefore, looking at the extent to which local pollutants exceed agreed-upon air quality standards is critical to making a meaningful comparison of air quality among countries.

Another example from the measurement of waste: the Conference Board's report looked only at a metric of waste generation per capita, without taking into account how it is disposed of. Countries divert different fractions of waste away from landfills or combustors by recycling, composting, or other means, which result in different levels of environmental damage. The way waste is handled, and not necessarily

how much is generated, is a better indicator of environmental harm. Again, for the measurement of greenhouse gases, previous reports compared countries based on energy consumption per capita. This greatly distorts the picture because Canada is a large country with a sparse population and a wide range of temperatures to deal with. Our long transport distances and cold climate mean that, even if we became very energy efficient, we would still appear to have higher per-capita energy consumption, especially in comparison to the many small, milder countries in the European Union (EU). A better measure would be to look at carbon emissions per unit of economic activity (Gross Domestic Product or GDP) as well as comparing countries' abilities to reduce the intensity of carbon emissions per unit of GDP over a period of time, relative to each other. In addition, since the power sector is usually the largest contributor to CO_2 emissions in most countries, comparing national reliance on low-emitting sources is a better measure of how countries are reducing the intensity of greenhouse gas emissions.

In addition, in some cases, the previous reports ranked countries according to per-capita measures where such measures were environmentally meaningless (Holden and Sklenar, 2007). For instance, Boyd (2001) ranked Canada 25th (out of 29) in use of fertilizer based on annual per-capita consumption. However, that penalizes countries with relatively large agricultural sectors regardless of their actual environmental performance. If efficiency were measured based on fertilizer use per hectare, Canada would have ranked near the top (Holden and Sklenar, 2007). Boyd's report ranked Canada 22nd based on its annual pesticide use per capita whereas we would have ranked 4th based on pesticide use per hectare.

These flaws undermine the credibility of their findings and policy conclusions. For instance, the Suzuki report blamed Canada's allegedly poor environmental performance on our energy prices and environmental governance, leading them to call for regulatory changes to make energy substantially more expensive. Yet, to the extent their conclusions were actually driven by Canada's climate and geography, not our actual environmental progress, such measures would be unwarranted and would merely make us worse off without yielding commensurate environmental benefits.

Thus, we were not confident that the previous studies yielded methodologically sound rankings, and we set out to undertake a more reliable and transparent cross-country comparison using a broad set of indicators. We studied the methods behind the Environmental Performance Index (EPI) developed by researchers at Yale and Columbia Universities in 2016 and adapted it for our project. [1] The result is the first edition of *Comparing Environmental Performance of OECD Countries*, in which

[1] The 2016 EPI study (Hsu, et al., 2016) ranked Canada 25th out of 180 developed, developing, and least developing countries.

we examine the performance of 33 high-income countries [2] across 17 indicators grouped into 9 core categories. The data were equally weighted between measures related to human health and well-being and measures related to ecosystem protection. By comparing Canada's performance to other high-income countries we are able to determine how Canada is performing relative to its international counterparts and to identify areas of weakness and strength.

Overall, we find that Canada performs relatively well on a comprehensive index of environmental performance, ranking 10th out of 33 high-income OECD countries. In contrast to the reports that use a flawed methodology, our method shows that Canada performs better than the majority of high-income OECD countries on environmental protection. This conclusion holds up under alternative assumptions about how to weight the various measures.

It is important to keep in mind that the countries in the top half of the OECD group all achieve high levels of environmental protection, and there are often only small differences among them. Indexes like the ones we have discussed force countries to spread out in the relative rankings, even when there is little absolute difference between scores that place five or ten steps apart in the ranking.

The first section of this study summarizes the results for all 33 countries on the overall Index of Environmental Performance as well as Canada's ranking by indicator. The second section describes our methods, and explains what is being measured and how. This is followed by a detailed discussion and presentation of the results for the seven indicators of human health and well-being (section 3) and the ten indicators of the protection of ecosystems (section 4) that make up the composite index. The last section presents conclusions. The Appendix presents a recalculation using a different approach in which all the indicators are given equal weighting, to check if our main conclusion is dependent on the particular weighting scheme that was applied to the results.

[2] Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Latvia, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, South Korea, Spain, Sweden, Switzerland, United Kingdom, United States.

1 Index of Environmental Performance

The Index of Environmental Performance presented in this paper assesses the environmental performance of 33 high-income OECD countries across two broad objectives: protecting human health and well-being; and protecting ecosystems. The index is calculated using 17 indicators that measure 9 core categories grouped as below (see table 1 for a list of all indicators).

Protecting human health and well-being (7 indicators)

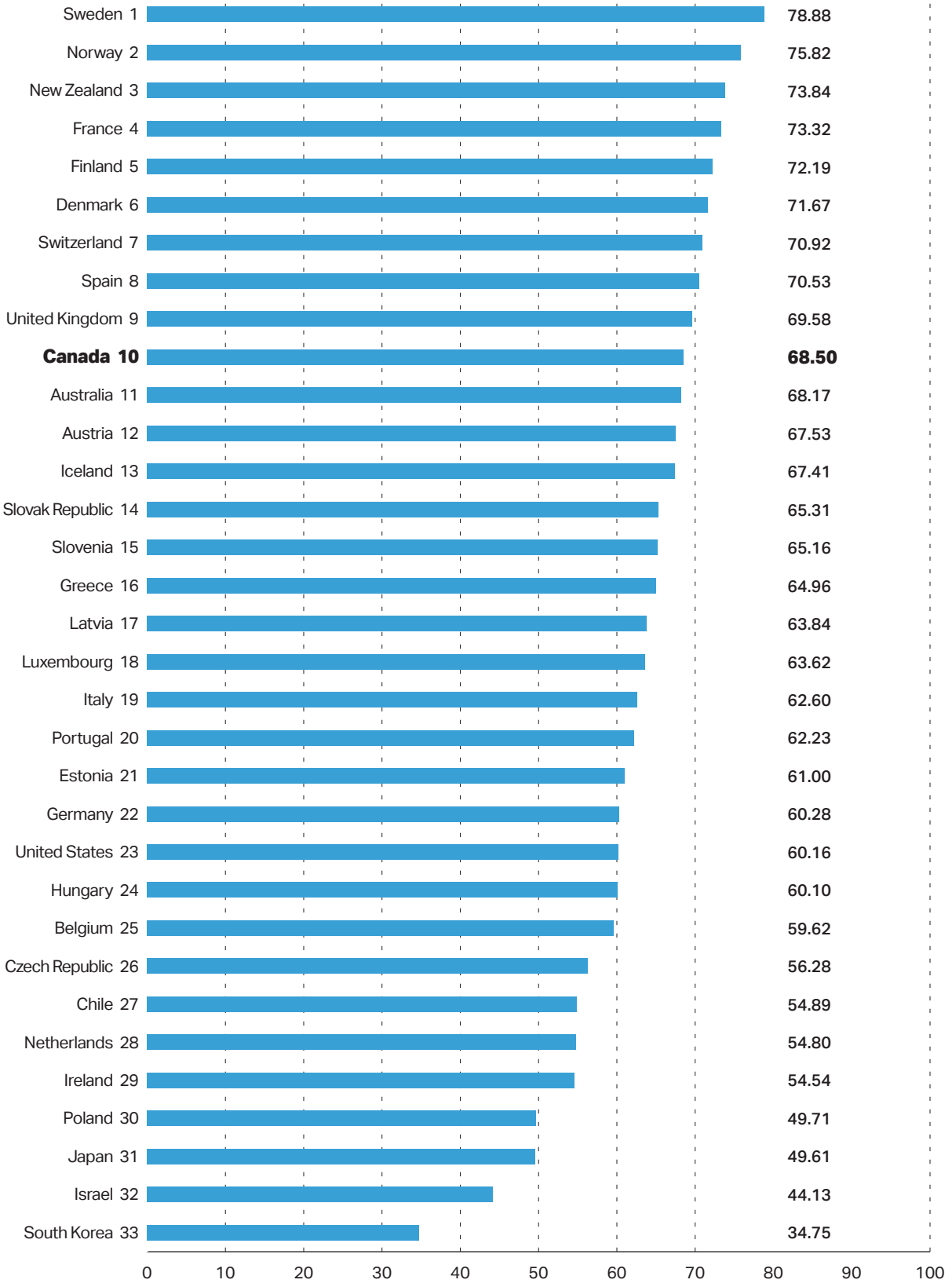
1. Air quality (2 indicators)
2. Water quality (2 indicators)
3. Greenhouse gases (3 indicators)

Protecting ecosystems (10 indicators)

1. Air emissions (2 indicators)
2. Water resources (2 indicators)
3. Forests (1 indicator)
4. Biodiversity (2 indicator)
5. Agriculture (2 indicators)
6. Fisheries (1 indicator)

For each indicator within each core category, the countries' environmental performances are ranked based on a scoring system, with values ranging from zero to 100. The highest possible score is 100, signaling strong environmental performance; the lowest possible score is zero, signaling poor environmental performance. The scores for all 17 indicators are then averaged to obtain the composite index. When aggregating the scores, we assign 50% weight to indicators of the protection of human health and well-being and 50% weight to indicators of the protection of ecosystems (Section 2 provides more details on the methods used). Finally, the jurisdictions are ranked based on their composite index (**figure 1**). Scores range from a low of 34.8 for South Korea to a high of 78.9 for Sweden. The average score is 62.9. Overall, Canada performs relatively well, obtaining a score of 68.5, which is 10th out of our sample

Figure 1: Index of Environmental Performance in Canada and the OECD



of 33 high-income OECD countries. Canada falls behind Sweden, Norway, New Zealand, France, Finland, Denmark, Switzerland, Spain, and the United Kingdom. The index suggests that Canada does a better job of environmental protection than the majority of high-income OECD countries. [3]

Table 1 presents the summary of Canada's OECD ranking and score by indicator. As shown, Canada ranks 9th out of 33 countries based on the two air quality indicators: average exposure to fine particulate matter and fine particulate matter exceedance. It ranks 3rd out of 32 countries based on the two water quality indicators that assess the health risks posed by water pollution: access to improved sanitation facilities and access to improved water sources. Canada ranks 10th out of 32 countries for the number of species at risk, 3rd on fertilizer use (nitrogen), and 8th on pesticide use.

In the areas where Canada appears to do worse than average, there are some caveats worth noting. Canada ranks 31st for carbon intensity (CO_2 emissions per unit of GDP) and 24th for its ability to reduce its carbon intensity over a decade. This reflects in part Canada's emergence as a major oil producer, but it is also heavily influenced by our geography and weather, which are outside our control. If we adjust CO_2 intensity to compensate for land size, Canada rises to 2nd out of 33. [4]

Canada ranks 29th based on its SO_X emissions intensity, which measures SO_X emissions generated per unit of activity. But on this measure most countries are clustered very tightly: the first 26 all have scores above 90 and Canada's is not far behind at 84.5. Also, Canada performs better in terms of its ability to reduce SO_X emissions intensity over a 10-year period, ranking 17th out of 33 countries, and ranks 6th overall for non-emitting electricity production.

For percentage change in forest cover, Canada ranks 28th and receives a relatively low score of 32.6. But, as our analysis shows, the absolute change in Canadian forest cover was nearly zero over the past decade: our ranking in this category in part reflects the fact that many OECD countries have increased their forest cover over the past decade and some were starting with relatively small forest stocks.

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[3] The Appendix shows the results of recomputing the Index of Environmental Performance by simply averaging the scores of all 17 indicators, giving each one equal weighting. Using this method, Canada ranks 13th out of 33, though the indicators in the 10th to 13th spots are tightly clustered between 68.2 and 69.2, so the change in ranking is not overly meaningful. We prefer the approach taken herein since the equal-weighting scheme makes the index depend too heavily on the availability of indicators rather than on the importance of the category. Nonetheless, this result indicates that our main conclusion, that Canada is performing better than the majority of high-income OECD countries, is not overly dependent on our chosen weighting scheme.

[4] We adjusted for land size by computing CO_2 intensity of GDP per hectare, obtaining land size data from the Central Intelligence Agency (2017) and World Bank (2014a).

Table 1. Summary of Canada's OECD ranking and score by indicator

Indicator	Score	Rank
Air Quality		
Average exposure to $PM_{2.5}$ (µg/M3)	83.5	9th out of 33
Average $PM_{2.5}$ exceedance (%)	79.0	9th out of 33
Water Quality		
Access to improved sanitation facilities (%)	98.4	3rd out of 32
Access to improved drinking water sources (%)	91.7	3rd out of 33
Greenhouse Gases		
Carbon intensity (Kg/PPP $GDP)	41.9	31st out of 33
Change in Carbon intensity (%)	42.5	24th out of 33
Low-emitting electricity production (%)	76.1	6th out of 33
Air Emissions		
SO_X emissions intensities (metric tons/PPP million $ GDP)	84.5	29th out of 33
Change in SO_X emissions intensities (%)	82.4	17th out of 32
Water resources		
Wastewater treatment rate (%)	39.7	23rd out of 33
Intensity of use of water (%)	99.1	6th out of 33
Forest		
Change in forest cover (%)	32.6	28th out of 33
Biodiversity		
Species at risk (%)	70.5	10th out of 32
Terrestrial protected areas (%)	3.9	32nd out of 33
Agriculture		
Nitrogen use balance (kg/ha)	94.0	3rd out of 31
Pesticide use (kg/ha)	94.6	8th out of 32
Fisheries		
Change in Marine Trophic Index (%)	45.6	16th out of 26

Policy implications

Indicators such as these do not, on their own, imply a need for looser or tighter policies. It is a mistake to argue that just because Canada is not at the top of every list we ought to adopt stricter policies: obviously it is impossible for every country to be in first place, and it is unrealistic to suppose any one country could be top-ranked in everything. Even where Canada ranks below the mid-point, recommendations to change environmental policies need to be based on comparisons of costs and benefits. Any particular ranking on any particular scale can be consistent with a country having appropriate environmental standards.

The main implication of this report is that Canada is not the environmental laggard as some have claimed in the past. Canadians enjoy high levels of environmental quality in absolute terms and in comparison to our OECD peers. Where our ranking is low it is sometimes unavoidable due to our geography or climate, and in other cases it reflects the tight distribution of outcomes among the world's wealthiest nations. In many areas of environmental quality that matter the most to Canadians, we compare favourably to the rest of the OECD and, by implication, the rest of the world.

2 Methods

The purpose of this report is to assess the environmental performance of 33 high-income countries in relation to two broad objectives: protection of human health and well-being, and protection of ecosystems. All of the countries included for comparison are members of the Organisation for Economic Co-operation and Development (OECD) and have been classified as "high-income" by the World Bank. [5]

Selecting data

Objectives, core categories, and indicators

The objectives and core categories we identified closely follow the framework presented in the Environmental Performance Index (EPI) study conducted by researchers at Yale and Columbia Universities in 2016 (Hsu, et al., 2016). Within the two top-level objectives we identify a series of core categories, each of which is made up of one, two, or three indicators, for a total of 17 indicators. While no selection of indicators can ever be comprehensive, our selection provides broad information on the overall environmental performance of each high-income OECD country. In the category of protection of human health and well-being, we look at air quality, water quality, and greenhouse gases. In the category of protection of ecosystems, we consider air emissions, water resources, forests, biodiversity, agriculture, and fisheries.

Time frame

For measures of current performance, we chose the most recent year that provided the most complete data. In some cases, more recent data was available for some countries, but we selected the year and interval that allowed complete coverage on a consistent time basis. In a case where the data were sparse and countries had inconsistent time series, we used decadal averages to compare across countries.

All the data used in this study are publicly available and in most cases were collected by international statistical agencies. The majority were supplied by the OECD, with the remainder from the World Bank, the United Nations Food and Agriculture Organization (FAO), and the Yale Center for Environmental Law and Policy.

[5] There are 35 countries in the OECD. Mexico and Turkey were not included in this index, as they are not classified as "high income" by the World Bank. High-income countries are defined as having had a gross national income (GNI) per capita of US$12,475 or more in 2015 (World Bank, 2017).

Calculating and comparing performance

We examined countries' relative environmental performance as follows. First, raw data on each individual indicator were collected. Second, the raw data were standardized by subtracting the average of the sample from each country's score and then dividing that score by the standard deviation of the sample. Next, the standardized raw values were converted to a 100-point scale using one of two complementary formulas.

Where higher values were indicative of better environmental performance, we used the following formula to derive the zero-to-100 scores:

$$\frac{(\text{indicator value} - \text{minimum value in the sample})}{(\text{maximum value} - \text{minimum value in the sample})} \times 100$$

By this means the best-performing country receives a score of 100 and the worst-performing country receives a score of zero.

Conversely, where higher values were indicative of worse environmental performance, we used the following formula:

$$\frac{(\text{maximum value in the sample} - \text{indicator value})}{(\text{maximum value in the sample} - \text{minimum value})} \times 100$$

By this means a jurisdiction with stronger environmental performance always receives a higher score whereas a jurisdiction with weaker performance always receives a lower score.

After calculating country scores on each individual indicator, we aggregated them to generate a composite environmental index for each country. Following the model of the 2016 EPI study (Hsu, et al., 2016), we assigned each of the two broad objectives—protection of human health and well-being and protection of ecosystems—equal weight in aggregation. The top-level weight was then divided equally between the core categories within that objective. Indicators were weighted according to the number within a category. The jurisdictions were then ranked according to their final score (composite environmental index). If data for a jurisdiction on a particular indicator were missing, we averaged around the remaining indicators. **Table 2** lists all of the indicators used in this study, along with their associated core categories and objectives, and the corresponding weights of each.

Table 2. Objectives, core categories, and indicators used in this study, with associated weights

Objectives	Core categories	Indicators
Protection of human health and well-being (50%)	1. Air Quality (16.67%)	Average exposure to $PM_{2.5}$ ($\mu g/M^3$)
		Average $PM_{2.5}$ exceedance (%)
	2. Water Quality (16.67%)	Access to improved sanitation facilities (%)
		Access to improved drinking water sources (%)
	3. Greenhouse Gases (16.67%)	Carbon intensity (Kg/PPP $GDP)
		Change in Carbon intensity (%)
		Low-emitting electricity production (%)
Protection of ecosystems (50%)	1. Air Emissions (8.33%)	SO_X emissions intensities (metric tons/PPP million $ GDP)
		Change in SO_X emissions intensities (%)
	2. Water Resources (8.33%)	Wastewater treatment rate (%)
		Intensity of use of water (%)
	3. Forest (8.33%)	Change in forest cover (%)
	4. Biodiversity (8.33%)	Threatened species (%)
		Terrestrial protected areas (%)
	5. Agriculture (8.33%)	Nitrogen use balance (kg/ha)
		Pesticide use (kg/ha)
	6. Fisheries (8.33%)	Change in Marine Trophic Index (%)

3 Indicators of Human Health and Well-Being

1 Air Quality

Air quality is one of the most important environmental indicators, as it directly affects human health and thereby has substantial economic and social consequences. High pollution levels, especially suspended matter 2.5 micrometers or less in diameter ($PM_{2.5}$) has been linked to lung impairment and elevated risk of cardiac disease (WHO, 2006). Fine particulate matter is usually the product of combustion through both human activities and natural sources such as volcanoes and forest fires (Hsu, et al., 2016). In order to capture health risks posed by air emissions, we have included two key indicators: average exposure to $PM_{2.5}$ and $PM_{2.5}$ exceedance.

Average exposure to $PM_{2.5}$

Average exposure to $PM_{2.5}$ measures the annual mean exposure level of an average resident to outdoor $PM_{2.5}$, expressed as population-weighted $PM_{2.5}$ levels in micrograms per cubic meter ($\mu g/m^3$). **Table 3** presents this measure for all 33 countries in 2015, as well as their ranks and corresponding scores. As shown, with an average exposure of 7.7 $\mu g/m^3$, Canada ranks 9th among the 33 high-income OECD countries and receives a score of 83.5. Iceland has the lowest mean exposure to $PM_{2.5}$ among the countries (average exposure of 2.9 $\mu g/m^3$) and receives a score of 100. Norway (average exposure of 4.4 $\mu g/m^3$) and New Zealand (average exposure of 5 $\mu g/m^3$) are the second and third best performers. Australia, Finland, Ireland, Estonia, and Sweden also ranked above Canada. However, Canada's $PM_{2.5}$ average exposure is far below the average of high-income OECD countries, which is 13.5 $\mu g/m^3$. The US ranks 14th with an average exposure of 10.9 $\mu g/m^3$ and receives a score of 72.6. The five poorest performers are South Korea (ranked 33rd with 32 $\mu g/m^3$ average exposure), Poland (32nd, 23.4 $\mu g/m^3$), Slovak Republic (31th, 22.5 $\mu g/m^3$), Israel (30th, 22.5 $\mu g/m^3$) and Hungary (29th, 22.4 $\mu g/m^3$).

Average $PM_{2.5}$ exceedance

$PM_{2.5}$ exceedance is a different indicator that measures the percentage of the population not exposed to $PM_{2.5}$ levels exceeding 10 micrograms per cubic meter ($\mu g/m^3$), which is a long-term guideline set by the World Health Organization based on evidence that ties health risks to exposure above this threshold. **Table 4** displays the $PM_{2.5}$ exceedance in 2015 for the 33 OECD countries, as well as their associated

Table 3: Average exposure to $PM_{2.5}$ (μg/m³), Canada and the OECD, 2015

Rank	Country	Data (μg/m³)	Score	Rank	Country	Data (μg/m³)	Score
1	Iceland	2.91	100.00	18	France	12.65	66.52
2	Norway	4.36	95.03	19	Germany	14.26	61.01
3	New Zealand	4.98	92.89	20	Belgium	14.90	58.79
4	Australia	5.24	92.00	21	Netherlands	15.14	57.98
5	Finland	6.02	89.30	22	Japan	15.47	56.83
6	Ireland	6.65	87.14	23	Austria	15.70	56.06
7	Estonia	6.94	86.16	24	Slovenia	17.11	51.19
8	Sweden	6.98	86.02	25	Chile	17.21	50.85
9	**Canada**	**7.71**	**83.51**	26	Greece	17.68	49.24
10	Latvia	9.99	75.66	27	Italy	19.99	41.30
11	Denmark	10.62	73.49	28	Czech Republic	20.25	40.40
12	Portugal	10.63	73.46	29	Hungary	22.44	32.87
13	United Kingdom	10.68	73.29	30	Israel	22.47	32.77
14	United States	10.87	72.63	31	Slovak Republic	22.54	32.55
15	Luxembourg	11.92	69.04	32	Poland	23.45	29.42
16	Spain	12.29	67.76	33	South Korea	32.01	0.00
17	Switzerland	12.51	67.01				

Source: OECD, 2015b.

scores and ranks. As shown, with 79% of the population not exposed to $PM_{2.5}$ levels greater than 10 μg/m³, Canada receives a score of 79 and ranks 9th out of 33 countries. Canada performs better than the majority of the OECD countries, including Denmark, Germany, Austria, Netherlands, Japan, United States, and the United Kingdon, and has an exceedance score far above the average of the 33 countries, which is 35.6%. The United States ranks 12th and receives a score of 41.3.

Iceland is the best performer, as 100% of its population was not exposed to $PM_{2.5}$ levels greater than 10 μg/m³ in 2015. Other top-performing countries are Norway (99.7 %), Finland (99.6%), Estonia (98.9%), Australia (97.8%), and Ireland (97.2%). Slovenia, Czech Republic, and Slovak Republic are the worst performers and together hold the last rank. In 2015, all of the population of these countries was exposed to $PM_{2.5}$ levels exceeding the WHO standard.

Table 4: Percentage of population not exposed to $PM_{2.5}$ above 10 µg/m^3, Canada and the OECD, 2015

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	Iceland	100.00	100.00	18	Austria	13.47	13.47
2	Norway	99.73	99.73	19	Switzerland	12.92	12.92
3	Finland	99.62	99.62	20	Italy	2.79	2.79
4	Estonia	98.90	98.90	21	Japan	1.94	1.94
5	Australia	97.78	97.78	22	Luxembourg	0.65	0.65
6	Ireland	97.17	97.17	23	Germany	0.57	0.57
7	New Zealand	94.20	94.20	24	Israel	0.55	0.54
8	Sweden	89.57	89.57	25	Netherlands	0.25	0.25
9	**Canada**	**78.96**	**78.96**	26	South Korea	0.19	0.19
10	Latvia	49.82	49.82	27	Greece	0.17	0.17
11	Portugal	46.73	46.73	28	Belgium	0.05	0.05
12	United States	41.28	41.28	29	Hungary	0.02	0.02
13	Denmark	35.54	35.54	30	Poland	0.01	0.01
14	United Kingdom	34.38	34.38	31	Slovak Republic	0.00	0.00
15	Chile	32.58	32.58	31	Czech Republic	0.00	0.00
16	Spain	25.71	25.71	31	Slovenia	0.00	0.00
17	France	19.27	19.27				

Source: OECD, 2015b.

2 Water Quality

Human health depends on adequate sanitation and clean water. Diarrhea, which is a major cause of death among children, is caused chiefly by a combination of unsafe drinking water, improper hygiene, and inadequate sanitation (WHO, 2006). Access to proper sanitation reduces a population's contact with dangerous bacteria and viruses and lowers environmental threats associated with waste management (Hsu, et al., 2016). Similarly, access to safe and reliable sources of drinking water lowers exposure to harmful contaminants, pollution, and disease, and thereby fosters human health. For these reasons, two key indicators are used to assess the health risks posed by water pollution: access to improved sanitation facilities and access to improved water sources.

Access to improved sanitation facilities

Access to improved sanitation facilities seeks to measure the percentage of the population using improved sanitation facilities, in other words, systems for safe disposal of human waste. Improved sanitation sources include ventilated improved pit (VIP)

latrines, flush or pour-flush systems (to piped sewer, septic tank, pit latrine), composting toilets, and pit latrines with slab (World Bank, 2015a). Table 5 shows the percentage of the population with access to improved sanitation facilities in 2015. As there are no data available for New Zealand, the table presents the remaining 32 countries, with relative scores and ranks.

Table 5: Percentage of the population with access to improved sanitation facilities, Canada and the OECD, 2015

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	Australia	100.0	100.00	9	Chile	99.1	92.62
1	Austria	100.0	100.00	9	Czech Republic	99.1	92.62
1	Japan	100.0	100.00	9	Slovenia	99.1	92.62
1	South Korea	100.0	100.00	10	Greece	99.0	91.80
1	United States	100.0	100.00	11	Iceland	98.8	90.16
1	Israel	100.0	100.00	11	Slovak Republic	98.8	90.16
2	Switzerland	99.9	99.18	12	France	98.7	89.34
2	Spain	99.9	99.18	13	Norway	98.1	84.43
3	**Canada**	**99.8**	**98.36**	14	Hungary	98.0	83.61
4	Portugal	99.7	97.54	15	Netherlands	97.7	81.15
5	Denmark	99.6	96.72	16	Luxembourg	97.6	80.33
6	Belgium	99.5	95.90	16	Finland	97.6	80.33
6	Italy	99.5	95.90	17	Estonia	97.2	77.05
7	Sweden	99.3	94.26	17	Poland	97.2	77.05
8	United Kingdom	99.2	93.44	18	Ireland	90.5	22.13
8	Germany	99.2	93.44	19	Latvia	87.8	0.00

Source: World Bank, 2015a.

As 99.8% of population has access to improved sanitation facilities, Canada ranks 3rd and receives a score of 98.4. Australia, Austria, Japan, South Korea, United States, and Israel together hold the first rank as 100% of their population has access to improved sanitation facilities. Switzerland and Spain together hold the second rank and receive a score of 99.2. All other countries fall behind Canada, including Denmark, Sweden, Germany, Norway, and the United Kingdom. Canada's share of population with access to improved sanitation facilities is still higher than the average of the 32 high-income countries, which is 98.4%. Latvia is the worst performer and receives a score of zero.

Access to improved sources of drinking water

Access to improved sources of drinking water measures the percentage of the population using an improved drinking water source, in other words water subject to treatment to remove pathogens and impurities that threaten human health. Improved drinking water sources include piped water on premises (piped household water connection located inside the user's dwelling, yard or plot), public taps, standpipes, tube wells, protected dug wells, rainwater collection and protected springs (World Bank, 2012). Table 6 presents data on access to improved water sources in 2012 for all 33 countries, along with their associated ranks and scores. With 99.8% of the population having access to improved drinking water source, Canada ranks 3rd and receives a score of 91.7. Twenty-three countries, including Australia, Austria, Denmark, Finland, and the United Kingdom, share the first rank as 100% of their populations have access to improved drinking water sources. South Korea, Ireland, Poland, Chile, and the United States are the worst performers based on this indicator.

Table 6: Percentage of the population with access to improved water sources, Canada and the OECD, 2012

Rank	Country	Data (%)	Score
1	Australia	100	100.00
1	Austria	100	100.00
1	Belgium	100	100.00
1	Czech Republic	100	100.00
1	Denmark	100	100.00
1	Finland	100	100.00
1	France	100	100.00
1	Germany	100	100.00
1	Greece	100	100.00
1	Hungary	100	100.00
1	Iceland	100	100.00
1	Israel	100	100.00
1	Italy	100	100.00
1	Japan	100	100.00
1	Luxembourg	100	100.00
1	Netherlands	100	100.00
1	New Zealand	100	100.00
1	Norway	100	100.00
1	Slovak Republic	100	100.00
1	Spain	100	100.00
1	Sweden	100	100.00
1	Switzerland	100	100.00
1	United Kingdom	100	100.00
2	Portugal	99.9	95.83
3	**Canada**	**99.8**	**91.67**
4	Estonia	99.5	79.17
4	Slovenia	99.5	79.17
5	Latvia	99.1	62.50
5	United States	99.1	62.50
6	Chile	98.7	45.83
7	Poland	98	16.67
8	Ireland	97.7	4.17
9	South Korea	97.6	0.00

Source: World Bank, 2012.

3 Greenhouse Gases

Climate change is arguably the most complex environmental challenge of our time. Depending on its magnitude, climate change may have negative impacts on agriculture, forestry, ecosystems, and the frequency and scale of extreme weather (OECD, 2015a). In this section, we take as given that most countries say they want to reduce emissions of greenhouse gases, even though in practice little progress has been made toward reaching a consensus on this issue's scope, origins, and solutions (Hsu, et al., 2016). The focus of emission-reduction efforts is carbon dioxide (CO_2). which is not covered by conventional air pollution regulatory measures and cannot be controlled by ordinary end-of-pipe emission-abatement technologies, making large-scale abatement relatively costly. The greenhouse gases category is presented by three indicators: carbon intensity, change in carbon intensity, and low-emitting electricity production.

Carbon intensity

Carbon intensity measures CO_2 emissions per unit of GDP, expressed in kilograms per 2011 Purchasing Power Parity dollar of GDP (kg/PPP$ GDP). **Table 7** presents carbon intensity data in 2014 for all 33 countries as well as the associated rankings and scores.

Table 7: Carbon intensity (kg/PPP $ of GDP), Canada and the OECD, 2014

Rank	Country	Data (kg/PPP $ of GDP)	Score
1	Switzerland	0.0761	100.00
2	Sweden	0.1014	94.67
3	France	0.1218	90.36
4	Denmark	0.1317	88.29
5	Iceland	0.1463	85.21
6	Norway	0.1465	85.17
7	Ireland	0.1509	84.23
8	Italy	0.1553	83.32
9	Austria	0.1558	83.21
10	Latvia	0.1571	82.93
11	Spain	0.1614	82.03
12	Portugal	0.1664	80.96
13	United Kingdom	0.1711	79.99
14	Hungary	0.1776	78.61
15	Luxembourg	0.1850	77.05
16	Belgium	0.2014	73.60
17	Germany	0.2047	72.90
18	Slovak Republic	0.2079	72.24
19	Chile	0.2109	71.60
20	Netherlands	0.2172	70.27
21	Slovenia	0.2183	70.03
22	Finland	0.2220	69.27
23	New Zealand	0.2230	69.05
24	Israel	0.2472	63.96
25	Japan	0.2556	62.19
26	Greece	0.2576	61.76
27	Poland	0.3088	50.99
28	Czech Republic	0.3148	49.72
29	United States	0.3182	48.99
30	South Korea	0.3462	43.11
31	**Canada**	**0.3519**	**41.90**
32	Australia	0.3548	41.28
33	Estonia	0.5508	0.00

Source: World Bank, 2005–2014a.

With 0.35 kg CO_2 of emissions per unit of GDP, Canada ranks 31st and receives a score of 41.9. The only countries with higher carbon intensity than Canada are Australia and Estonia. The top five countries with lowest carbon intensity are Switzerland (ranks 1st witha carbon intensity of 0.08), Sweden (2nd, 0.1 kg/PPP$ GDP), France (3rd, 0.12 kg/PPP$ GDP), Denmark (4th, 0.13 kg/PPP$ GDP) and Iceland (5th, 0.15kg/PPP$ GDP).

Change in carbon intensity

Change in carbon intensity measures the ability of countries to reduce their carbon emissions (CO_2 emissions) per unit of GDP over a decade relative to each other. Table 8 presents the change in carbon intensity over the 10-year period of 2005 to 2014 as compared to 2004 levels for all 33 countries, as well as the corresponding scores and ranks. With a reduction in carbon intensity of 17.4% over a decade, Canada ranks 24th out of 33 countries and receives a score of 42.49. This is noteworthy since it coincides with a decade in which the oil-sands sector expanded rapidly. Finland, Greece, Netherlands, New Zealand, South Korea, Chile, Japan, Norway, and Estonia all perform worse than Canada. Chile and Norway are the only countries with increased carbon intensity over the 10-year period.

Table 8: Change (%) in carbon intensity, Canada and the OECD, 2005–2014

Rank	Country	Data (% change)	Score	Rank	Country	Data (% change)	Score
1	Slovak Republic	−43.19	100.00	18	Belgium	−22.46	53.70
2	Spain	−34.43	80.42	19	Israel	−20.80	50.00
3	Luxembourg	−33.95	79.37	20	Germany	−20.14	48.52
4	Poland	−33.03	77.31	21	Australia	−19.70	47.53
5	Denmark	−32.47	76.07	22	United States	−19.17	46.36
6	Czech Republic	−31.13	73.07	23	Latvia	−18.01	43.77
7	Hungary	−31.12	73.04	**24**	**Canada**	**−17.44**	**42.49**
8	United Kingdom	−29.68	69.82	25	Finland	−16.65	40.71
9	Ireland	−29.46	69.33	26	Greece	−15.20	37.49
10	Austria	−28.92	68.13	27	Netherlands	−15.01	37.07
11	Portugal	−28.78	67.82	28	New Zealand	−13.42	33.50
12	Italy	−28.50	67.18	29	South Korea	−8.06	21.54
13	Switzerland	−28.36	66.87	30	Chile	−6.31	17.64
14	France	−27.06	63.97	31	Japan	−6.04	17.02
15	Sweden	−26.80	63.39	32	Norway	0.36	2.73
16	Slovenia	−25.80	61.16	33	Estonia	1.58	0.00
17	Iceland	−22.57	53.95				

Source: World Bank, 2005–2014b.

One important shortcoming of these two indicators should be noted: as carbon emissions and economic growth or decline are closely linked, the observed low carbon intensity or mitigation trends over a decade for most countries could be due to overall economic decline and not necessarily to policy actions or market forces meant to lower carbon emissions. Therefore, the third indicator under this category may provide a clearer image of how countries are truly performing in their efforts at decarbonization.

Low-emitting electricity production

Low-emitting electricity production measures the share of total electricity generated by low emitting sources of energy—that is, renewables as well as nuclear (Echávarri, 2006). Renewable sources include hydroelectric, solar, wind, tide, geothermal, and biomass. **Table 9** shows low-emitting electricity production data for all 33 countries in 2011. Canada, with 76.2 % of its electricity generated by share of renewable and nuclear sources, ranks 6th, behind Iceland, Norway, Switzerland, France, and Sweden. Canada's performance is much better than the OECD average, where the share of renewables and nuclear was only 44.1% in 2011. Iceland is the best performer, with almost all of its electricity in 2011 generated by low-emitting sources; Israel is the poorest, as almost none of its electricity is generated by low-emitting sources.

Table 9: Low-emitting electricity production (%), Canada and the OECD, 2011

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	Iceland	99.99	100.00	18	Luxembourg	32.81	32.56
2	Norway	96.24	96.24	19	Germany	32.62	32.37
3	Switzerland	94.51	94.50	20	Chile	32.49	32.23
4	France	90.28	90.25	21	South Korea	31.40	31.14
5	Sweden	88.52	88.49	22	United States	30.14	29.87
6	**Canada**	**76.18**	**76.10**	23	Denmark	27.84	27.56
7	New Zealand	74.63	74.55	24	United Kingdom	25.44	25.15
8	Slovak Republic	69.65	69.54	25	Italy	24.15	23.86
9	Slovenia	62.18	62.05	26	Japan	19.02	18.71
10	Austria	60.62	60.47	27	Ireland	18.52	18.21
11	Belgium	58.88	58.73	28	Greece	13.80	13.47
12	Finland	49.15	48.96	29	Australia	9.62	9.27
13	Spain	48.65	48.46	30	Netherlands	8.25	7.90
14	Latvia	48.54	48.35	31	Poland	3.65	3.28
15	Hungary	45.90	45.70	32	Estonia	3.09	2.72
16	Portugal	41.49	41.27	33	Israel	0.38	0.00
17	Czech Republic	38.29	38.06				

Source: International Energy Agency, 2011.

4 Indicators of the Protection of Ecosystems

1 Air Emissions

In addition to affecting human health, air pollution can be detrimental to ecosystems. In particularly, emissions from sulphur compounds in the atmosphere are major contributors to acid deposition, which includes both acidic rain and other forms of acid precipitation. Acid deposition removes nutrients from soil, which damages forests and crops and decreases agricultural productivity. Two indicators were used to measure air emissions: SO_X emissions intensity per unit of GDP [6] and change in SO_X emissions intensity (per unit of GDP) over a 10-year period.

SO_X emissions intensity per unit of GDP

SO_X emissions intensity per unit of GDP is a direct measure of total man-made emissions from sulphur oxides (SO_X), expressed in metric tons per unit of millions of GDP (in 2010 constant Purchasing Power Parity). **Table 10** presents this data for 2013. Out of 33 countries, Canada ranks 29th and receives a score of 84.5. Switzerland emits the lowest amount of SO_X (0.02 metric tons) per unit of its GDP and receives a score of 100. Other top performers are Luxembourg (emissions intensity of 0.033, score of 99.8), Netherlands (0.039, 99.64), Austria (0.041, 99.61) and Denmark (0.053, 99.39). Iceland is the poorest performer, with a relatively high SO_X emissions intensity, and receives a score of zero.

Change in SO_X emissions intensity

Change in SO_X emissions intensity is a measure to assess countries' progress toward lowering emission intensities. **Table 11** shows the percentage change in emissions intensity over the 10-year period from 2004 to 2013. As data for Chile for this period were not available, 32 countries are included, with their relative scores and ranks. With a rank of 17 and a score of 82.4, Canada performs better on this indicator than on the previous one. Between 2004 and 2013, Canada's SO_X emission intensity declined by almost 53% as compared to 2004 levels, which was better than the average of the OECD countries (51.7%). Hungary is the best performer, reducing its

[6] The emission data should be divided by GDP, area, or some other denominator in order to make the data comparable across the countries. That is the reason that we cannot simply look at absolute amount of generated emissions and rank countries accordingly.

Table 10: SO_X emissions intensity (metric tons/PPP $ millions GDP), Canada and the OECD, 2013

Rank	Country	Data (metric tons/PPP $ millions GDP)	Score	Rank	Country	Data (metric tons/PPP $ millions GDP)	Score
1	Switzerland	0.020	100.00	18	Portugal	0.201	96.65
2	Luxembourg	0.033	99.75	19	Slovenia	0.210	96.49
3	Netherlands	0.039	99.64	20	Finland	0.232	96.08
4	Austria	0.041	99.61	21	South Korea	0.246	95.81
5	Denmark	0.053	99.39	22	United States	0.279	95.21
6	Norway	0.056	99.32	23	Slovak Republic	0.372	93.49
7	Sweden	0.057	99.30	24	Czech Republic	0.476	91.56
8	Italy	0.073	99.02	25	New Zealand	0.502	91.09
9	France	0.083	98.82	26	Greece	0.551	90.19
10	Latvia	0.093	98.64	27	Chile	0.598	89.32
11	Belgium	0.099	98.54	28	Israel	0.719	87.08
12	Germany	0.111	98.32	**29**	**Canada**	**0.859**	**84.48**
13	Ireland	0.129	97.99	30	Poland	0.976	82.33
14	Hungary	0.134	97.90	31	Estonia	1.114	79.77
15	Japan	0.150	97.59	32	Australia	2.254	58.72
16	United Kingdom	0.161	97.38	33	Iceland	5.430	0.00
17	Spain	0.186	96.93				

Source: OECD, 2004–2013a; 2004–2013b.

SO_X emission intensity by more than 80% over a decade. In contrast, Iceland is the worst performer as its emission intensity increased by 82.2 % over the same period.

2 Water Resources

In addition to its importance for human health and economic development, clean water is essential for the well-being of ecosystems. Pollution from human activities (industrial, agricultural, and residential) and water abstraction can all affect the quality of water (OECD, 2015a). Data limitations at the global level restricted us from directly assessing how countries maintain their water quality, but following the practice of the 2016 EPI study, we have used an indicator that is key driver of water quality—wastewater treatment. [7] This indicator tracks the proportion of wastewater

[7] Despite the importance of water quality, there are still challenges in comparing how countries perform relative to each other. One difficulty is that the definition of water quality varies widely depending on the intended use, source, and location (Hsu, et al., 2016).

Table 11: Change (%) in SO_X emissions intensity from 2004 to 2013 as compared to 2004 levels, Canada and the OECD

Rank	Country	Data (% change)	Score	Rank	Country	Data (% change)	Score
1	Hungary	−81.44	100.00	**17**	**Canada**	**−52.60**	**82.38**
2	Spain	−80.95	99.70	18	Switzerland	−52.17	82.11
3	Slovenia	−79.42	98.77	19	Poland	−52.02	82.03
4	Belgium	−74.36	95.68	20	Israel	−51.87	81.93
5	Portugal	−70.96	93.60	21	Austria	−51.31	81.59
6	United States	−70.42	93.27	22	Luxembourg	−49.95	80.76
7	Italy	−68.60	92.16	23	Finland	−46.68	78.76
8	Ireland	−68.37	92.01	24	Sweden	−45.69	78.15
9	Greece	−68.36	92.01	25	Czech Republic	−45.66	78.14
10	Estonia	−66.05	90.60	26	Norway	−40.72	75.12
11	Latvia	−65.67	90.36	27	Japan	−35.24	71.77
12	France	−61.36	87.73	28	South Korea	−34.72	71.45
13	Slovak Republic	−61.26	87.67	29	Germany	−32.32	69.99
14	United Kingdom	−58.65	86.07	30	New Zealand	−26.59	66.49
15	Netherlands	−58.39	85.92	31	Australia	−26.47	66.41
16	Denmark	−57.57	85.42	32	Iceland	82.21	0.00

Source: OECD, 2004–2013a; 2004–2013b.

from municipalities, industry, and household sources that are treated at all stages—primary, secondary, and tertiary—before being released into the environment. [8] A second indicator, intensity of water use (or "water stress"), was used to compare countries' ability to ensure sustainable management of water resources. Water abstraction rates, especially for industrial processes, reflects concerns that inefficient usage can cause loss of wetlands, low river flows, desertification, and reduced food production (OECD, 2008).

Wastewater treatment rate

The wastewater treatment rate measures the percentage of wastewater that is treated at the municipal level, weighted by the population covered by the sewage

[8] Primary treatment uses basic processes such as settlement tanks to reduce biochemical oxygen demand (BOD) and remove suspended solids from water. Secondary treatment involves biological degradation, further reducing nutrients. Tertiary treatment involves using advanced technology to go beyond previous steps to remove remnant contaminants (Hsu, et al., 2016).

network. [9] As shown in table 12, with almost 70% of its wastewater being treated at municipal level in 2014, Canada ranks 23th out of 33 countries and receives a score of 39.7. The top five performers based on this indicator are Netherlands (with 99.3% rate of wastewater treatment and a score of 100), Luxembourg (96.8%, 95), United Kingdom (96.3%, 94), Germany (95.3%, 91.9) and Switzerland (95.2%, 91.6). The worst performer is United States, with 50.4% of its wastewater being treated.

Table 12: Wastewater treatment rate (%), Canada and the OECD, 2014

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	Netherlands	99.27	100.00	18	Italy	81.17	62.93
2	Luxembourg	96.84	95.02	19	France	79.56	59.64
3	United Kingdom	96.34	93.99	20	Greece	77.62	55.67
4	Germany	95.30	91.86	21	Estonia	71.86	43.87
5	Switzerland	95.16	91.58	22	New Zealand	70.19	40.45
6	Australia	95.00	91.25	**23**	**Canada**	**69.81**	**39.68**
7	Spain	94.52	90.27	24	Czech Republic	63.01	25.74
8	Austria	94.31	89.83	25	Iceland	60.06	19.70
9	Israel	94.27	89.75	26	Slovenia	59.78	19.13
10	Latvia	94.23	89.67	27	Poland	57.18	13.80
11	Sweden	93.20	87.56	28	Japan	56.53	12.48
12	Denmark	91.60	84.28	29	Slovak Republic	54.69	8.72
13	Belgium	89.78	80.55	30	Portugal	54.12	7.54
14	Chile	84.50	69.74	31	Ireland	51.11	1.37
15	Norway	83.83	68.38	32	Hungary	51.10	1.36
16	Finland	83.72	68.16	33	United States	50.44	0.00
17	South Korea	82.42	65.50				

Source: Hsu, Angel, et al., 2016: Wastewater Data Appendix, <http://epi.yale.edu/data>.

Intensity of water use (water stress)

Intensity of water use or water stress measures freshwater withdrawal as a percentage of total renewable water sources. As data were sparse and countries had inconsistent time series, the decadal averages from 2003 to 2012 were calculated

[9] Rural areas usually use decentralized treatment systems, such as septic tanks, to treat their wastewater. The ideal indicator would measure total waste generation from both municipal and rural sources. However, as a result of limited data, this indicator, which is adapted from the 2016 EPI study, does not account for decentralized treatment systems in rural areas and only takes into account wastewater treatment at the municipal level.

to produce performance scores on the intensity of water use, shown in **table 13**. Out of 33 countries, Canada ranks 6th and receives a score of 99.1. Only Latvia, Norway, Iceland, Luxembourg, and the Slovak Republic perform better than Canada. Canada's water-use intensity (1.4%) is much lower the OECD average of 12.9%. The water-use intensity for the best performer, Latvia, is 0.7%. In contrast, Israel has the highest water use intensity with 79.7% of its total renewable water sources being withdrawn.

Table 13. Water use intensity (%) from 2003 to 2012, Canada and the OECD

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	Latvia	0.65	100.00	18	Denmark	9.94	88.25
2	Norway	0.77	99.85	19	Portugal	11.82	85.87
3	Iceland	1.10	99.43	20	Netherlands	11.90	85.77
4	Luxembourg	1.27	99.22	21	Estonia	13.53	83.72
5	Slovak Republic	1.35	99.12	22	Greece	14.02	83.09
6	**Canada**	**1.38**	**99.08**	23	France	14.41	82.60
7	Ireland	1.43	99.02	24	Czech Republic	14.49	82.50
8	Sweden	1.53	98.89	25	United States	14.62	82.34
9	New Zealand	1.55	98.87	26	Japan	19.07	76.71
10	Slovenia	2.92	97.13	27	Poland	19.42	76.27
11	Australia	3.45	96.46	28	Germany	21.19	74.03
12	Switzerland	3.75	96.08	29	Italy	28.10	65.28
13	Chile	3.83	95.98	30	Spain	32.16	60.15
14	Austria	4.49	95.14	31	Belgium	33.38	58.61
15	Hungary	5.11	94.36	32	South Korea	41.66	48.14
16	United Kingdom	5.61	93.73	33	Israel	79.72	0.00
17	Finland	5.97	93.28				

Source: FAO, 2003–2012.

3 Forests

Forests are essential to sustaining both human civilization and the planet's biological and physical cycles (Hsu, et al., 2016). They provide timber and other forest products and regulate soil, air, and water. Forests act as carbon sinks, storing carbon in their biomass and soils. Deforestation accounts for somewhere between 8% and 20% of total annual global carbon emissions (van der Werf, 2009; Emerson, et al., 2010). Therefore. the reduction in forest cover has negative implications for habitat preservation, ecosystem health, and climate change. As OECD (2015a) reported,

human activities that impinge on forest cover include expansion of agricultural, transport infrastructure expansion, air pollution, unsustainable forestry, and intentional burning. This category consists of one indicator: the change in the amount of forest cover. As a result of limited data, we could not add other relevant indicators, such the intensity of forest use.

Change in forest cover

Change in forest cover is measured as a percentage of total land over the decade from 2006 to 2015. A regression was used to calculate the slope (trend) over the 10-year period. As shown in table 14, even though its forest cover has remained fairly constant, Canada ranked 28th and received a score of 32.6. This relatively poor performance is the result of the fact that most of Canada's peer countries increased their forest coverage over the same period. The top performers are Chile, Greece, France, Spain, and Italy. Portugal experienced the most significant decline in its forest cover and receives a score of zero.

Table 14: Change in forest cover (trend) from 2006 to 2015, Canada and the OECD

Rank	Country	Slope	Score	Rank	Country	Slope	Score
1	Chile	0.254	100.00	18	Belgium	0.028	41.26
2	Greece	0.234	94.76	19	Finland	0.026	40.74
3	France	0.206	87.44	20	Austria	0.026	40.74
4	Spain	0.190	83.26	21	Slovenia	0.023	39.85
5	Italy	0.183	81.43	22	Slovak Republic	0.016	38.21
6	Denmark	0.135	69.12	23	Iceland	0.013	37.30
7	Switzerland	0.094	58.39	24	Germany	0.007	35.81
8	Ireland	0.085	56.14	25	Norway	0.005	35.42
9	Latvia	0.083	55.57	26	Japan	0.003	34.79
10	Poland	0.077	54.04	27	Luxembourg	0.000	34.00
11	Hungary	0.059	49.39	**28**	**Canada**	**–0.006**	**32.57**
12	United States	0.059	49.35	29	New Zealand	–0.010	31.44
13	Israel	0.055	48.16	30	Australia	–0.026	27.30
14	United Kingdom	0.054	47.95	31	Estonia	–0.041	23.25
15	Sweden	0.044	45.36	32	South Korea	–0.123	2.19
16	Netherlands	0.033	42.65	33	Portugal	–0.131	0.00
17	Czech Republic	0.028	41.28				

Source: World Bank, 2006–2015.

4 Biodiversity

Biodiversity is an important indicator of the health of ecosystems, an indicator of the ability of land resources to provide valuable services such as habitat for plants and animals, cleaning of water resources and air, and regulating the local climate (Boyd, 2001). This category includes two indicators: species at risk and terrestrial protected areas.

Species at risk

Species at risk measures the number of species in danger, or likely soon to be in danger, of extinction as a percentage of known or assessed species in a country. **Table 15** presents data on species at risk for the latest year available, which corresponds to the late 2000s for most countries, as well as the corresponding scores and ranks for 32 countries. The data presented for each country was calculated as an average of the country's data covering mammals, birds, vascular plants, fish, freshwater fish, and invertebrates. Data for Israel were not available for this indicator. As shown, out of 32 countries, Canada ranks 10th and receives a score of 70.5. Countries ranking above Canada are New Zealand (ranked 1st with a score of 100), Latvia (2nd, 91.4),

Table 15: Species at risk (%), Canada and the OECD, most recent year

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	New Zealand	4.04	100.00	17	Italy	20.15	49.25
2	Latvia	6.76	91.44	18	Japan	20.56	47.97
3	South Korea	7.09	90.39	19	Luxembourg	22.00	43.44
4	Estonia	7.47	89.20	20	United States	22.15	42.97
5	Australia	9.93	81.47	21	Belgium	23.46	38.84
6	Norway	10.17	80.69	22	Netherlands	24.64	35.10
7	United Kingdom	10.47	79.74	23	France	26.11	30.47
8	Chile	10.60	79.34	24	Portugal	27.24	26.93
9	Denmark	13.06	71.60	25	Iceland	27.94	24.73
10	**Canada**	**13.40**	**70.52**	26	Slovenia	28.18	23.97
11	Ireland	13.59	69.91	27	Hungary	29.17	20.85
12	Finland	15.52	63.85	28	Spain	29.62	19.41
13	Poland	15.56	63.71	29	Switzerland	30.46	16.78
14	Sweden	15.60	63.58	30	Germany	31.95	12.08
15	Slovak Republic	16.51	60.73	31	Czech Republic	33.94	5.82
16	Greece	16.99	59.21	32	Austria	35.78	0.00

Note: "Most recent year" corresponds to the late 2000s for most countries.
Source: OECD, 2017.

South Korea (3rd, 90.4), Estonia (4th, 89.2), Australia (5th, 81.5), Norway (6th, 80.7), United Kingdom (7th, 79.7), Chile (8th, 79.3), and Denmark (9th, 71.6). Austria is the poorest performer for this category with almost 36% of species threatened.

It should be noted that the quality of data on this indicator varies from country to country as each has different standards and protocols for categorizing species as endangered and, therefore, there are anomalies in the listing processes, making comparisons across countries difficult.

Terrestrial protected areas

This indicator measures terrestrial protected areas as a percentage of total land area. Terrestrial protected areas are partially or totally protected areas of at least 1,000 hectares that are designated by national authorities such as nature reserves, national parks, protected landscape, natural monuments, scientific reserves with limited public access, and areas managed mainly for sustainable use (World Bank, 2014c). **Table 16** displays the terrestrial protected areas as a percentage of total land area in 2014 for 33 OECD countries, as well as their corresponding ranks and scores.

Table 16: Terrestrial protected areas, Canada and the OECD, 2014

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	Slovenia	53.59	100.00	18	Estonia	20.66	28.40
2	Germany	37.4	64.80	19	Israel	19.85	26.64
3	Slovak Republic	36.63	63.12	20	Japan	19.35	25.55
4	Greece	34.86	59.27	21	Chile	18.34	23.35
5	Luxembourg	34.61	58.73	22	Denmark	18.33	23.33
6	New Zealand	32.53	54.21	23	Latvia	18.22	23.09
7	Poland	30.00	48.71	24	Iceland	16.68	19.74
8	Norway	29.24	47.05	25	Finland	14.81	15.68
9	United Kingdom	28.43	45.29	26	Sweden	14.78	15.61
10	Austria	28.35	45.12	27	Australia	14.63	15.29
11	Spain	27.97	44.29	28	Ireland	14.39	14.76
12	France	25.33	38.55	29	United States	13.88	13.66
13	Belgium	22.86	33.18	30	Netherlands	11.56	8.61
14	Hungary	22.55	32.51	31	Switzerland	9.93	5.07
15	Portugal	22.09	31.51	**32**	**Canada**	**9.38**	**3.87**
16	Italy	21.47	30.16	33	South Korea	7.6	0.00
17	Czech Republic	21.11	29.38				

Source: World Bank, 2014.

As shown, with almost 10% of its terrestrial areas being protected, Canada ranks 32nd and receives a score of 3.9. Slovenia is the best performer with 53.6% of its terrestrial area protected; South Korea is the poorest performer with 7.6% of its terrestrial area protected.

Although Canada may seem to be performing poorly on this indicator, bear in mind that the lack of designated protection for a specific area does not imply that it is subject to development or that biodiversity is threatened. Less than 1% of Canada's total landmass is urban (Statistics Canada, 2009). Therefore, a large portion of its unprotected landmass is located in remote areas where biodiversity is unlikely to be threatened.

5 Agriculture

Agricultural activities can have several negative environmental impacts, including loss of habitat, degradation of soil and fertility, and deterioration of water and air. Among the main concerns relating to agriculture are excessive use of fertilizers (nitrogen and phosphorous) and intensive use of pesticides (OECD, 2015a). Runoff from fields where there has been excessive use of nitrogen has several negative impacts on air and water quality, contributes to climate changes, and may lead to ozone layer depletion (Hsu, et al., 2016). Likewise, pesticides used in agriculture pose several threats to human health and the environment by polluting water resources, degrading habitat, and contributing to loss of biodiversity (Boyd, 2001). This category includes two indicators: nitrogen-use balance and average use of pesticides.

Nitrogen-use balance

Nitrogen-use balance provides information about the intensity of nutrients in agricultural systems. It is defined as the difference between the nitrogen inputs entering a farming system and the nitrogen outputs leaving the system (the uptake of nitrogen for crop and pasture production). While nitrogen inputs are necessary in farming system to maintain and raise crops and increase productivity, nitrogen not taken up by crops is often lost to environment through nitrogen leaching, ammonia volatilization, and nitrous oxide emissions (Hsu, et al., 2016). **Table 17** presents data on nitrogen-use balance for 31 countries for the year 2013 as well as countries' associated ranks and scores. The nitrogen balance data is expressed in terms of kilograms of nitrogen surplus per hectare of agricultural land. The lower the nitrogen surplus, the better the management of the nitrogen resource for agricultural production. Data for Israel and Chile were not available.

Out of 31 countries, Canada ranks 3rd and receives a score of 94. Only Iceland and Australia have lower nitrogen surplus and perform better than Canada. Portugal

Table 17: Nitrogen use balance (surplus), Canada and the OECD, 2013

Rank	Country	Data (kg/ha)	Score	Rank	Country	Data (kg/ha)	Score
1	Iceland	8.27	100.00	16	Poland	55.00	80.47
2	Australia	18.47	95.74	17	Greece	56.00	80.05
3	**Canada**	**22.59**	**94.02**	18	Switzerland	61.00	77.96
4	Estonia	23.00	93.84	19	United Kingdom	66.00	75.87
5	Latvia	28.00	91.75	20	Italy	70.00	74.20
6	Sweden	30.00	90.92	21	Slovenia	70.00	74.20
7	United States	31.78	90.18	22	Czech Republic	76.00	71.69
8	Portugal	36.00	88.41	23	Denmark	87.00	67.09
8	Spain	36.00	88.41	23	Germany	87.00	67.09
9	Hungary	38.00	87.57	24	Norway	104.00	59.99
10	Austria	41.00	86.32	25	Luxembourg	127.00	50.37
11	Ireland	44.00	85.07	26	Belgium	138.00	45.77
12	Finland	45.00	84.65	27	Netherlands	146.00	42.43
13	Slovak Republic	49.00	82.98	28	Japan	153.45	39.32
14	France	50.00	82.56	29	South Korea	247.51	0.00
15	New Zealand	51.70	81.85				

Source: OECD, 2013.

and Spain together hold the 8th rank and receive a score of 88.4. Similarly, Denmark and Germany hold the 23rd rank and each receive a score of 67.1. With 22.6 kilograms of nitrogen surplus per hectare in 2013, Canada's performance is much better than the OECD average of 67.6 nitrogen surplus over the same period. The poorest performer for this indicator is South Korea with 247.5 kilograms of nitrogen surplus.

Average use of pecticides

Average use of pesticides is measured per area of cropland (calculated in kg/hectare). Due to sparse and inconsistent time series, the decadal averages from 2004 to 2013 were used. As there were no data available for Luxembourg for this indicator, table 18 presents data, scores, and ranks for the remaining 32 countries. With average use of 1.03 (kg per hectare) of pesticides, Canada ranks 8th out of 32 countries and receives a score of 94.6. Only Iceland, Finland, Australia, Sweden, Estonia, Latvia, and Norway perform better than Canada. The bottom five countries are Israel, Chile, Japan, South Korea, and Netherlands. The OECD average for this indicator is 4.6 kg pesticide per hectare.

Table 18: Average use of pesticides, Canada and the OECD, 2004–2013

Rank	Country	Data (kg/ha)	Score	Rank	Country	Data (kg/ha)	Score
1	Iceland	0.04	100.00	17	Spain	2.52	86.50
2	Finland	0.70	96.37	18	Ireland	2.57	86.24
3	Australia	0.73	96.23	19	France	2.93	84.28
4	Sweden	0.73	96.22	20	Germany	3.37	81.89
5	Estonia	0.77	96.00	21	United Kingdom	3.63	80.49
6	Latvia	0.84	95.63	22	Switzerland	4.38	76.40
7	Norway	0.86	95.54	23	Slovenia	5.42	70.72
8	**Canada**	**1.03**	**94.60**	24	Italy	7.45	59.73
9	Slovak Republic	1.13	94.06	25	Portugal	7.50	59.43
10	Poland	1.55	91.77	26	Belgium	7.82	57.69
11	Denmark	1.57	91.69	27	New Zealand	9.45	48.85
12	Czech Republic	1.65	91.21	28	Netherlands	9.83	46.77
13	Greece	2.07	88.97	29	South Korea	12.60	31.74
14	Hungary	2.12	88.65	30	Japan	12.75	30.91
15	United States	2.43	86.99	31	Chile	14.55	21.10
16	Austria	2.46	86.85	32	Israel	18.44	0.00

Source: FAO, 2004–2013.

6 Fisheries

Fish play a significant role in human food supplies and aquatic ecosystems (OECD, 2015a). Furthermore, in many countries, fisheries are a significant contributor to the economy, providing employment opportunities and sustainable income. As WHO reports, roughly one billion people worldwide rely on fish as the most significant source of animal protein in their diets (Emerson, et al., 2010). Fishing, coastal development, pollution loads from land-based sources, maritime dumping, and maritime transport are the main pressures on fish resources (OECD, 2015a). These pressures adversely affect marine biodiversity, ecosystem stability, and the supply of fish for consumption. Thus, sustainable management of fish resources is critical for countries. This category includes one indicator: change in Marine Trophic Index.

Change in Marine Trophic Index

Marine Trophic Index measures the degree to which countries are "fishing down the food chain," that is, the degree to which countries are catching smaller and smaller fish (Emerson, et al., 2010). Humans tend to fish large predatory fish varieties at

the top of the food chain. As these sources become scares and depleted, smaller species are chosen, causing the food chain to become unbalanced (Emerson, et al., 2010). In this way, Marine Trophic Index is a proxy for capturing over-fishing. In order to calculate this index, each species is assigned a number based on its location on the food chain: herbivores are assigned lower numbers and carnivores are assigned higher numbers. Using datasets from commercial fish landings, the index is calculated by averaging trophic levels for the overall catch.

Table 19 presents the change in Marine Trophic Index for 26 countries, as well as their associated scores and ranks. A regression was used to calculate the slope of trend line over the 10-year period from 2005 to 2014. No data were available for the following seven countries for this indicator: Austria, Czech Republic, Hungary, Luxembourg, Slovak Republic, Switzerland, and the United States.

Out of 26 countries, Canada ranks 16th and receives a score of 45.6. The –0.002 coefficient of trend line indicates that Canada's sustainability of fish resources declined over the past decade. The top five performers that have managed to improve upon their fish resources are Slovenia, France, Latvia, Greece, and Estonia. Sweden and Finland together hold the 10th rank and receive a score of 51.9. Ireland is experiencing the highest decline in its sustainability of fish resources and accordingly receives a score of zero.

Table 19: Change (trend) in Marine Trophic Index, Canada and the OECD, 2005–2014

Rank	Country	Slope	Score	Rank	Country	Slope	Score
1	Slovenia	0.0295	100.00	14	Italy	**–0.0012**	47.19
2	France	0.0132	71.88	15	Netherlands	**–0.0015**	46.67
3	Latvia	0.0095	65.52	**16**	**Canada**	**–0.0021**	**45.63**
4	Greece	0.0087	64.17	17	United Kingdom	**–0.0036**	43.02
5	Estonia	0.0079	62.92	18	Belgium	**–0.0048**	41.04
6	Poland	0.0075	62.08	19	Iceland	**–0.0053**	40.21
7	Portugal	0.0072	61.56	20	Spain	–0.0072	36.98
8	Norway	0.0059	59.48	21	Japan	**–0.0081**	35.31
9	New Zealand	0.0054	58.54	22	Australia	**–0.0084**	34.79
10	Sweden	0.0015	51.88	23	Israel	**–0.0193**	16.09
10	Finland	0.0015	51.88	24	Chile	**–0.0222**	11.15
11	Denmark	0.0014	51.72	25	Ireland	**–0.0287**	0.00
12	Germany	0.0004	49.95				

Source: Sea around Us, 2005–2014.

5 Conclusion

The Index of Environmental Performance shows that Canada performs better than the majority of high-income OECD countries on environmental protection. Canada ranks 10th out of the 33 high-income OECD countries and receives an overall score of 68.5, compared to a top rank of 78.9 (Sweden). The data provide compelling evidence that Canada is not an environmental laggard and is, in fact, among the top 10 countries. The purpose of this report is primarily descriptive and comparative. Our results do not, on their own, imply that policies need to be tightened or changed. Such decisions need to be based on comparisons of marginal costs and benefits of specific policy proposals.

Appendix

Table A1 presents the results of the Index of Environmental Performance when we took the simple average of the scores of all 17 indicators, weighting each one equally, to obtain an overall score ranging from zero to 100. Similar to the results presented in figure 1, with a score of 68.2, Canada performs relatively strongly and ranks 13th out of 33 high-income OECD countries.

The top five performers are Sweden (with a score of 79.0), Norway (75.6), France (73.2), Denmark (72.3), and United Kingdom (71.7). The five poorest performers are South Korea (with a score of 38.3), Israel (46.5), Japan (48.8), Poland (53.5) and Chile (55.6).

Table A1. Index of Environmental Performance, Canada and the OECD, giving equal weighting, score out of 100

Rank	Country	score	Rank	Country	score
1	Sweden	79.05	18	Italy	63.28
2	Norway	75.54	19	Iceland	62.97
3	France	73.16	20	Portugal	62.07
4	Denmark	72.33	21	Germany	62.04
5	United Kingdom	71.74	22	Hungary	61.65
6	Finland	71.63	23	Estonia	60.91
7	Switzerland	71.55	24	Belgium	60.70
8	Spain	71.14	25	United States	59.73
9	New Zealand	71.00	26	Ireland	57.94
10	Austria	69.16	27	Czech Republic	56.95
11	Latvia	68.51	28	Netherlands	55.77
12	Slovak Republic	68.29	29	Chile	55.56
13	**Canada**	**68.22**	30	Poland	53.52
14	Australia	67.74	31	Japan	48.77
15	Slovenia	66.85	32	Israel	46.46
16	Luxembourg	66.68	33	South Korea	38.26
17	Greece	65.96			

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The Fraser Institute maintains a rigorous peer review process for its research. New research, major research projects, and substantively modified research conducted by the Fraser Institute are reviewed by experts with a recognized expertise in the topic area being addressed. Whenever possible, external review is a blind process. Updates to previously reviewed research or new editions of previously reviewed research are not reviewed unless the update includes substantive or material changes in the methodology.

The review process is overseen by the directors of the Institute's research departments who are responsible for ensuring all research published by the Institute passes through the appropriate peer review. If a dispute about the recommendations of the reviewers should arise during the Institute's peer review process, the Institute has an Editorial Advisory Board, a panel of scholars from Canada, the United States, and Europe to whom it can turn for help in resolving the dispute.

Editorial Advisory Board