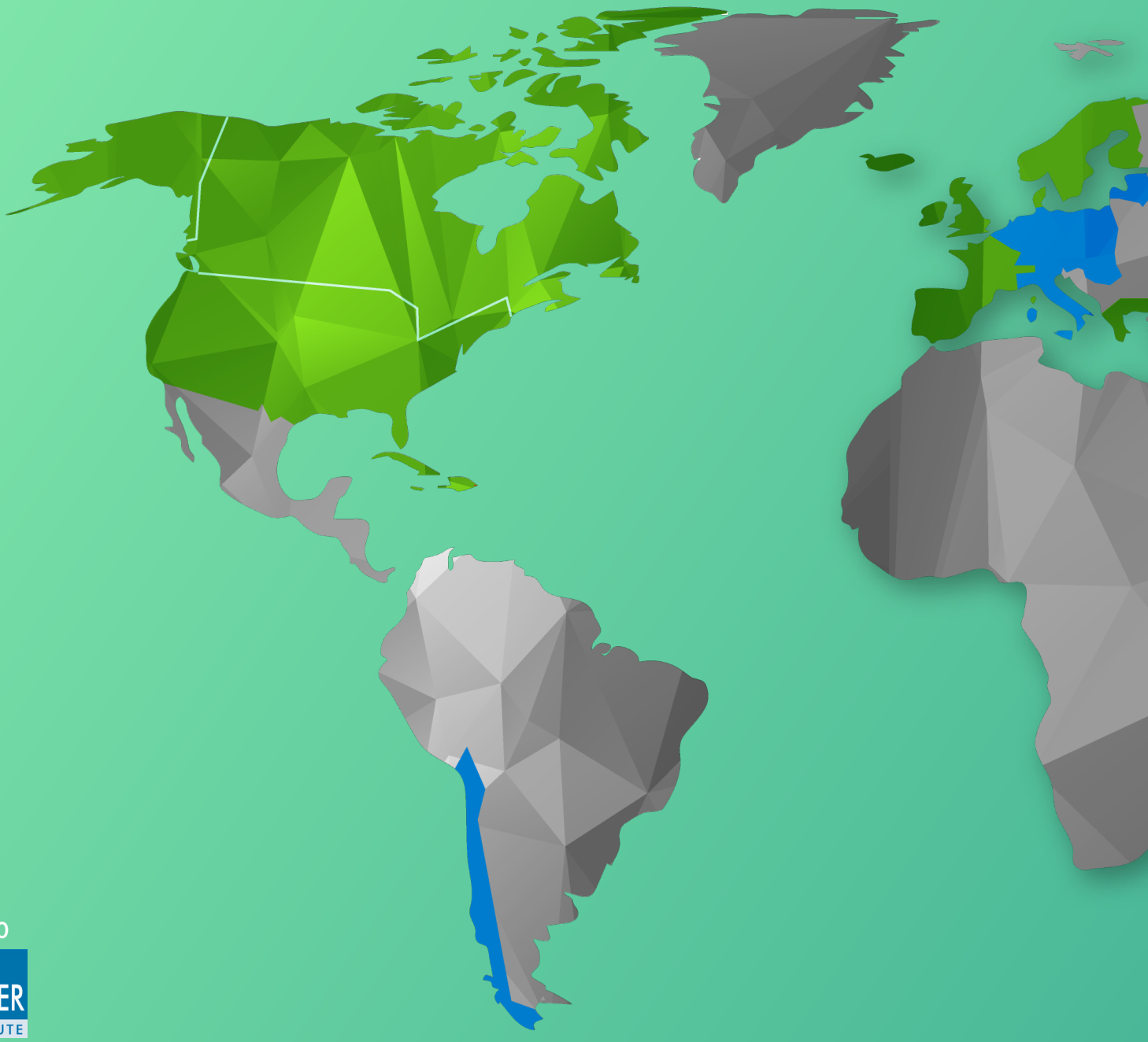
ENVIRONMENTAL RANKING FOR CANADA AND THE OECD

Second Edition

Elmira Aliakbari, Jairo Yunis, 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. As noted in the previous edition of this report, we regard the methodologies behind these studies as flawed as they unfairly represent Canada's environmental performance in some respects and do not always use the most meaningful and relevant performance measures. Thus, we developed an improved and transparent methodology that allows us to measure and compare environmental performance among OECD countries.

This report is the second edition of the Fraser Institute's *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 track 9 core categories. Under the heading of protecting human health and well-being, we examine air quality, water quality, and greenhouse gases. Under the objective of 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 protection for human health and well-being and to indicators of ecosystem protection. 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 41.4 for South Korea to a high of 80.0 for Sweden, with an average of 62.2 across all 33 high-income countries. Canada performs relatively well, obtaining an overall score of 67, which places it 12th out of 33 high-income OECD countries. Canada ranks behind Sweden, New Zealand, Finland, Denmark, Spain, the United Kingdom, Switzerland, France, Norway, the United States, and Luxembourg. Our method shows that Canada performs better than the majority of high-income OECD countries on environmental protection.

For air quality (under the heading impact on human health and well-being), Canada performs really well, ranking highly out of 33 countries based on the two air-quality indicators: average exposure to fine particulate matter (4th) and fine particulate matter exceedance (1st).

For water quality, Canada ranks 13th out of 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. Note that on these two measure nearly all countries have very good scores and there is little difference among countries.

For greenhouse gases, Canada ranks 31st and 21st, respectively, for its carbon intensity (CO_2 emissions per unit of GDP) and its ability to reduce its carbon intensity over a decade. However, it ranks 8th 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 27th 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 52% compared to 2007 levels.

Canada ranks 19th for its waste-water treatment rate and 4th for the intensity of use of its water resources. On the latter measure, only Iceland, Latvia, Norway, the Slovak Republic, and Luxembourg perform better than Canada.

Despite preserving its forest cover for over a decade, Canada ranks 29th, because forest cover has grown somewhat in many other countries. Chile, with the most significant increase in its forest cover over the decade, is the best performer while Estonia, with the most significant decline in its forest cover, is the poorest.

Canada ranks 12th out of 32 countries for the number of species at risk and 32nd out 33 countries for the percentage of its terrestrial land designated as protected areas.

Canada has a good record on environmental issues related to agriculture, ranking 4th on fertilizer use (nitrogen) and 11th on pesticide use. Only Iceland, Australia, and Estonia perform better than Canada, using less fertilizer per hectare.

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 expected 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 that has been claimed in the past. 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 an unavoidable result of our geography or climate, and in other cases it reflects the tight distribution of outcomes among the world's wealthiest nations. In many areas or 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. Recent reports have presented Canada as an environmental laggard, ranking it near the bottom of the list of OECD countries. In particular, 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.

We regard the methodologies behind these studies as flawed as they unfairly represent Canada's environmental performance in some respects and do not always use the most meaningful and relevant performance measures. In the first edition of this report (McKitrick, Aliakbari, and Stedman, 2018), we concluded that their results are sensitive to faulty assumptions that tend to unfairly penalize Canada's environmental record. For instance, for air quality measures, these 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 measure of emissions per capita 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. [1] To avoid these flawed assumptions, we developed an improved and transparent methodology that allows us to measure and compare environmental performance among OECD 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 (DeWiel, Hayward, Jones, and Smith, 1997), followed by others such as Brown, Green, Hansen, and Fredricksen (2004), McKitrick (2008), Wood (2013), McKitrick and Aliakbari (2017), and McKitrick, Aliakbari, and Stedman (2018). Our familiarity with the subject made us curious about the discrepancy between the dismal

[1] For additional information and examples, see McKitrick, Aliakbari, and Stedman, 2018.

results reported above and the public records of air and water quality that show that Canadians generally experience high levels of environmental quality. 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 the 2018 version of the report. [2] The methodology used in this year's publication is consistent with the previous version.

The result is the second edition of *Environmental Ranking for Canada and the OECD*, in which we examine the performance of 33 high-income countries 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 12th 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 even 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 on the 17 specific indicators that make up the composite index. The last section presents conclusions. The Appendix (p. 32) 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] The 2016 and 2018 EPI studies ranked Canada 25th out of 180 developed, developing, and least developed countries.

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 follows:

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):

4. Air emissions (2 indicators)
5. Water resources (2 indicators)
6. Forests (1 indicator)
7. Biodiversity (2 indicator)
8. Agriculture (2 indicators)
9. 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 relating to protection of human health and well-being and 50% weight to indicators relating to protecting the ecosystem (section 2 provides more details on the methods used). Finally, the jurisdictions are ranked based on their composite index. These results are presented

in **figure 1**. Scores range from a low of 41.4 for South Korea to a high of 80 for Sweden. The average score is 62.2. Overall, Canada performs relatively well, obtaining a score of 67, which is 12th out of our sample of 33 high-income OECD countries. Canada falls behind Sweden, New Zealand, Finland, Denmark, Spain, the United Kingdom, Switzerland, France, Norway, the United States, and Luxembourg. 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 highly out of 33 countries based on the two air-quality indicators: average exposure to fine particulate matter (4th) and fine particulate matter exceedance (1st). It ranks 8th out of 33 countries based on low-emitting electricity production, namely electricity generated by nuclear power and renewable energy sources. Canada ranks 4th out of 28 countries for intensity of water use, which measures freshwater withdrawal as a percentage of total renewable water resources. Finally, the country also excels for its balanced use of fertilizer (nitrogen-use balance).

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 21st for its ability to reduce its 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, both factors outside our control.

Canada ranks 27th 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 24 all have scores above 90. Also, Canada performs better in terms of its ability to reduce SO_X emissions intensity over a 10-year period, ranking 20th out of 33 countries

For percentage change in forest cover, Canada ranks 29th and receives a relatively low score of 40.9. 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 (p. 32) presents 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 14th out of 33, though the indicators in the 11th to 14th spots are tightly clustered between 65.6 and 65.3 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.

Figure 1: Index of Environmental Performance in Canada and the OECD, 2020

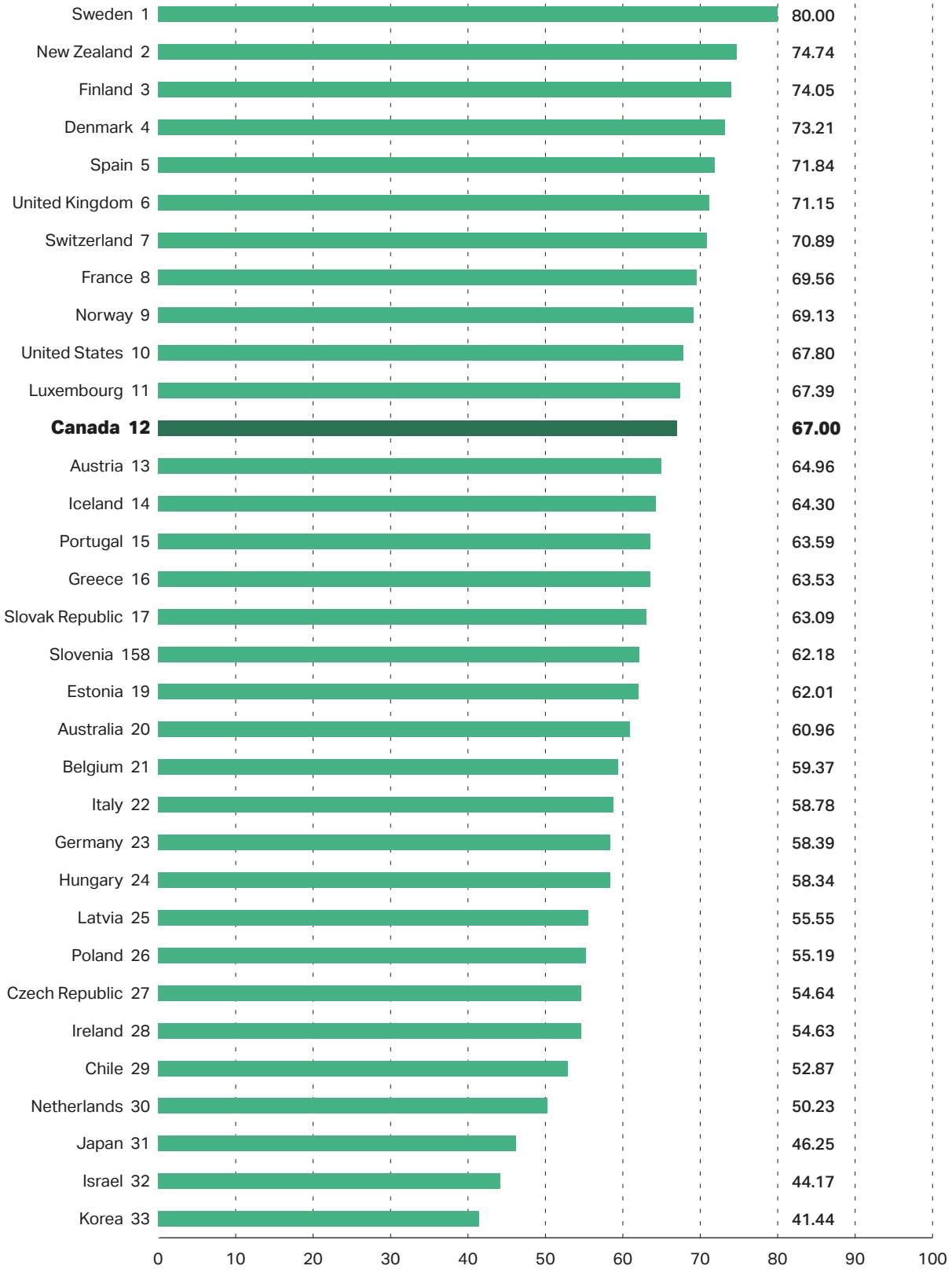

Table 1. Summary of Canada's OECD ranking and score by indicator

	Score	Rank
Air Quality		
Average exposure to $PM_{2.5}$ ($\mu g/m^3$)	97.1	4th out of 33
Average $PM_{2.5}$ exceedance (%)	100	1st out of 33
Water Quality		
Access to improved sanitation facilities (%)	91.8	13th out of 33
Access to improved drinking water sources (%)	78.4	13th out of 33
Greenhouse Gases		
Carbon intensity (thousand tonnes/PPP millions $GDP)	24.5	31st out of 33
Change in Carbon intensity (%)	32.2	21st out of 33
Low-emitting electricity production (%)	78.2	8th out of 33
Air Emissions		
SO_X emissions intensities (kg/PPP thousands $GDP)	80	27th out of 33
Change in SO_X emissions intensities (%)	51.1	20th out of 33
Water resources		
Wastewater treatment rate (%)	57	19th out of 33
Intensity of use of water (%)	98.5	4th out of 28
Forest		
Change in forest cover (%)	40.9	29th out of 33
Biodiversity		
Threatened species (%)	55	12th out of 32
Terrestrial protected areas (%)	0.05	32nd out of 33
Agriculture		
Nitrogen use balance (kg/ha)	90.2	4th out of 31
Pesticide use (kg/ha)	88.6	11th out of 33
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 less restrictive or more restrictive 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 an environmental laggard as it has been portrayed 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 as a result of 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. [4]

Data selection

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, Esty, Levy, de Sherbinin, 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.

The time frame was chosen as follows: for measures of current performance we chose the most recent year that provided the most complete data. In some cases more recent data were available for some countries, but we selected the year and interval that allowed complete coverage on a consistent time basis. In the 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), the World Health Organization, and the Yale Center for Environmental Law and Policy.

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[4] There are 35 countries in the OECD. Two of these 35 countries, Mexico and Turkey, were not included here, as they are not classified as "high income" by the World Bank. High-income countries are defined as having a gross national income (GNI) per capita of $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:

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

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:

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

By this means a jurisdiction with a stronger environmental performance always receives a higher score whereas a jurisdiction with a 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, 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 area. 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%)	a. Average exposure to $PM_{2.5}$ ($\mu g/m^3$)
		b. Average $PM_{2.5}$ exceedance (%)
	2. Water Quality (16.67%)	a. Access to improved sanitation facilities (%)
		b. Access to improved drinking water sources (%)
	3. Greenhouse Gases (16.67%)	a. Carbon intensity (*thousand tonnes/PPP millions $GDP*)
		b. Change in carbon intensity (%)
		c. Low-emitting electricity production (%)
Protection of ecosystems (50%)	1. Air Emissions (8.33%)	a. SO_X emissions intensities *(Kg/PPP thousands $GDP)*
		b. Change in SO_X emissions intensities (%)
	2. Water Resources (8.33%)	a. Wastewater treatment rate (%)
		b. Intensity of use of water (%)
	3. Forest (8.33%)	a. Change in forest cover (%)
	4. Biodiversity (8.33%)	a. Threatened species (%)
		b. Terrestrial protected areas (%)
	5. Agriculture (8.33%)	a. Nitrogen use balance (kg/ha)
		b. Pesticide use (kg/ha)
	6. Fisheries (8.33%)	a. Change in Marine Trophic Index (%)

3. Detailed Discussion of Core Categories and Indicators

1. Human health and well-being—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; OECD, 2015). Fine particulate matter is usually the product of combustion through both human activities and natural sources such as volcanoes and forest fires (Hsu, Esty, Levy, de Sherbinin, 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 $PM_{2.5}$ 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 2017, as well as their ranks and corresponding scores. As shown, with an average exposure of 6.5 $\mu g/m^3$, Canada ranks 4th among the 33 high-income OECD countries and receives a score of 97.1.

Finland has the lowest mean exposure to $PM_{2.5}$ among the countries (average exposure of 5.9 $\mu g/m^3$) and receives a score of 100. New Zealand (average exposure of 6 $\mu g/m^3$) and Sweden (average exposure of 6.1 $\mu g/m^3$) are the second and third best performers. The average for high-income OECD countries was 12.3 $\mu g/m^3$, well above Canada's mean exposure. The United States ranks 8th with an average exposure of 7.4 $\mu g/m^3$ and receives a score of 92.4. The five poorest performers are South Korea (ranked 33rd with 25.1 $\mu g/m^3$ average exposure), Chile (32nd, 22.1 $\mu g/m^3$), Poland (31th, 20.9 $\mu g/m^3$), Israel (30th, 20.8 $\mu g/m^3$) and Slovak Republic (29th, 17.9 $\mu g/m^3$).

$PM_{2.5}$ exceedance is a different indicator that measures the percentage of the population not exposed to $PM_{2.5}$ levels exceeding 10 $\mu g/m^3$, 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 2017 for 33 OECD countries, as well as their associated scores and ranks. As shown, with

Table 3: Average $PM_{2.5}$ exposure (μg/m³) in 2017, with corresponding scores and ranks

Rank	Country	Data (μg/m³)	Score	Rank	Country	Data (μg/m³)	Score
1	Finland	5.91	100.00	18	France	11.96	68.52
2	New Zealand	5.99	99.55	19	Netherlands	12.09	67.87
3	Sweden	6.13	98.81	20	Germany	12.09	67.85
4	**Canada**	**6.46**	**97.12**	21	Austria	12.69	64.74
5	Iceland	6.78	95.44	22	Belgium	13.10	62.60
6	Estonia	6.84	95.13	23	Latvia	14.11	57.35
7	Norway	7.05	94.07	24	Hungary	16.08	47.08
8	United States	7.36	92.42	25	Czech Republic	16.21	46.40
9	Portugal	8.12	88.48	26	Slovenia	16.25	46.20
10	Ireland	8.27	87.70	27	Greece	16.48	45.04
11	Australia	8.52	86.39	28	Italy	16.50	44.93
12	Spain	9.91	79.16	29	Slovak Republic	17.93	37.46
13	Luxembourg	10.18	77.78	30	Israel	20.81	22.50
14	Denmark	10.35	76.87	31	Poland	20.94	21.81
15	Switzerland	10.44	76.40	32	Chile	22.14	15.61
16	United Kingdom	10.44	76.40	33	South Korea	25.14	0.00
17	Japan	11.86	69.03				

Source: OECD, 2018.

100% of its population not exposed to $PM_{2.5}$ levels greater than 10 μg/m³, Canada receives a score of 100 and ranks 1st out of 33 countries. Canada is the top performer in this category, along with Estonia, Finland, and New Zealand—all with a score of 100. The average OECD population not exposed to $PM_{2.5}$ levels exceeding 10 μg/m³ was 40.3%.

Other top-performing countries are Ireland (97.7%), Sweden (97%), United States (96.9%), Norway (96.2%), and Iceland (94.3%). The Slovak Republic and Hungary, with zero percent of their population not exposed to WHO standard $PM_{2.5}$ levels, are the worst performers and together hold the last rank.

Table 4. Percentage of population not exposed to PM2.5 above 10 µg/m³ (%) in 2017, with corresponding scores and ranks

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	**Canada**	**100.00**	**100.00**	15	Japan	19.37	19.37
1	Estonia	100.00	100.00	16	Austria	12.96	12.96
1	Finland	100.00	100.00	17	Latvia	10.74	10.74
1	New Zealand	100.00	100.00	18	Germany	9.69	9.69
2	Ireland	97.69	97.69	19	Belgium	6.47	6.47
3	Sweden	97.04	97.04	20	Italy	5.33	5.33
4	United States	96.85	96.85	21	Chile	2.71	2.71
5	Norway	96.18	96.18	22	South Korea	0.76	0.76
6	Iceland	94.26	94.26	23	Netherlands	0.47	0.47
7	Portugal	84.93	84.93	24	Greece	0.43	0.43
8	Australia	74.02	74.02	25	Czech Republic	0.11	0.11
9	Spain	53.64	53.64	26	Slovenia	0.08	0.08
10	Switzerland	46.00	46.00	27	Poland	0.06	0.06
11	Denmark	37.34	37.34	28	Israel	0.01	0.01
12	United Kingdom	35.00	35.00	29	Hungary	0.00	0.00
13	Luxembourg	27.00	27.00	29	Slovak Republic	0.00	0.00
14	France	20.17	20.17				

Source: OECD, 2018.

2. Human health and well-being—water quality

Human health depends on adequate sanitation and clean water resources. 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; Pruss-Ustun, 2004). Access to proper sanitation reduces a population's contact with dangerous bacteria and viruses and lowers environmental threats associated with waste management (Hsu, Esty, Levy, de Sherbinin, 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 seeks to measure the percentage of the population using both basic and safely managed sanitation services, in other words

Table 5: Access to improved sanitation facilities (%) in 2017, with corresponding scores and ranks

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	Chile	100.00	100.00	15	Estonia	99.15	90.25
1	Israel	100.00	100.00	16	Czech Republic	99.13	90.11
1	New Zealand	100.00	100.00	17	United Kingdom	99.11	89.84
1	South Korea	100.00	100.00	18	Slovenia	99.11	89.83
2	Australia	99.99	99.90	19	Greece	98.98	88.39
3	Austria	99.97	99.69	20	Poland	98.80	86.25
4	United States	99.97	99.66	21	Iceland	98.78	86.09
5	Spain	99.90	98.91	22	Italy	98.77	85.98
6	Japan	99.89	98.80	23	France	98.65	84.58
7	Switzerland	99.89	98.75	24	Norway	98.05	77.78
8	Portugal	99.61	95.53	25	Hungary	97.99	77.05
9	Denmark	99.60	95.40	26	Slovak Republic	97.94	76.45
10	Belgium	99.49	94.13	27	Netherlands	97.71	73.88
11	Finland	99.45	93.69	28	Luxembourg	97.60	72.59
12	Sweden	99.30	91.95	29	Latvia	92.15	10.32
13	**Canada**	**99.29**	**91.84**	30	Ireland	91.25	0.00
14	Germany	99.23	91.15				

Source: WHO, 2019.

systems for safe disposal of human waste. Improved sanitation sources include ventilated improved pit (VIP) latrines, flush/pour-flush systems (to piped sewer, septic tank, pit latrine), composting toilets, and pit latrines with slab (WHO, 2019). **Table 5** shows the percentage of population with access to improved sanitation facilities in 2017.

With improved sanitation facilities provided for 99.3% of its population, Canada ranks 13th and receives a score of 91.8. Chile, Israel, New Zealand, and South Korea together hold the first rank as 100% of their population has access to improved sanitation facilities. These countries are followed by Australia with a score of 99.9 and Austria with a score of 99.7. Other countries that fall behind Canada include 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 33 high-income OECD countries (98.8%). Ireland is the worst performer (91.3%) and receives a score of zero.

Table 6: Access to improved drinking water sources (%) in 2017, with corresponding scores and ranks

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	Austria	100.00	100.00	2	Australia	99.97	98.85
1	Belgium	100.00	100.00	3	Spain	99.93	97.17
1	Denmark	100.00	100.00	4	Portugal	99.91	96.46
1	Finland	100.00	100.00	5	Luxembourg	99.89	95.76
1	France	100.00	100.00	6	Czech Republic	99.88	95.40
1	Germany	100.00	100.00	7	Chile	99.83	93.58
1	Greece	100.00	100.00	8	South Korea	99.79	91.85
1	Hungary	100.00	100.00	9	Poland	99.72	89.43
1	Iceland	100.00	100.00	10	Estonia	99.71	88.98
1	Israel	100.00	100.00	11	Slovenia	99.54	82.15
1	Netherlands	100.00	100.00	12	Italy	99.44	78.61
1	New Zealand	100.00	100.00	**13**	**Canada**	**99.44**	**78.36**
1	Norway	100.00	100.00	14	Latvia	99.31	73.36
1	Slovak Republic	100.00	100.00	15	United States	99.27	71.95
1	Sweden	100.00	100.00	16	Japan	99.01	62.01
1	Switzerland	100.00	100.00	17	Ireland	97.39	0.00
1	United Kingdom	100.00	100.00				

Source: UNICEF and WHO, 2019.

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 sources of drinking water 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 (UNICEF and WHO, 2019; World Bank, 2012). Table 6 presents data on access to improved water sources in 2017 for all 33 countries, along with their associated ranks and scores. With improved drinking-water sources provided for 99.4% of its population, Canada ranks 13th and receives a score of 78.4. Seventeen countries, including Austria, Denmark, Finland, Israel, and the United Kingdom, share the first rank as 100% of their populations have access to improved drinking water sources. Ireland, Japan, the United States, and Latvia are the worst performers based on this indicator.

3. Human health and well-being—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, 2015). In this section, we take as given that most countries say they want to reduce greenhouse-gas emissions, even though in practice little progress has been made toward reaching a consensus on this issue's scope, origins, and solutions (Hsu, Esty, Levy, de Sherbinin, 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 shown by three indicators: carbon intensity, change in carbon intensity, and low-emitting electricity production.

Carbon intensity measures CO_2 emissions per unit of GDP, expressed in thousands of tonnes per million US dollars of GDP in 2015 constant Purchasing Power Parity. **Table 7** presents carbon intensity data in 2016 for all 33 countries as well as

Table 7. Carbon intensity in 2016, with corresponding ranks and scores

Rank	Country	Data (000 tonnes/PPP million$ GDP)	Score	Rank	Country	Data (000 tonnes/PPP million$ GDP)	Score
1	Switzerland	0.073	100	18	Finland	0.197	66.067
2	Sweden	0.087	96.221	19	Germany	0.201	65.027
3	Ireland	0.119	87.552	20	Iceland	0.203	64.701
4	France	0.127	85.23	21	Slovak Republic	0.211	62.524
5	Denmark	0.133	83.57	22	Chile	0.212	62.112
6	Norway	0.140	81.596	23	Slovenia	0.214	61.55
7	United Kingdom	0.142	81.175	24	Israel	0.214	61.529
8	Latvia	0.145	80.422	25	Japan	0.234	56.24
9	Luxembourg	0.147	79.84	26	Greece	0.246	52.975
10	Austria	0.153	78.18	27	United States	0.286	41.861
11	Italy	0.156	77.439	28	Czech Republic	0.293	40.133
12	Spain	0.156	77.408	29	Poland	0.307	36.221
13	Portugal	0.161	76.088	30	South Korea	0.320	32.673
14	Hungary	0.177	71.696	**31**	**Canada**	**0.350**	**24.541**
15	Belgium	0.186	69.169	32	Australia	0.358	22.343
16	Netherlands	0.191	67.813	33	Estonia	0.440	0
17	New Zealand	0.192	67.607				

Source: OECD, 2019a, 2019b.

the associated rankings and scores. With 0.35 thousand tonnes of CO_2 emissions per unit of GDP, Canada ranks 31st and receives a score of 24.5. 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 with 0.073 thousand tonnes of CO_2 emissions/unit of GDP), Sweden (2nd, 0.087), Ireland (3rd, 0.12), France (4th, 0.13), and Denmark (5th, 0.13)

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 from 2007 to 2016 as compared to 2007 levels for all 33 countries, as well as the corresponding scores and ranks. With a reduction in carbon intensity of 16.5% over a decade, Canada ranks 21st out of 33 countries and receives a score of 32.24. This is noteworthy since it coincides with a decade in which the oil-sands sector expanded rapidly. Portugal, Austria, Greece, Germany, Estonia, Latvia, Norway, Iceland, Japan, the Netherlands, South Korea, and Chile perform worse than Canada.

Table 8. Change in carbon intensity, 2007–2016, with corresponding ranks and scores

Rank	Country	Data (% change)	Score	Rank	Country	Data (% change)	Score
1	Ireland	−36.81	100.00	18	France	−19.29	41.62
2	Denmark	−35.60	95.96	19	Slovenia	−18.29	38.32
3	United Kingdom	−34.77	93.18	20	Australia	−17.64	36.13
4	Luxembourg	−32.87	86.86	**21**	**Canada**	**−16.47**	**32.24**
5	Slovak Republic	−30.52	79.03	22	Portugal	−16.44	32.14
6	Sweden	−30.05	77.46	23	Austria	−15.50	29.02
7	Spain	−29.17	74.53	24	Greece	−15.32	28.42
8	Israel	−28.73	73.09	25	Germany	−14.82	26.73
9	Finland	−28.16	71.17	26	Estonia	−13.60	22.69
10	Poland	−27.55	69.16	27	Latvia	−12.81	20.05
11	Belgium	−25.45	62.16	28	Norway	−12.18	17.95
12	Czech Republic	−25.34	61.78	29	Iceland	−11.21	14.73
13	Hungary	−24.55	59.15	30	Japan	−10.07	10.92
14	United States	−23.50	55.66	31	Netherlands	−8.89	6.98
15	New Zealand	−23.02	54.07	32	South Korea	−8.08	4.29
16	Italy	−21.01	47.36	33	Chile	−6.79	0.00
17	Switzerland	−20.49	45.64				

Source: OECD, 2019a, 2019b.

One important shortcoming of the above two indicators should be noted: as there is a close link between carbon emissions and economic growth or decline, the observed low carbon intensity or mitigation trends over a decade for most countries could be an outcome of overall economic decline and not necessarily the result of 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 terms of decarbonization. Low-emitting electricity production measures the share of total electricity generated by low emitting sources of energy—i.e., renewables and nuclear. Renewable sources include hydroelectric, solar, wind, tide, geothermal, and biomass. Nuclear is also considered a low-emitting source of electricity (Echávarri, 2006). **Table 9** shows low-emitting electricity production data for all 33 countries in 2015. Canada, with 78.6% of its electricity generated by renewable and nuclear energy sources, ranks 8th, behind Iceland, Sweden, Norway, Switzerland, France, New Zealand, and the Slovak Republic. Canada's performance is much better than the OECD average, where the share of renewables and nuclear

Table 9. Low-emitting electricity production in 2015, with corresponding ranks and scores

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	Iceland	99.98	100.00	18	United Kingdom	45.75	44.72
2	Sweden	98.00	97.98	19	Czech Republic	43.89	42.82
3	Norway	97.71	97.69	20	Chile	43.60	42.53
4	Switzerland	97.13	97.10	21	Germany	43.55	42.47
5	France	93.49	93.38	22	Italy	38.68	37.51
6	New Zealand	80.08	79.71	23	United States	32.55	31.26
7	Slovak Republic	79.55	79.17	24	Luxembourg	32.38	31.09
8	**Canada**	**78.56**	**78.16**	25	South Korea	31.89	30.59
9	Finland	78.40	78.00	26	Greece	28.66	27.29
10	Austria	76.49	76.05	27	Ireland	27.97	26.58
11	Slovenia	67.51	66.90	28	Japan	16.90	15.30
12	Denmark	65.51	64.86	29	Netherlands	15.95	14.33
13	Hungary	62.77	62.06	30	Estonia	14.42	12.77
14	Belgium	58.33	57.54	31	Poland	13.80	12.14
15	Spain	55.57	54.72	32	Australia	13.64	11.98
16	Latvia	50.17	49.22	33	Israel	1.89	0.00
17	Portugal	47.53	46.53				

Source: World Bank, 2018a, 2018b.

was only 52.5% in 2015. Iceland is the best performer, with almost all of its electricity in 2015 generated by low-emitting sources (99.9%); Israel is the worst performer, with almost none of its electricity generated by low-emitting sources (1.9%).

4. Ecosystem protection—air emissions

In addition to affecting human health, air pollution can be detrimental to ecosystems. In particular, sulphur compounds emitted into 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 and change in SO_X emissions intensity (per unit of GDP) over a 10-year period.

SO_X emissions intensity per unit of GDP is a direct measure of total man-made emissions from sulphur oxides (SO_X), expressed in kilograms per 1,000 US dollars of GDP in 2010 constant Purchasing Power Parity. **Table 10** presents this data for 2016.

Table 10. SO_X emissions intensity in 2016, with corresponding scores and ranks

Rank	Country	Data(kg/PPP 000s$ GDP	Score	Rank	Country	Data (kg/PPP 000s$ GDP	Score
1	Switzerland	0.0120	100.00	16	Japan	0.1470	95.94
2	Luxembourg	0.0190	99.79	17	United States	0.1540	95.73
3	Austria	0.0360	99.28	18	Slovak Republic	0.1670	95.33
3	Netherlands	0.0360	99.28	19	Portugal	0.1680	95.30
4	Denmark	0.0380	99.22	20	Finland	0.1870	94.73
5	Sweden	0.0410	99.13	21	South Korea	0.2000	94.34
6	Ireland	0.0460	98.98	22	Greece	0.2370	93.23
7	Norway	0.0490	98.89	23	Czech Republic	0.3570	89.61
8	Italy	0.0570	98.65	24	Israel	0.3800	88.92
9	France	0.0580	98.62	25	New Zealand	0.4250	87.57
10	United Kingdom	0.0690	98.28	26	Poland	0.6170	81.79
11	Latvia	0.0770	98.04	**27**	**Canada**	**0.6770**	**79.98**
11	Slovenia	0.0770	98.04	28	Chile	0.9120	72.91
12	Belgium	0.0840	97.83	29	Estonia	0.9800	70.86
13	Germany	0.0900	97.65	30	Australia	2.2270	33.32
14	Hungary	0.0950	97.50	31	Iceland	3.3340	0.00
15	Spain	0.1430	96.06				

Source: OECD, 2019c.

Out of 33 countries, Canada ranks 27th and receives a score of 80. Switzerland produces the lowest SO_X emissions (0.01 kilograms per unit of its GDP) and receives a score of 100. Other top performers are Luxembourg (with 0.02 emission intensity and a score of 99.8), Austria and the Netherlands (both with 0.0360, 99.3), and Denmark (0.0380, 99.2.). Iceland is the poorest performer, with a relatively high SO_X emissions intensity of 3.33 kilograms per unit of GDP and a score of zero.

Changes 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 2007 to 2016. Canada ranks 20th in this indicator after reducing SO_X emissions intensity by 52%, as compared to 2007 levels, over the decade. Greece is the best performer, reducing its SO_X emission intensity by more than 80% over the decade. In contrast, Australia is the worst performer as its emission intensity decreased by only 19.3% over the same period.

Table 11. Change in SOX emissions intensity (%) over 2007-2016 as compared to 2007 levels, with corresponding scores and ranks

Rank	Country	Data (% change)	Score	Rank	Country	Data (% change)	Score
1	Greece	−83.23	100.00	18	Netherlands	−56.10	57.52
2	Ireland	−82.03	98.13	19	Latvia	−54.71	55.34
3	Spain	−79.12	93.57	**20**	**Canada**	**−52.02**	**51.13**
4	United States	−78.09	91.96	21	Czech Republic	−51.16	49.79
5	United Kingdom	−74.54	86.39	22	Finland	−50.66	49.00
6	Slovenia	−70.94	80.76	23	Sweden	−48.10	44.99
7	Belgium	−70.53	80.11	24	Austria	−44.62	39.53
8	Portugal	−69.23	78.08	25	Hungary	−40.63	33.29
9	Slovak Republic	−68.96	77.66	26	Germany	−36.17	26.31
10	France	−67.05	74.66	27	Chile	−34.58	23.81
11	Denmark	−65.45	72.17	28	South Korea	−32.20	20.10
12	Luxembourg	−64.81	71.17	29	New Zealand	−30.44	17.34
13	Italy	−63.92	69.77	30	Norway	−27.94	13.42
14	Poland	−62.10	66.92	31	Japan	−27.23	12.31
15	Estonia	−61.22	65.54	32	Iceland	−24.64	8.25
16	Israel	−59.36	62.62	32	Australia	−19.37	0.00
17	Switzerland	−57.14	59.15				

Source: OECD, 2019c.

5. Ecosystem protection—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 affect the quality of water (OECD, 2015).

Data limitations at the global level restricted us from directly assessing how countries maintain their water quality, but following the 2016 EPI study, we have used an indicator that is key driver of water quality—wastewater treatment. [5] This indicator tracks the proportion of wastewater from municipalities, industry, and households that are treated at all levels—primary, secondary, and tertiary stages—before releasing into the environment. [6] 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 measures the percentage of wastewater that is treated at the municipal level, weighted by the population covered by the sewage network. [7] As shown in **table 12**, with over 70% of its wastewater being treated at municipal level in 2016, Canada ranks 19th out of 33 countries and receives a score of 57.03. The top five performers based on this indicator are the Netherlands (with a wastewater treatment rate of 99.1% and a score of 100), United Kingdom (98.4%, 98.8), Luxembourg (97.8%, 98), Spain (97.4% and 97.3), and Switzerland (97%, 96.8). The worst performer is Slovenia with 34.7% of its wastewater being treated.

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[5] Despite the importance of water quality, there are still challenges when trying to compare 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, Esty, Levy, de Sherbinin, et al., 2016).

[6] 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, Esty, Levy, de Sherbinin, et al., 2016).

[7] Rural areas generally make use of 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 data limitations, this indicator, which is adapted from the 2016 EPI study (Hsu, Esty, Levy, de Sherbinin, et al., 2016), does not account for decentralized treatment systems in rural areas and only takes into account wastewater treatment at the municipal level.

Table 12. Wastewater treatment rate (%) in 2016, with corresponding scores and ranks

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	Netherlands	99.10	100.00	18	Estonia	71.88	57.74
2	United Kingdom	98.35	98.83	**19**	**Canada**	**71.42**	**57.03**
3	Luxembourg	97.81	98.00	20	Latvia	71.14	56.60
4	Spain	97.37	97.31	21	New Zealand	70.19	55.12
5	Switzerland	97.02	96.77	22	Norway	69.86	54.61
6	Germany	96.81	96.44	23	Czech Republic	67.76	51.35
7	Israel	95.44	94.32	24	France	66.42	49.27
8	Australia	95.00	93.63	25	Iceland	60.06	39.40
9	Austria	91.90	88.82	26	Japan	57.84	35.94
10	Chile	87.51	82.01	27	Portugal	56.58	34.00
11	Sweden	87.00	81.21	28	Hungary	54.57	30.87
12	Denmark	86.66	80.68	29	United States	50.44	24.46
13	South Korea	84.84	77.87	30	Poland	49.42	22.88
14	Belgium	83.79	76.23	31	Ireland	44.42	15.12
15	Greece	81.08	72.02	32	Slovak Republic	39.62	7.67
16	Italy	79.62	69.76	33	Slovenia	34.68	0.00
17	Finland	75.95	64.05				

Source: Wendling, Emerson, Esty, Levy, de Sherbinin, et al., 2018.

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 2008 to 2017 were calculated to produce performance scores on water use intensity, shown in **table 13**. Out of 28 countries, Canada ranks 4th and receives a score of 98.5. Only Iceland, Latvia, and the Slovak Republic perform better than Canada. Canada's water use intensity (1.2%) is much lower the OECD average of 11.8%. Iceland, the best performer in this category, had a water use intensity of 0.16 and a score of 100. In contrast, Israel has the highest water use intensity with 71.3% of its total renewable water sources being withdrawn. No data were available for Chile, Finland, South Korea, Portugal, and Norway.

Table 13. Water use intensity (%) over 2008-2017, with corresponding scores and ranks

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	Iceland	0.1629	100.00	15	Netherlands	10.2795	85.78
2	Latvia	0.6144	99.37	16	Denmark	12.245	83.01
3	Slovak Republic	1.219	98.52	17	France	12.815	82.21
4	**Canada**	**1.227**	**98.50**	18	Czech Republic	13.2	81.67
5	Luxembourg	1.287	98.42	19	Estonia	13.33	81.49
6	Sweden	1.455	98.18	20	United States	14.06	80.46
7	Ireland	1.456	98.18	21	Greece	15.475	78.47
8	New Zealand	2.3055	96.99	22	Poland	17.81	75.19
9	Slovenia	2.917	96.13	23	Germany	18.645	74.02
10	Australia	3.19	95.74	24	Japan	18.89	73.67
11	Switzerland	3.748	94.96	25	Italy	22.985	67.91
12	Austria	4.494	93.91	26	Belgium	25.395	64.53
13	Hungary	4.5915	93.77	27	Spain	29.385	58.92
14	United Kingdom	5.591	92.37	28	Israel	71.29	0.00

Source: FAO, 2016.

6. Ecosystem protection—forests

Forests are essential to sustaining both human civilization and the planet's biological and physical cycles (Hsu, Esty, Levy, de Sherbinin, 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 the OECD (2015) reported, human activities that impinge on forest cover include agricultural expansion, 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 data limitations, we could not add other relevant indicators, such the intensity of forest use.

Change in forest cover is measured as a percentage of total land over the decade from 2007 to 2016. 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

Table 14. Change in forest cover, 2007–2016, with corresponding ranks and scores

Rank	Country	Slope	Score	Rank	Country	Slope	Score
1	Chile	0.31	100.00	18	Austria	0.03	46.89
2	Greece	0.23	86.40	19	Belgium	0.02	46.35
3	France	0.21	81.06	20	Slovenia	0.02	45.57
4	Italy	0.18	76.64	21	Finland	0.02	44.98
5	Spain	0.15	70.16	22	Slovak Republic	0.01	44.38
6	Denmark	0.15	69.79	23	Iceland	0.01	44.34
7	Switzerland	0.09	59.90	24	Norway	0.01	43.26
8	Ireland	0.08	57.93	25	Germany	0.00	42.36
9	Poland	0.07	56.15	26	Japan	0.00	41.93
10	Israel	0.07	55.35	27	Luxembourg	0.00	41.91
11	United Kingdom	0.06	53.20	28	Australia	0.00	41.09
12	Latvia	0.06	52.92	**29**	**Canada**	**−0.01**	**40.89**
13	Sweden	0.06	52.79	30	New Zealand	−0.01	40.73
14	Hungary	0.05	52.03	31	South Korea	−0.12	19.34
15	United States	0.05	51.17	32	Portugal	**−0.13**	17.26
16	Netherlands	0.03	47.40	33	Estonia	**−0.22**	0.00
17	Czech Republic	0.03	47.23				

Source: World Bank, 2020a.

fairly constant, Canada ranked 29th and received a score of 40.9. This relatively low rank came about because most of Canada's peer countries increased their forest coverage over the same period. The top performers are respectively Chile, Greece, France, Italy, and Spain. Estonia experienced the most significant decline in its forest cover and receives a score of zero.

7. Ecosystem protection—biodiversity

Biodiversity is an important indicator of the health of ecosystems, and relates to 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 measures the number of threatened species (in danger or likely soon to be in danger of extinction) as a percentage of known or assessed species in a

Table 15. Threatened species, most recent year, with corresponding ranks and scores

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	New Zealand	0.81	100.00	17	Greece	16.99	50.10
2	Latvia	6.76	81.64	18	Japan	17.96	47.11
3	South Korea	7.04	80.77	19	United States	22.15	34.21
4	Estonia	7.47	79.45	20	Belgium	23.10	31.28
5	Chile	10.11	71.30	21	Luxembourg	23.42	30.29
6	Norway	10.17	71.12	22	Spain	25.50	23.88
7	Australia	10.30	70.72	23	France	26.16	21.83
8	Denmark	13.06	62.22	24	Netherlands	26.16	21.83
9	United Kingdom	13.60	60.55	25	Hungary	27.01	19.21
10	Ireland	14.09	59.04	26	Portugal	27.24	18.52
11	Italy	14.43	57.99	27	Iceland	27.94	16.36
12	**Canada**	**15.42**	**54.96**	28	Slovenia	28.18	15.62
13	Poland	15.56	54.51	29	Austria	30.40	8.77
14	Sweden	15.60	54.38	30	Czech Republic	30.43	8.68
15	Slovak Republic	16.55	51.47	31	Germany	31.74	4.63
16	Finland	16.59	51.35	32	Switzerland	33.24	0.00

Source: OECD, 2017.

country. **Table 15** presents data on threatened species for the latest year available—the late 2010s for most countries—as well as the corresponding scores and ranks for 32 countries (data for Israel were not available). The result for each country was calculated as an average of the country's data covering mammals, birds, vascular plants, fish, freshwater fish, and invertebrates. As shown, out of 32 countries, Canada ranks 12th and receives a score of 55.0 (well above the OECD average of 44.1). Countries ranking above Canada are New Zealand (ranked 1st with a score of 100), Latvia (2nd, 81.6), South Korea (3rd, 80.8), Estonia (4th, 79.5), Chile (5th, 71.3), Norway (6th, 71.1), Australia (7th, 70.7), Denmark (8th, 62.2), and the United Kingdom (9th, 60.6). With 33.2% of all known species at risk, Switzerland is the worst performer in this category, receiving a score of 0.

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

The Terrestrial protected areas 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; these include nature reserves, national parks, protected landscapes, natural monuments, scientific reserves with limited public access, and areas managed mainly for sustainable use (World Bank, 2020a). **Table 16** displays the terrestrial protected areas as a percentage of total land area in 2018 for 33 OECD countries, as well as their corresponding ranks and scores. As shown, with almost 10% of its terrestrial areas protected, Canada ranks 32th. Slovenia is the best performer with terrestrial protected areas making up 53.6% of total land area; Switzerland is the worst performer with 9.7% of its total land designated as protected areas.

Table 16. Terrestrial protected areas in 2018, with corresponding ranks and scores

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	Slovenia	53.62	100.00	18	Estonia	20.22	24.01
2	Luxembourg	40.87	70.99	19	Israel	19.95	23.39
3	Poland	39.65	68.21	20	Australia	19.27	21.84
4	Germany	37.75	63.89	21	Chile	18.49	20.09
5	Slovak Republic	37.63	63.62	22	Latvia	18.17	19.35
6	Greece	35.22	58.13	23	Iceland	18.15	19.31
7	New Zealand	32.55	52.05	24	Denmark	18.10	19.19
8	Japan	29.39	44.87	25	Norway	17.11	16.93
9	United Kingdom	28.68	43.26	26	Finland	15.02	12.19
10	Austria	28.40	42.62	27	Sweden	14.88	11.87
11	Spain	28.07	41.86	28	Ireland	14.44	10.87
12	France	25.79	36.69	29	United States	12.99	7.57
13	Belgium	23.29	31.00	30	South Korea	11.67	4.56
14	Portugal	22.90	30.11	31	Netherlands	11.24	3.59
15	Hungary	22.60	29.42	**32**	**Canada**	**9.69**	**0.05**
16	Czech Republic	22.16	28.41	33	Switzerland	9.67	0.00
17	Italy	21.54	27.01				

Source: World Bank, 2020a.

Although Canada may seem to be performing poorly based on this indicator, bear in mind that the lack of a protection designation 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, 2013). Therefore, a large portion of its unprotected land mass is located in remote areas where biodiversity is unlikely to be threatened.

8. Ecosystem protection—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 about the effects of agriculture are excessive use of fertilizers (nitrogen and phosphorous) and intensive use of pesticides (OECD, 2015). Run-off from excessive use of nitrogen has several negative impacts on air and water quality, contributes to changes in the climate, and may lead to depletion of the ozone layer (Hsu, Esty, Levy, de Sherbinin, et al., 2016). Likewise, pesticides used in agriculture pose several threats to human health and 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 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, Esty, Levy, de Sherbinin, et al., 2016). **Table 17** presents data on nitrogen-use balance for 31 countries for the year 2015 as well as the countries' associated ranks and scores. The data on nitrogen-balance are expressed as kilograms of nitrogen surplus per hectare of agricultural land. The lower the nitrogen surplus, the better the management of nitrogen resource for agricultural production. Data for Israel and Chile were not available.

Out of 31 countries, Canada ranks 4th and receives a score of 90.2. Only Iceland, Australia, and Estonia have lower nitrogen surplus and perform better than Canada. Hungary and Spain together hold the 9th rank and receive a score of 83.4. Similarly, Austria and Portugal both rank 10th with a score of 82.3, and France and Ireland both rank 11th with a score of 81.8. With 26.6 kilograms of nitrogen surplus per hectare in 2015, Canada's performance is much better than the OECD average of

Table 17. Nitrogen use balance (surplus) in 2015, with corresponding ranks and scores

Rank	Country	Data (kg/ha)	Score	Rank	Country	Data (kg/ha)	Score
1	Iceland	8.42	100.00	14	Finland	49.00	78.00
2	Australia	19.81	93.83	15	Greece	59.00	72.58
3	Estonia	22.00	92.64	16	Switzerland	60.00	72.04
4	**Canada**	**26.58**	**90.16**	17	New Zealand	60.07	72.00
5	United States	27.53	89.64	18	Italy	66.00	68.79
6	Latvia	28.00	89.39	19	Denmark	80.00	61.20
7	Sweden	32.00	87.22	20	Germany	82.00	60.11
8	Slovak Republic	38.00	83.97	21	United Kingdom	83.00	59.57
9	Hungary	39.00	83.42	22	Czech Republic	98.00	51.44
9	Spain	39.00	83.42	23	Norway	100.00	50.35
10	Austria	41.00	82.34	24	Luxembourg	129.00	34.63
10	Portugal	41.00	82.34	25	Belgium	132.00	33.01
11	France	42.00	81.80	26	Japan	172.27	11.17
11	Ireland	42.00	81.80	27	Netherlands	189.00	2.10
12	Slovenia	45.00	80.17	28	South Korea	192.88	0.00
13	Poland	48.00	78.54				

Source: OECD, 2020b.

67.5 kilograms/hectare over the same period. The worst performer for this indicator is South Korea with 192.9 kilograms of nitrogen surplus. Data for Chile and Israel were not available.

Average use of pesticides in measured per area of cropland calculated as kilograms per hectare (kg/ha). As a result of sparse and inconsistent time series, the decadal averages from 2008 to 2017 were used. Table 18 presents data, scores, and ranks for the 33 high-income OECD countries. With average use of 1.9 kg/ha of pesticides, Canada ranks 11th out of 33 countries and receives a score of 88.6. Canada's average use of pesticides is well below the OECD average of 4.14 kg/ha. Top performers were Iceland with an average use of 0.03 kg/ha, Sweden (0.7), Finland (0.71), Estonia (0.86), and Norway (0.89). The bottom five countries are respectively Israel, Japan, South Korea, Netherlands, and New Zealand.

Table 18. Average use of pesticides, 2008–2017, with corresponding ranks and scores

Rank	Country	Data (kg/ha)	Score	Rank	Country	Data (kg/ha)	Score
1	Iceland	0.03	100.00	18	Spain	3.00	81.76
2	Sweden	0.70	95.87	19	United Kingdom	3.05	81.40
3	Finland	0.71	95.80	20	France	3.52	78.56
4	Estonia	0.86	94.87	21	Germany	3.70	77.44
5	Norway	0.89	94.73	22	Ireland	3.77	77.01
6	Latvia	1.05	93.73	23	Slovenia	4.61	71.83
7	Slovak Republic	1.19	92.87	24	Switzerland	4.92	69.90
8	Denmark	1.42	91.44	25	Chile	5.61	65.66
9	Australia	1.65	90.05	26	Portugal	6.67	59.16
10	Czech Republic	1.71	89.68	27	Belgium	6.88	57.89
11	**Canada**	**1.89**	**88.58**	28	Italy	6.96	57.37
12	Poland	1.93	88.31	29	New Zealand	8.70	46.69
13	Hungary	2.09	87.32	30	Netherlands	9.10	44.24
14	Greece	2.18	86.79	31	South Korea	11.94	26.71
15	Luxembourg	2.38	85.55	32	Japan	12.01	26.30
16	United States	2.47	84.97	33	Israel	16.29	0.00
17	Austria	2.61	84.12				

Source: FAO, 2019.

9. Ecosystem protection—fisheries

Fish resources play a significant role in human food supplies and aquatic ecosystems (OECD, 2015). Furthermore, in many countries, fisheries are a significant contributor to the economy, providing employment 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, 2015). 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 the Marine Trophic Index.

The Marine Trophic Index measures the degree to which countries are "fishing down the food chain", meaning 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 scarce 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 overfishing. 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 the trend line over a 10-year period from 2005 to 2014 since there has not been any update for the Marine Trophic Index. No data were available for the following 7 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 in Marine Trophic Index from 2005 to 2014, with corresponding ranks and scores

Rank	Country	Slope	Score	Rank	Country	Slope	Score
1	Slovenia	0.0295	100.00	13	South Korea	0.0000	49.27
2	France	0.0132	71.88	14	Italy	−0.0012	47.19
3	Latvia	0.0095	65.52	15	Netherlands	−0.0015	46.67
4	Greece	0.0087	64.17	**16**	**Canada**	**−0.0021**	**45.63**
5	Estonia	0.0079	62.92	17	United Kingdom	−0.0036	43.02
6	Poland	0.0075	62.08	18	Belgium	−0.0048	41.04
7	Portugal	0.0072	61.56	19	Iceland	−0.0053	40.21
8	Norway	0.0059	59.48	20	Spain	−0.0072	36.98
9	New Zealand	0.0054	58.54	21	Japan	−0.0081	35.31
10	Sweden	0.0015	51.88	22	Australia	−0.0084	34.79
10	Finland	0.0015	51.88	23	Israel	−0.0193	16.09
11	Denmark	0.0014	51.72	24	Chile	−0.0222	11.15
12	Germany	0.0004	49.95	25	Ireland	−0.0287	0.00

Source: Sea Around Us, 2005–2014.

4. Conclusion

The Index of Environmental Performance shows that Canada performs better than the majority of high-income OECD countries on environmental protection. Canada ranks 12th out of 33 high-income OECD countries and receives an overall score of 67.0, compared to a top rank of 80.0 (Sweden). The data provide compelling evidence that Canada is not an environmental laggard—in fact, Canadians enjoy high levels of environmental quality in absolute terms and in comparison to our OECD peers.

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 the 16 indicators, weighting each one equally, to obtain an overall score ranging from zero to 100. As it does as shown by the results presented in section 1 and in the first edition of this report, with a score of 68.2 Canada performs well, ranking 13th out of 33 high-income OECD countries. Canada's score is well above the OECD average of 61.9. The top five performers are Sweden (with a score of 78.6), the United Kingdom (72.9), Finland (72.6), Denmark (72.4), and Spain (71.5), which have scores not that higher than Canada's. The five poorest performers are respectively South Korea (with a score of 40.5), Japan (45.1, Israel (45.6), the Netherlands (50.1), and the Czech Republic (54).

Table A1. Index of Environmental Performance giving equal weighting to indicators, score out of 100

Rank	Country	Score	Rank	Country	Score
1	Sweden	78.65	18	Estonia	61.14
2	Denmark	73.21	19	Iceland	60.18
3	United Kingdom	72.78	20	Italy	59.90
4	New Zealand	72.23	21	Latvia	59.61
5	Finland	71.93	22	Belgium	59.49
6	Spain	71.73	23	Australia	59.09
7	Switzerland	69.79	24	Hungary	58.99
8	Luxembourg	68.85	25	Ireland	58.62
9	France	68.83	26	Germany	58.57
10	Norway	66.75	27	Poland	57.04
11	Slovak Republic	65.63	28	Czech Republic	54.66
12	United States	65.61	29	Chile	50.90
13	**Austria**	**65.43**	30	Netherlands	49.40
14	Canada	65.25	31	Israel	46.52
15	Greece	64.97	32	Japan	44.48
16	Slovenia	63.13	33	Korea	39.57
17	Portugal	62.28			

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Notre mission consiste à améliorer la qualité de vie des Canadiens et des générations à venir en étudiant, en mesurant et en diffusant les effets des politiques gouvernementales, de l'entrepreneuriat et des choix sur leur bien-être.

Peer review—validating the accuracy of our research

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