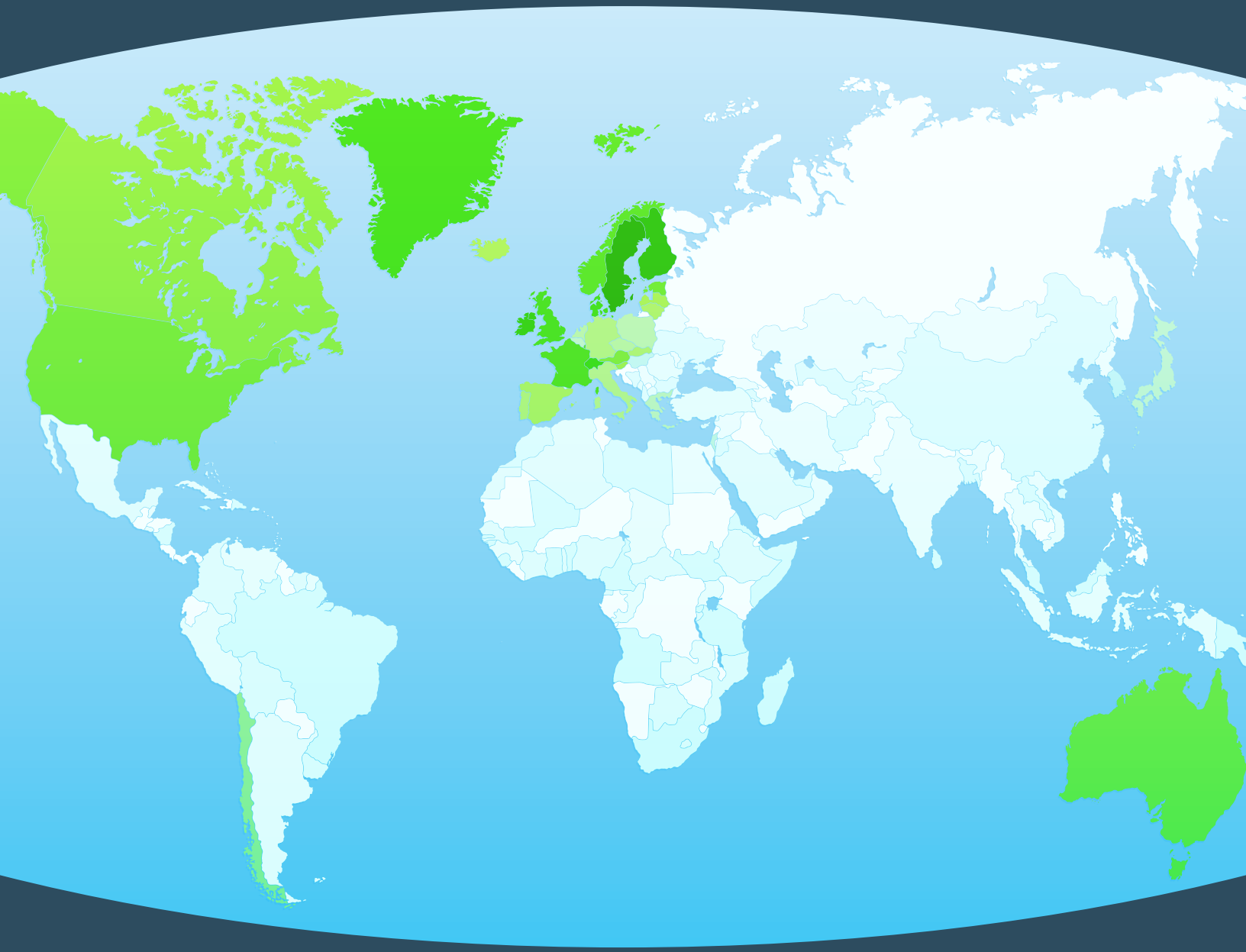
Environmental Ranking for Canada and the OECD

Third Edition

Elmira Aliakbari & Julio Mejia



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by Elmira Aliakbari and Julio Mejia

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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. 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 is the Fraser Institute's third edition of *Environmental Ranking for Canada and the OECD*, in which we rank 34 high-income countries across two broad objectives: protecting human health and well-being, and protecting ecosystems. We calculate an overall Index of Environmental Performance, a composite measure based on 19 indicators that track 11 core categories. Under the heading of protecting human health and well-being, we examine air quality, water quality, greenhouse gases, and two newly added categories of heavy metals and solid-waste management. Under the objective of protecting ecosystems, we consider six core categories: air emissions, water resources, forests, biodiversity, agriculture, and fisheries. To construct the index, we assign equal weight to composite indicators of human health and well-being protection and to indicators of ecosystem protection. The index scores range from zero to 100 and a higher score means a jurisdiction has a stronger environmental performance while a lower score indicates weaker environmental performance.

The overall scores range from a low of 47.5 for South Korea to a high of 81.5 for Sweden, with an average of 65.5 across all 34 high-income countries. Canada performs relatively well, obtaining an overall score of 69.9, which places it 14th out of 34 high-income OECD countries, behind Sweden, Finland, Ireland, Switzerland, Denmark, the United Kingdom, France, Norway, Luxembourg, New Zealand, Estonia, the United States, and Austria. Our method shows that Canada performs better than the majority of high-income OECD countries on environmental protection.

For air quality (under impact on human health and well-being), Canada performs well, ranking highly out of 34 countries based on two air-quality indicators: average exposure to fine particulate matter (8th) and fine particulate matter exceedance (6th). For water quality, Canada ranks 19th and 11th out of 34 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 measures nearly all countries have very good scores and there is little difference among countries.

In the category of greenhouse gases, Canada ranks 32nd for carbon intensity (CO_2 emissions per unit of GDP) and 30th for its ability to reduce its carbon intensity

over a decade. However, it ranks 7th based on low-emitting electricity production, which measures the share of total electricity generated by low-emitting sources of energy—renewables and nuclear.

Canada performs well in the newly added category of heavy metals and its corresponding indicator, which measures lead exposure, ranking 7th out of 34 high-income OECD countries. Only Finland, Chile, Israel, Japan, Denmark, and Iceland perform better than Canada in this category. With more than 99.9% of its solid waste under control and safely treated, Canada ranks 21st in the category of solid-waste management. The Netherlands is the best performer in this category, with 100% of the country's solid waste being controlled and treated in an environmentally safe manner.

Canada ranks 30th 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. Moreover, Canada's SO_X emission intensity declined by 52.4% compared to 2009 levels, which ranks Canada in the 16th place for its decrease in sulphur emissions intensity over the period studied.

Canada ranks 21st for its wastewater-treatment rate and 6th for the intensity of use of its water resources. On the latter measure only Iceland, Latvia, Norway, Lithuania, and the Slovak Republic perform better than Canada.

Despite preserving its forest cover over a decade, Canada ranks 26th because forest cover has increased somewhat in many other countries. Canada ranks 18th out of 33 countries for the number of species at risk and 33rd out of 34 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 14th on pesticide use. Only Iceland and Australia perform better than Canada, using less fertilizer per hectare. Finally, Canada performs well and ranks 9th out of 26 countries in the fisheries category, which measures changes in the marine trophic level.

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 unavoidable because 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. Several 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. And, 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.

As we argued in previous editions, the methodologies behind these studies is flawed because they unfairly represent Canada's environmental performance in some respects and do not always use the most meaningful and relevant performance measures. In the 2018 edition of the report, we concluded that their results are sensitive to faulty assumptions that tend to unfairly penalize Canada's environmental record. For instance, with respect to 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, 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 results reported above and the public records of air and water quality, which show that Canadians generally experience high

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

levels of environmental quality. Thus, we were not confident that the earlier 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 and 2020 versions of the report. [2] The methodology used this year is mostly consistent with the previous versions. The only change we have made in this version is the addition of two new core categories under the human health and well-being objective: heavy metals and solid waste management. The heavy metals category has one indicator, which measures lead exposure per 100,000 inhabitants. The category of solid-waste management also has one indicator, which measures the percentage of solid waste that is uncontrolled and not treated in an environmentally safe manner.

The result is the third edition of *Environmental Ranking for Canada and the OECD*, in which we examine the performance of 34 high-income countries across 19 indicators grouped into 11 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 14th out of 34 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 discussed above 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 34 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 of the results on the 19 specific indicators that make up the composite index. The last section presents our conclusions. The Appendix presents a recalculation of the overall index 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 study assesses the environmental performance of 34 high-income OECD countries across two broad objectives: protecting human health and well-being, and protecting ecosystems. The index is calculated using 19 indicators that measure 11 core categories grouped as follows:

Human health and well-being (5 core categories)

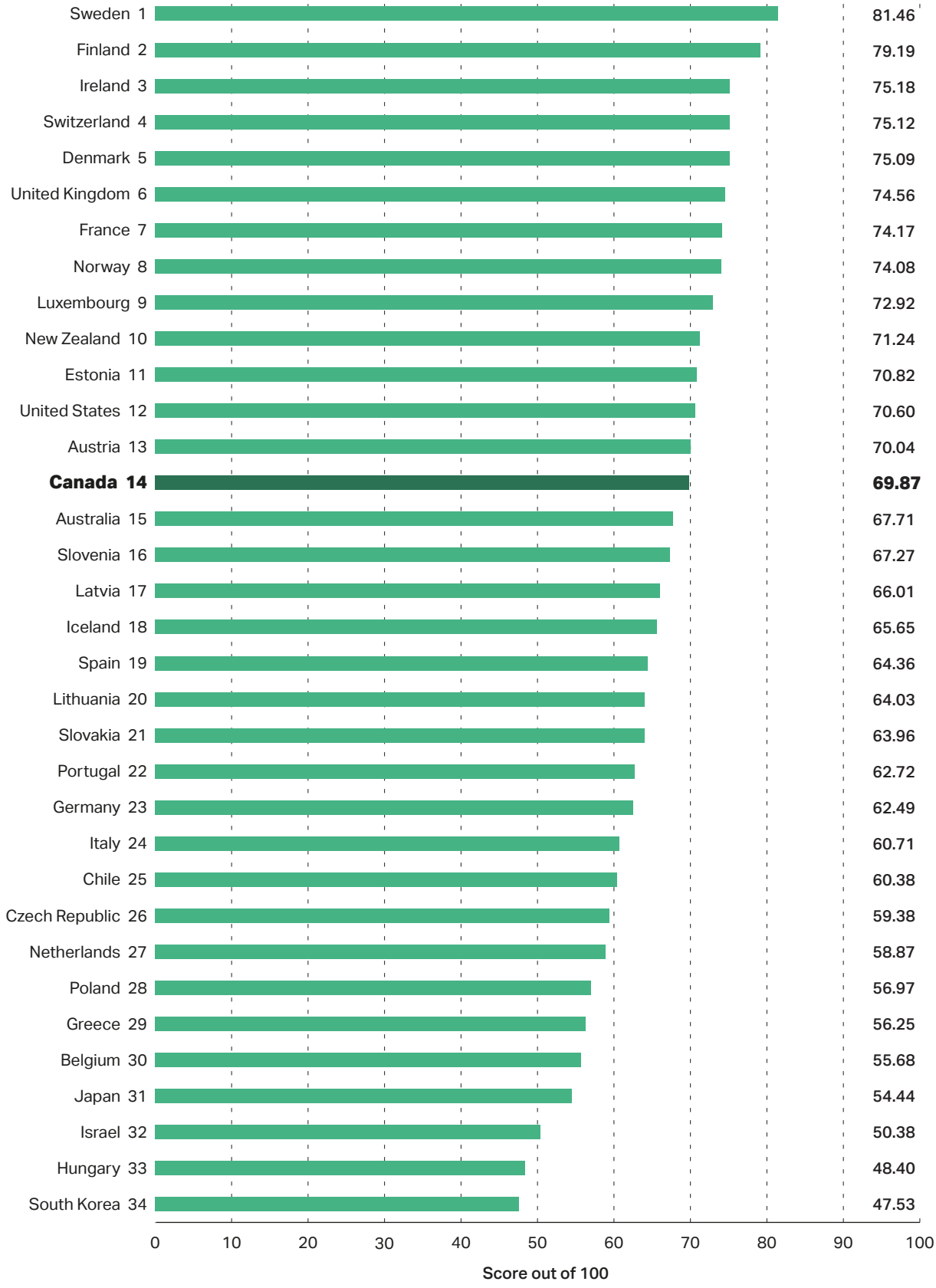
1. Air quality (2 indicators)
2. Water quality (2 indicators)
3. Greenhouse gases (3 indicators)
4. Heavy metals (1 indicator)
5. Solid waste management (1 indicator)

Ecosystem protection (6 core categories)

6. Air emissions (2 indicators)
7. Water resources (2 indicators)
8. Forests (1 indicator)
9. Biodiversity (2 indicator)
10. Agriculture (2 indicators)
11. 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 19 indicators are then averaged to obtain the composite index. When aggregating the scores, we assign 50% weight to indicators relating to human health and well-being protection and 50% weight to indicators relating to ecosystem protection. (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 47.5 for South Korea to a high of 81.5 for Sweden. The average score is 65.5. Overall, Canada performs relatively well, obtaining a score of 69.9, which is 14th out of our sample of 34 high-income OECD countries. Canada falls behind Sweden, Finland, Ireland, Switzerland, Denmark, United Kingdom, France,

Figure 1: Index of Environmental Performance in Canada and the OECD, 2023



Norway, Luxembourg, New Zealand, Estonia, the United States, and Austria. 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 8th and 6th out of 34 countries based on the two air quality indicators—average exposure to fine particulate matter and fine particulate matter exceedance. It ranks 7th out of 34 countries based on low-emitting electricity production, namely electricity generated by nuclear power and renewable energy sources. Moreover, Canada ranks 7th out of 34 for exposure of its population to heavy metals. Canada ranks 6th out of 34 countries in intensity of water use, which measures freshwater withdrawal as a percentage of total renewable water resources. Canada also excels in nitrogen-use balance (use of fertilizer), ranking 3rd out of 32.

In the areas where Canada appears to do worse than average there are some caveats worth noting. Canada ranks 32nd and 30th for carbon intensity (CO_2 emissions per unit of GDP) and the 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, which are outside our control.

Canada ranks 30th based on the intensity of its SO_X emissions, which measures SO_X emissions generated per unit of activity. But, on this measure, most countries are clustered very tightly: the first 27 countries all have scores above 90. Also, Canada performs better in its ability to reduce SO_X emissions intensity over a 10-year period, ranking 16th out of 34 countries

For percentage change in forest cover, Canada ranks 26th and receives a relatively low score of 37.3. But, as our analysis shows, the absolute change in Canadian forest cover was nearly zero over the past decade and 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.

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

[3] The Appendix presents the results of recomputing the Index of Environmental Performance by simply averaging the scores of all 19 indicators, giving each one equal weighting. Using this method, Canada ranks 13th out of 34. 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.

Table 1. Summary of Canada's OECD ranking and score by indicator, 2022

	Score	Rank
Air Quality		
Average exposure to $PM_{2.5}$ ($\mu g/m^3$)	93.34	8th out of 34
Average $PM_{2.5}$ exceedance (%)	98.23	6th out of 34
Water Quality		
Access to improved sanitation facilities (%)	88.79	19th out of 34
Access to improved drinking water sources (%)	70.07	11th out of 34
Greenhouse Gases		
Carbon intensity (thousand tonnes/PPP millions $GDP)	19.85	32nd out of 34
Change in Carbon intensity (%)	16.1	30th out of 34
Low-emitting electricity production (%)	80.52	7th out of 34
Heavy Metal		
Lead Exposure (per 100k inhabitants)	90.58	7th out of 34
Solid Waste Management		
Uncontrolled solid waste (%)	85.34	21st out of 34
Air Emissions		
SO_X emissions intensities (kg/PPP thousands $GDP)	83.74	30th out of 34
Change in SO_X emissions intensities (%)	64.44	16th out of 34
Water resources		
Wastewater treatment rate (%)	61.44	21th out of 34
Intensity of use of water (%)	98.35	6th out of 34
Forest		
Change in forest cover (%)	37.29	26th out of 34
Biodiversity		
Threatened species (%)	54.96	18th out of 33
Terrestrial protected areas (%)	1.52	33th out of 34
Agriculture		
Nitrogen use balance (kg/ha)	92.37	3rd out of 32
Pesticide use (kg/ha)	87.1	14th out of 34
Fisheries		
Change in Marine Trophic Index (%)	56.8	9th out of 26

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. Where our ranking is low it is sometimes unavoidable because 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 34 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 of the Environmental Performance Index (EPI) used 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 19 indicators. This year we have included two new categories: heavy metals and solid waste management. Each of these new categories have one indicator. 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 human health and well-being, we look at air quality, water quality, greenhouse gases, and the two newly added categories of heavy metals and solid waste management. In the category of ecosystem protection, we consider air emissions, water resources, forests, biodiversity, agriculture, and fisheries.

For measures of current performance we chose the most recent year—excluding the pandemic period (2020/21)—that provided the most complete data. In some cases more recent data were available for some countries but we selected the year that allowed complete coverage on a consistent time basis. In cases 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, British Petroleum (BP), the Institute for Health Metrics and Evaluation, and the Yale Center for Environmental Law and Policy.

[4] There are currently 38 countries in the OECD. Of the 38 countries, Colombia, Costa Rica, 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 $13,205 or more in 2023 (World Bank, 2023a).

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 (Hsu, Esty, Levy, de Sherbinin, *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 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 (10%)	a. Average exposure to $PM_{2.5}$ ($\mu g/m^3$)
		b. Average $PM_{2.5}$ exceedance (%)
	2. Water Quality (10%)	a. Access to improved sanitation facilities (%)
		b. Access to improved drinking water sources (%)
	3. Greenhouse Gases (10%)	a. Carbon intensity (*thousand tonnes/PPP millions $GDP*)
		b. Change in carbon intensity (%)
		c. Low-emitting electricity production (%)
	4. Heavy metal (10%)	a. Lead exposure per 100,000 inhabitants
	5. Solid waste management (10%)	a. Uncontrolled solid waste
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 34 countries for the year 2019, as well as their ranks and corresponding scores. With an average exposure of 7.0 micrograms per cubic meter, Canada ranks 8th among the 34 high-income OECD countries and receives a score of 93.3.

Finland has the lowest mean exposure to $PM_{2.5}$ among the countries (average exposure of 5.6 ($\mu g/m^3$) and receives a score of 100. Sweden (average exposure of 5.7) and Estonia (average exposure of 5.9) are the second and third best performers. The average for high-income OECD countries was 12.2 micrograms per cubic meter, well above Canada's mean exposure. The US ranks 9th with an average exposure of 7.7 and receives a score of 90.7. The five poorest performers are South Korea (ranked 34th with 27.4 micrograms per cubic meter of average exposure), Chile (33rd, 23.7), Poland (32nd, 22.8), Israel (31st, 19.4) and Slovak Republic (30th, 18.5).

$PM_{2.5}$ 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 2019 for 34 OECD countries, as well as their associated scores and ranks. With 100% of their population not exposed to $PM_{2.5}$ levels greater than 10 $\mu g/m^3$, Estonia, Finland, and New Zealand receive a score of 100 and rank 1st out of 34 countries. Canada ranks 6th in this category with 98.2% of its population not exposed to $PM_{2.5}$ levels greater than 10 $\mu g/m^3$. The average OECD population not exposed to $PM_{2.5}$ levels exceeding 10 micrograms per cubic meter was 43.5%.

Table 3: Average $PM_{2.5}$ exposure (μg/m³), 2019, with corresponding scores and ranks

Rank	Country	Data (μg/m³)	Score	Rank	Country	Data (μg/m³)	Score
1	Finland	5.64	100.00	18	France	11.37	73.73
2	Sweden	5.72	99.62	19	Germany	11.93	71.16
3	Estonia	5.95	98.57	20	Netherlands	12.03	70.68
4	New Zealand	6.05	98.11	21	Austria	12.22	69.80
5	Iceland	6.37	96.63	22	Latvia	12.71	67.59
6	Norway	6.67	95.28	23	Belgium	12.73	67.50
7	Australia	6.75	94.91	24	Japan	13.65	63.28
8	**Canada**	**7.09**	**93.34**	25	Greece	14.32	60.19
9	United States	7.68	90.66	26	Italy	15.85	53.19
10	Ireland	7.85	89.87	27	Hungary	16.60	49.76
11	Portugal	8.18	88.36	28	Czech Republic	16.97	48.06
12	Denmark	9.78	80.99	29	Slovenia	17.06	47.62
13	Spain	9.99	80.03	30	Slovak Republic	18.53	40.91
14	United Kingdom	10.02	79.90	31	Israel	19.42	36.79
15	Switzerland	10.04	79.80	32	Poland	22.77	21.47
16	Luxembourg	10.09	79.59	33	Chile	23.68	17.26
17	Lithuania	10.47	77.85	34	South Korea	27.45	0.00

Source: OECD, 2019.

Other top-performing countries are Australia (99.99%), Ireland (99.40%), Norway (99.25%), and Sweden (98.37%). On the other hand, Israel, Hungary, and the Slovak Republic, where all the population is exposed to levels of $PM_{2.5}$ above WHO standard, are the worst performers and hold the last position in the rank.

2. Human health and well-being—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; 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

Table 4. Percentage of population not exposed to PM2.5 above 10 µg/m³ (%), 2019, with corresponding scores and ranks

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	Estonia	100.00	100.00	16	France	30.73	30.51
1	Finland	100.00	100.00	17	Latvia	30.51	17.59
1	New Zealand	100.00	100.00	18	Austria	17.59	13.17
2	Australia	99.99	99.99	19	Germany	13.17	8.58
3	Ireland	99.40	99.40	20	Italy	8.58	6.94
4	Norway	99.25	99.25	21	Belgium	6.94	3.39
5	Sweden	98.37	98.37	22	Greece	3.39	2.35
6	**Canada**	**98.23**	**98.23**	23	Japan	2.35	1.40
7	Iceland	96.53	96.53	24	Netherlands	1.40	1.38
8	United States	94.39	94.39	25	Chile	1.38	0.55
9	Portugal	84.83	84.83	26	Korea	0.55	0.33
10	Denmark	63.59	63.59	27	Czech Republic	0.33	0.04
11	Spain	52.92	52.92	28	Slovenia	0.04	0.01
12	Switzerland	51.47	51.47	29	Poland	0.01	0.00
13	Lithuania	47.82	45.41	30	Israel	0.00	0.00
14	United Kingdom	45.41	31.44	30	Hungary	0.00	0.00
15	Luxembourg	31.44	30.73	30	Slovak Republic	0.00	0.00

Source: OECD, 2019.

key indicators are used to assess the health risks posed by water pollution: access to improved sanitation facilities and access to improved drinking 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 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 2019.

With 99.03% of its population accessing improved sanitation facilities, Canada ranks 19th and receives a score of 88.8. Chile, New Zealand, and Poland 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 Iceland, France, and Norway. Canada's share of population with access to improved sanitation

Table 5: Access to improved sanitation facilities (%), 2019, with corresponding scores and ranks

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	Chile	100.00	100.00	15	Germany	99.23	91.10
1	New Zealand	100.00	100.00	16	Estonia	99.14	90.06
1	Poland	100.00	100.00	17	Czechia	99.13	89.94
2	Australia	99.99	99.88	18	United Kingdom	99.11	89.71
3	Austria	99.97	99.65	**19**	**Canada**	**99.03**	**88.79**
4	Israel	99.95	99.42	20	Greece	98.99	88.32
5	South Korea	99.94	99.31	21	Iceland	98.78	85.90
6	Japan	99.93	99.19	22	France	98.65	84.39
7	Spain	99.90	98.84	23	Slovenia	98.09	77.92
7	Switzerland	99.90	98.84	24	Norway	98.05	77.46
8	Italy	99.89	98.73	25	Hungary	97.99	76.76
9	United States	99.70	96.53	26	Netherlands	97.69	73.29
10	Portugal	99.61	95.49	27	Luxembourg	97.59	72.14
11	Denmark	99.60	95.38	28	Slovakia	97.53	71.45
12	Belgium	99.49	94.10	29	Lithuania	93.92	29.71
13	Finland	99.45	93.64	30	Latvia	92.41	12.25
14	Sweden	99.29	91.79	31	Ireland	91.35	0.00

Source: WHO, 2022a.

facilities is still higher than the average of the 34 high-income OECD countries (98.6%). Ireland is the worst performer (91.4 %) and receives a score of zero.

Access to improved drinking water sources 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 2019 for all 34 countries, along with their associated ranks and scores. With 99.2% of its population having access to improved drinking water sources, Canada ranks 11th and receives a score of 70.1. Seventeen countries, including Austria, Belgium, Chile, Denmark, Finland, Israel, and the United Kingdom, share the first rank as 100% of their populations have access to improved drinking water sources. Ireland, Lithuania, and Japan are the worst performers based on this indicator.

Table 6: Access to improved drinking water sources (%), 2019, with corresponding scores and ranks

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	Austria	100.00	100.00	2	Australia	99.97	98.84
1	Belgium	100.00	100.00	2	Poland	99.97	98.72
1	Chile	100.00	100.00	3	Spain	99.93	97.36
1	Denmark	100.00	100.00	3	Italy	99.93	97.14
1	Finland	100.00	100.00	4	Portugal	99.92	96.81
1	France	100.00	100.00	5	Czechia	99.91	96.62
1	Germany	100.00	100.00	6	Luxembourg	99.88	95.52
1	Greece	100.00	100.00	6	South Korea	99.88	95.41
1	Hungary	100.00	100.00	6	Sweden	99.88	95.38
1	Iceland	100.00	100.00	7	United States	99.83	93.34
1	Israel	100.00	100.00	8	Estonia	99.59	84.26
1	Netherlands	100.00	100.00	9	Slovenia	99.50	80.77
1	New Zealand	100.00	100.00	10	Latvia	99.46	79.42
1	Norway	100.00	100.00	**11**	**Canada**	**99.22**	**70.07**
1	Slovakia	100.00	100.00	12	Japan	99.08	64.58
1	Switzerland	100.00	100.00	13	Lithuania	98.01	23.60
1	United Kingdom	100.00	100.00	14	Ireland	97.40	0.00

Source: UNICEF and WHO, 2022.

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 an impact 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 presented 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 millions of US dollars of GDP in 2017 constant Purchasing Power Parity. **Table 7** presents carbon intensity data in 2018 for all 34 countries as well as the associated rankings and scores. With 0.32 thousand tonnes of CO_2 emission per unit of GDP, Canada ranks 32nd and receives a score of 19.8. 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 0.06 thousand tonnes of CO_2 emissions/unit of GDP), Sweden (2*nd*, 0.08), Ireland (3rd, 0.10), Denmark (4th, 0.11), and France (5th, 0.11)

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 2009 to 2018 as compared to 2009 levels for all 34 countries, as well as the corresponding scores and ranks. With a reduction in carbon intensity of 12.4% over a decade,

Table 7. Carbon intensity, 2018, with corresponding ranks and scores

Rank	Country	Data (000 tonnes/2017 PPP million$ GDP)	Score	Rank	Country	Data (000 tonnes/2017 PPP million$ GDP)	Score
1	Switzerland	0.0613	100.00	18	Germany	0.1701	66.55
2	Sweden	0.0790	94.56	19	Belgium	0.1709	66.31
3	Ireland	0.0957	89.43	20	Finland	0.1728	65.73
4	Denmark	0.1116	84.55	21	Israel	0.1821	62.87
5	France	0.1117	84.52	22	Iceland	0.1826	62.72
6	United Kingdom	0.1222	81.29	23	Slovenia	0.1844	62.16
7	Norway	0.1299	78.92	24	Chile	0.1860	61.68
8	Latvia	0.1357	77.13	25	Slovak Republic	0.2127	53.45
9	Austria	0.1362	76.97	26	Japan	0.2160	52.44
10	Luxembourg	0.1368	76.81	27	Greece	0.2295	48.29
11	Italy	0.1374	76.62	28	Czech Republic	0.2505	41.83
12	Lithuania	0.1379	76.47	29	United States	0.2682	36.40
13	Spain	0.1433	74.78	30	Poland	0.2802	32.70
14	Portugal	0.1470	73.66	31	South Korea	0.3072	24.41
15	Hungary	0.1626	68.87	**32**	**Canada**	**0.3220**	**19.85**
16	Netherlands	0.1642	68.37	33	Australia	0.3399	14.36
17	New Zealand	0.1700	66.59	34	Estonia	0.3865	0.00

Sources: OECD, 2023a; World Bank, 2023b..

Canada ranks 30th out of 34 countries and receives a score of 16.1. Norway, South Korea, Estonia, and Chile perform worse than Canada.

One important shortcoming of the above 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 the 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 terms of decarbonization.

Low-emitting electricity production measures the share of total electricity generated by low emitting sources of energy—that is, renewables and nuclear. Renewable sources include hydroelectric, solar, wind, tide, geothermal, and biomass. Nuclear is also considered a low-emitting source of electricity (Echavarri, 2007). **Table 9** shows low-emitting electricity production data for all 34 countries

Table 8. Change in carbon intensity, 2009–2018, with corresponding ranks and scores

Rank	Country	Data (% change)	Score	Rank	Country	Data (% change)	Score
1	Ireland	−46.13	100.00	18	United States	−19.70	34.26
2	Denmark	−38.50	81.03	19	Italy	−19.57	33.93
3	United Kingdom	−36.06	74.95	20	Belgium	−19.39	33.48
4	Switzerland	−29.73	59.21	21	Lithuania	−22.89	42.18
5	Israel	−29.66	59.04	22	Australia	−19.14	32.86
6	Sweden	−29.51	58.65	23	Netherlands	−17.37	28.46
7	Luxembourg	−28.18	55.35	24	Spain	−16.45	26.18
8	Slovak Republic	−26.78	51.88	25	Latvia	−15.37	23.48
9	Finland	−26.30	50.66	26	Portugal	−15.09	22.78
10	Czech Republic	−25.43	48.50	27	Austria	−13.80	19.59
11	Iceland	−23.76	44.35	28	Japan	−13.03	17.66
12	Hungary	−23.47	43.64	29	Greece	−12.78	17.05
13	Slovenia	−23.28	43.16	**30**	**Canada**	**−12.40**	**16.10**
14	Poland	−22.18	40.43	31	Norway	−10.49	11.34
15	France	−22.06	40.12	32	Korea	−9.65	9.25
16	New Zealand	−20.92	37.30	33	Estonia	−9.49	8.86
17	Germany	−20.54	36.35	34	Chile	−5.93	0.00

Sources: OECD, 2023a; World Bank, 2023b.

in 2019. Canada, with 81.4 % of its electricity generated by renewable and nuclear energy sources, ranks 7th, behind Iceland, Sweden, Norway, Switzerland, France, and New Zealand. Canada's performance is much better than the OECD average, where the share of renewables and nuclear was only 56.1% in 2019. Iceland is the best performer, with almost all of its electricity in 2019 generated by low-emitting sources (99.9%); Israel is the worst performer, with less than 5% of its electricity generated by low-emitting sources.

4. Human health and well-being—heavy metals

Heavy metals are persistent environmental pollution and associated with the poisoning of humans. Sources of heavy metal contamination include industrial activities, air or water pollution, mining, smelting, foods, medicines, recycling, and improperly coated food containers (WHO, 2022b). Lead is one of the most common heavy metal

Table 9. Low-emitting electricity production, 2019, with corresponding ranks and scores

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	Iceland	99.95	100.00	18	Germany	51.96	49.69
2	Sweden	97.90	97.86	19	Portugal	51.56	49.27
3	Norway	97.15	97.06	20	Chile	50.44	48.10
4	Switzerland	93.30	93.03	21	Latvia	49.53	47.15
5	France	90.99	90.61	22	Czech Republic	46.30	43.76
6	New Zealand	81.88	81.06	23	Luxembourg	41.88	39.13
7	**Canada**	**81.36**	**80.52**	24	Italy	39.65	36.79
8	Finland	80.44	79.55	25	Ireland	38.11	35.17
9	Denmark	78.18	77.18	26	United States	36.75	33.75
10	Slovak Republic	77.22	76.17	27	Greece	33.07	29.88
11	Austria	73.62	72.40	28	Korea	30.54	27.24
12	Slovenia	67.52	66.00	29	Estonia	27.30	23.83
13	Belgium	67.28	65.75	30	Japan	23.97	20.35
14	Lithuania	62.22	60.44	31	Netherlands	22.00	18.28
15	Hungary	61.18	59.36	32	Australia	20.78	17.01
16	Spain	57.79	55.81	33	Poland	15.52	11.49
17	United Kingdom	54.27	52.11	34	Israel	4.56	0.00

Source: BP p.l.c., 2019.

pollutants, and even low-level exposure can increase the risk of high blood pressure, kidney damage, miscarriage, and long-term harm to children's brain and nervous system development. This category includes one indicator: lead exposure.

The *lead exposure* indicator measures the number of age-standardized disability-adjusted life-years lost per 100,000 persons (DALY rate) from exposure to lead. **Table 10** presents this measure for all 34 countries, along with their ranks and respective scores. With a 45.1 DALYs lost per 100,000 inhabitants, Canada ranks 7th among the 34 high-income OECD countries and receives a score of 90.6. The average DALY rate attributable to lead exposure for the countries included in the study is 90.1.

Finland ranks 1st among the 34 countries and has the lowest exposure (26.7 DALY rate from lead exposure) receiving a score of 100. Portugal (222.3), Greece (186.6), and Belgium (182.0) are the worst performing countries for this indicator.

5. Human health and well-being—solid waste management

Poor waste collection, transport, treatment, and disposal are associated with disease-spreading vermin, contamination of air, food and water as well as soil and groundwater pollution. Improper waste collection leads to environmental pollution,

Table 10. Lead exposure (per 100,000 inhabitants), 2019, with corresponding ranks and scores

Rank	Country	Data	Score	Rank	Country	Data	Score
1	Finland	26.69	100.00	18	Germany	76.87	74.35
2	Chile	30.73	97.94	19	Slovenia	78.33	73.60
3	Israel	40.11	93.14	20	Lithuania	83.76	70.83
4	Japan	42.65	91.84	21	France	95.67	64.74
5	Denmark	44.64	90.83	22	Australia	101.83	61.60
6	Iceland	45.10	90.59	23	United States	106.05	59.43
7	**Canada**	**45.12**	**90.58**	24	New Zealand	106.27	59.32
8	Luxembourg	45.74	90.26	25	Latvia	106.43	59.24
9	Sweden	47.27	89.48	26	Czechia	118.49	53.08
10	United Kingdom	53.55	86.27	27	Italy	127.03	48.71
11	Norway	54.91	85.57	28	Slovakia	133.69	45.31
12	Netherlands	56.93	84.54	29	Spain	143.27	40.41
13	Korea	57.94	84.03	30	Hungary	163.41	30.12
14	Switzerland	58.34	83.82	31	Poland	171.16	26.16
15	Austria	69.49	78.12	32	Belgium	181.96	20.63
16	Estonia	70.84	77.43	33	Greece	186.57	18.28
17	Ireland	71.43	77.13	34	Portugal	222.33	0

Source: Institute for Health Metrics and Evaluation, 2019.

and blockages of water drains, which favour standing waters and generates cholera and vector-borne diseases such as malaria and dengue (WHO, 2021). The category of solid waste management includes one indicator: uncontrolled solid waste.

The *uncontrolled solid waste* indicator refers to the percentage of improper disposal, recycling, incineration, anaerobic digestion, or composting of garbage, trash, refuse, or discarded material that could generate environmental risks (EPI, 2022). This indicator counts waste as "uncontrolled" if it is not treated through composting, recycling, incineration, or anaerobic digestion, or disposed of in a sanitary landfill.

Table 11 presents this measure for all 34 countries, along with their ranks and corresponding scores. Note that all countries are clustered extremely closely together, properly handling at least 99.5% of solid waste. With only 0.1% of Canada's solid waste being uncontrolled, it ranks 21st and receives a score of 85.3. The Netherlands is the top performing country in this category; nearly zero percent of its solid waste is uncontrolled and it received a score of 100. The worst performing country in this category is Hungary, which has 0.5% uncontrolled solid waste and a score of 0, followed by Chile and Latvia.

Table 11. Uncontrolled solid waste (%) in 2019, with corresponding ranks and scores

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	Netherlands	0.004	100.000	18	Ireland	0.061	88.598
2	Switzerland	0.005	99.800	19	Czech Republic	0.063	88.278
3	Sweden	0.006	99.640	20	Japan	0.073	86.277
4	Denmark	0.006	99.560	**21**	**Canada**	**0.077**	**85.337**
5	Norway	0.012	98.380	22	Israel	0.080	84.797
6	Germany	0.015	97.740	23	Iceland	0.081	84.597
7	Finland	0.017	97.479	24	Italy	0.087	83.477
8	Belgium	0.017	97.359	25	Greece	0.095	81.796
9	Austria	0.019	96.979	26	Estonia	0.097	81.416
10	Korea	0.021	96.599	27	New Zealand	0.105	79.796
11	Luxembourg	0.024	95.979	28	Lithuania	0.113	78.156
12	France	0.031	94.619	29	Slovenia	0.123	76.115
13	United Kingdom	0.040	92.719	30	Poland	0.131	74.695
14	United States	0.041	92.699	31	Slovakia	0.132	74.395
15	Australia	0.050	90.758	32	Latvia	0.141	72.615
16	Portugal	0.054	89.998	33	Chile	0.243	52.130
17	Spain	0.060	88.778	34	Hungary	0.504	0.000

Source: EPI, 2022a.

6. Ecosystem protection—air emissions

In addition to affecting human health, air pollution can be detrimental to ecosystems and emissions of sulphur compounds 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 12** presents this data for 2018. Out of 34 countries, Canada ranks 30th and receives a score of 83.7. Switzerland produces the lowest SO_X emissions (0.008 kilograms per unit of its

Table 12. SO_X emissions intensity, 2018, with corresponding scores and ranks

Rank	Country	Data(kg/PPP 000s$ GDP	Score	Rank	Country	Data (kg/PPP 000s$ GDP	Score
1	Switzerland	0.008	100.00	18	Japan	0.109	96.50
2	Luxembourg	0.015	99.76	19	Spain	0.111	96.43
3	Austria	0.025	99.41	20	Slovak Republic	0.115	96.29
4	Netherlands	0.027	99.34	21	Finland	0.132	95.70
5	Sweden	0.034	99.10	22	Portugal	0.135	95.60
6	Ireland	0.037	98.99	23	Lithuania	0.138	95.49
7	Denmark	0.038	98.96	24	Korea	0.142	95.35
8	France	0.043	98.79	25	Israel	0.167	94.49
9	Italy	0.047	98.65	26	Czech Republic	0.243	91.85
10	Norway	0.050	98.54	27	Greece	0.291	90.19
11	Belgium	0.058	98.27	28	New Zealand	0.362	87.73
12	United Kingdom	0.061	98.16	29	Poland	0.426	85.51
13	Slovenia	0.065	98.02	**30**	**Canada**	**0.477**	**83.74**
14	Germany	0.071	97.82	31	Chile	0.616	78.92
14	Latvia	0.071	97.82	32	Estonia	0.708	75.73
15	Hungary	0.077	97.61	33	Australia	1.715	40.81
16	United States	0.107	96.57	34	Iceland	2.892	0.00

Source: OECD, 2018.

GDP) and receives a score of 100. Other top performers are Luxembourg (with 0.015 emission intensity and a score of 99.8), Austria (with 0.025, 99.4), the Netherland (0.027, 99.3) and Sweden (0.034, 99.1). Iceland is the poorest performer, with relatively high SO_X emissions intensity of 2.89 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 13** shows the percentage change in emissions intensity over the 10-year period from 2009 to 2018. Canada ranks 16th for this indicator after reducing SO_X emissions intensity by 52.4% as compared to 2009 levels. United States is the best performer, reducing its SO_X emission intensity by almost 80% over the decade. In contrast, Norway is the worst performer as its emission intensity decreased by only 3.8% over the same period.

Table 13. Change in SO_X emissions intensity (%), 2009–2018 as compared to 2009 levels, with corresponding scores and ranks

Rank	Country	Data (% change)	Score	Rank	Country	Data (% change)	Score
1	United States	−79.18	100.00	18	Lithuania	−51.24	62.91
2	Slovak Republic	−75.22	94.73	19	Finland	−50.19	61.51
3	Israel	−74.85	94.25	20	Sweden	−49.25	60.27
4	Ireland	−73.94	93.05	21	Netherlands	−43.75	52.97
5	Greece	−72.13	90.63	22	Korea	−42.97	51.93
6	United Kingdom	−66.85	83.63	23	Iceland	−40.93	49.23
7	France	−62.93	78.43	24	Portugal	−40.79	49.04
8	Belgium	−62.58	77.96	25	Chile	−40.60	48.78
9	Switzerland	−61.90	77.07	26	Hungary	−38.89	46.51
10	Slovenia	−59.88	74.37	27	Germany	−38.26	45.68
11	Estonia	−59.00	73.22	28	Denmark	−37.70	44.94
12	Luxembourg	−57.14	70.74	29	Spain	−36.93	43.92
13	Italy	−55.66	68.78	30	Australia	−36.76	43.69
14	Czech Republic	−53.80	66.31	31	Japan	−35.50	42.02
15	Latvia	−53.59	66.04	32	Austria	−32.43	37.94
16	**Canada**	**−52.40**	**64.44**	33	New Zealand	−28.46	32.67
17	Poland	−51.43	63.16	34	Norway	−3.85	0

Source: OECD, 2018.

7. 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 all 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 (Hsu, Esty, Levy, de Sherbinin, *et al*., 2016), 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 household sources that is treated at all levels—primary, secondary, and tertiary stages—before release 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 14**, with over 67.4% of its wastewater being treated at municipal level in 2018, Canada ranks 21th out of 34 countries and receives a score of 61.4. Denmark, Finland, Netherlands, and Sweden are ranked as the top performers with 100% wastewater management rate and a score of 100. Other top performers include the United Kingdom (with 98.50% wastewater management rate and a score of 98.23), Luxembourg (with a rate of 98.51% and a score of 98.22) and Germany (with a rate of 97.0% and a score of 96.45). The worst performer is Iceland with 15.6% of its wastewater being treated.

Intensity of water use or water stress measures freshwater withdrawal as a percentage of total renewable water sources. The performance scores on water use intensity are shown in **table 15**. Out of 34 countries, Canada ranks 6th and receives

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[5] 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, 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 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, due to 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 14. Wastewater treatment rate (%) in 2018, with corresponding scores and ranks

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	Denmark	100.00	100.00	15	New Zealand	79.90	76.19
1	Finland	100.00	100.00	16	Korea	76.84	72.57
1	Netherlands	100.00	100.00	17	Japan	75.32	70.78
1	Sweden	100.00	100.00	18	Chile	71.86	66.67
2	United Kingdom	98.51	98.23	19	Estonia	69.60	64.00
3	Luxembourg	98.50	98.22	20	Belgium	67.88	61.96
4	Germany	97.00	96.45	**21**	**Canada**	**67.44**	**61.44**
5	Switzerland	96.71	96.10	22	Norway	64.29	57.71
6	Austria	94.00	92.89	23	Poland	60.95	53.76
7	Australia	92.70	91.36	24	Czech Republic	60.75	53.52
8	Spain	91.51	89.95	25	United States	58.89	51.32
9	Latvia	90.70	88.99	26	Italy	58.75	51.15
10	Ireland	89.73	87.83	27	Portugal	54.98	46.69
11	Slovenia	89.09	87.08	28	Hungary	53.76	45.24
12	France	88.00	85.79	29	Lithuania	51.39	42.44
13	Israel	81.70	78.33	30	Slovakia	43.68	33.31
14	Greece	81.66	78.29	31	Iceland	15.55	0.00

Source: EPI, 2022b.

a score of 98.3. Only Iceland, Latvia, Norway, Lithuania, and the Slovak Republic perform better than Canada. Canada's water use intensity (1.2%) is much lower the OECD average of 10.9%. Iceland, the best performer in this category, had a water use intensity of 0.2 and a score of 100. In contrast, Israel has the highest water use intensity with 65.4% of its total renewable water sources being withdrawn.

8. 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 *et al.*, 2009; Yale Center for Environmental Law and Policy, 2010). Therefore, the reduction in forest cover has negative implications for habitat preservation,

Table 15. Water use intensity (%), 2019, with corresponding scores and ranks

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	Iceland	0.17	100.00	18	Estonia	7.86	88.21
2	Latvia	0.51	99.48	19	Portugal	7.92	88.12
3	Norway	0.68	99.21	20	Chile	9.22	86.12
4	Lithuania	1.04	98.67	21	Netherlands	9.23	86.10
5	Slovakia	1.11	98.56	22	France	12.73	80.75
6	**Canada**	**1.25**	**98.35**	23	United States	14.48	78.06
7	Sweden	1.36	98.17	24	Greece	14.79	77.59
8	Luxembourg	1.41	98.10	25	Poland	14.85	77.49
9	Australia	1.99	97.21	26	Czechia	14.85	77.49
10	Finland	2.73	96.08	27	Denmark	15.37	76.69
11	Ireland	2.74	96.05	28	Germany	15.87	75.93
12	Slovenia	2.96	95.72	29	Italy	17.80	72.97
13	New Zealand	3.02	95.63	30	Japan	18.40	72.06
14	Switzerland	3.19	95.38	31	Belgium	24.05	63.39
15	Hungary	4.29	93.68	32	Spain	26.43	59.74
16	Austria	4.49	93.37	33	South Korea	41.89	36.04
17	United Kingdom	5.73	91.48	34	Israel	65.39	0.00

Source: FAO, 2019.

ecosystem health, and climate change. As 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 forest cover. Due to data limitations, we could not add other relevant indicators, such the intensity of forest use.

Forest cover change measures the change in forest cover as a percentage of total land over the decade from 2010 to 2019. A regression was used to calculate the slope (trend) over the 10-year period. As shown in **table 16**, even though its forest cover has remained fairly constant, Canada ranked 26th and received a score of 37.3. This relatively poor performance is a result of the fact that most of Canada's peer countries increased their forest coverage over the same period. The top performers are Chile, Denmark, France, Italy, and Estonia. South Korea experienced the most significant decline in its forest cover and receives a score of zero.

Table 16. Change in forest cover, 2010–2019, with corresponding ranks and scores

Rank	Country	Slope	Score	Rank	Country	Slope	Score
1	Chile	0.2050	100.00	18	Norway	0.0228	45.45
2	Denmark	0.1984	98.01	19	Slovak Republic	0.0219	45.17
3	France	0.1523	84.22	20	United States	0.0131	42.55
4	Italy	0.1452	82.10	21	Spain	0.0100	41.61
5	Estonia	0.1009	68.82	22	Iceland	0.0064	40.53
6	Ireland	0.0965	67.51	23	New Zealand	0.0051	40.16
7	Switzerland	0.0870	64.68	24	Luxembourg	0.0000	38.62
8	Latvia	0.0765	61.53	24	Greece	0.0000	38.62
9	Portugal	0.0746	60.97	25	Belgium	−0.0022	37.97
10	Australia	0.0673	58.78	**26**	**Canada**	**−0.0044**	**37.29**
11	Finland	0.0624	57.29	27	Germany	−0.0073	36.45
12	Lithuania	0.0585	56.15	28	Japan	−0.0103	35.54
13	United Kingdom	0.0564	55.50	29	Netherlands	−0.0154	34.01
14	Poland	0.0533	54.57	30	Hungary	−0.0158	33.89
15	Austria	0.0469	52.65	31	Slovenia	−0.0337	28.53
16	Czech Republic	0.0277	46.93	32	Israel	−0.1095	5.84
17	Sweden	0.0233	45.59	33	South Korea.	−0.1290	0

Source: World Bank, 2023c .

9. Ecosystem protection—biodiversity

Biodiversity is an important indicator of the health of ecosystems, tracking 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 country. **Table 17** presents data on threatened species for the latest year available, as well as the corresponding scores and ranks for 33 countries (data for Israel were not available). The presented data for each country were calculated as an average of the country's data covering mammals, birds, vascular plants, fish, freshwater fish, and invertebrates. As shown, out of 33 countries, Canada ranks 18th and receives a score of 55.0 (well above the OECD average score of 48.0). Top performers for

Table 17. 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	**18**	**Canada**	**15.42**	**54.96**
2	Korea	6.58	82.21	19	Slovak Republic	16.32	52.17
3	Latvia	6.76	81.64	20	Greece	16.99	50.10
4	Lithuania	7.83	78.36	21	France	17.41	48.83
5	United Kingdom	9.29	73.86	22	Japan	18.10	46.68
6	United States	9.99	71.68	23	Belgium	23.10	31.28
7	Australia	10.74	69.38	24	Luxembourg	23.57	29.82
8	Sweden	12.83	62.92	25	Netherlands	26.16	21.84
9	Poland	13.24	61.66	26	Portugal	27.24	18.52
10	Estonia	13.65	60.41	27	Czech Republic	27.65	17.26
11	Spain	13.85	59.77	28	Iceland	27.94	16.36
12	Italy	13.98	59.38	29	Austria	28.13	15.77
13	Denmark	14.18	58.77	30	Slovenia	28.18	15.62
14	Ireland	14.20	58.72	31	Hungary	29.49	11.59
15	Finland	14.45	57.94	32	Germany	31.80	4.45
16	Norway	14.98	56.30	33	Switzerland	33.24	0.00
17	Chile	15.13	55.83				

Source: OECD, 2023b.

this indicator are New Zealand (ranked 1st with a score of 100), South Korea (2nd, 82.2), Latvia (3rd, 81.6), Lithuania (4th, 78.4) and the United Kingdom (5th, 73.9). 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 vary from one country to another. Countries have different standards and protocols for categorizing species as endangered and therefore there are anomalies in the listing processes, making comparisons across 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 as nature reserves, national parks, protected landscape, natural monuments, scientific reserves with limited public access, and areas managed mainly for sustainable use

(World Bank, 2014). **Table 18** displays the terrestrial protected areas as a percentage of total land area in 2019 for 34 OECD countries, as well as their corresponding ranks and scores. As shown, with 10.7% of its terrestrial areas protected, Canada ranks 33th. Slovenia is the best performer with 53.6% terrestrial protected areas; Switzerland is the worst performer with almost 10% of its total land designated as protected areas.

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, 2009). Therefore, a large portion of its unprotected landmass is located in remote areas where biodiversity is unlikely to be threatened.

Table 18. Terrestrial protected areas in 2018, with corresponding ranks and scores

Rank	Country	Data (%)	Score	Rank	Country	Data (%)	Score
1	Slovenia	53.56	100.00	18	Italy	21.48	26.37
2	Luxembourg	51.18	94.54	19	Estonia	20.58	24.29
3	Poland	39.74	68.27	20	Chile	20.42	23.93
4	Slovak Republic	37.59	63.33	21	Israel	19.95	22.85
5	Germany	37.38	62.86	22	Iceland	19.50	21.83
6	Greece	35.22	57.89	23	Australia	19.27	21.28
7	New Zealand	32.81	52.36	24	Latvia	18.18	18.79
8	Japan	29.39	44.51	25	Denmark	17.23	16.62
9	United Kingdom	28.71	42.95	26	Lithuania	17.03	16.16
10	Austria	28.42	42.29	27	Norway	16.83	15.69
11	Spain	28.10	41.56	28	South Korea	15.70	13.10
12	France	26.34	37.52	29	Ireland	14.44	10.20
13	Belgium	24.91	34.25	30	Sweden	14.37	10.06
14	Portugal	22.92	29.66	31	Finland	13.28	7.54
15	Hungary	22.60	28.93	32	United States	12.99	6.89
16	Netherlands	22.48	28.65	**33**	**Canada**	**10.66**	**1.52**
17	Czech Republic	22.16	27.93	34	Switzerland	9.99	0

Source: World Bank, 2023d.

10. 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 relating to agriculture are excessive use of fertilizers (nitrogen and phosphorous) and intensive use of pesticides (OECD, 2015). Run-off from excessive nitrogen use has several negative impacts on air and water quality, contributes to climate change, and may lead to ozone layer depletion (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—that is, the uptake of nitrogen for crop and pasture production. While nitrogen inputs are necessary in farming 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). Because time series are sparse and inconsistent, the decadal averages from 2010 to 2019 were used to compare countries. **Table 19** presents data on the average decadal nitrogen use balance for 32 countries for the period from 2010 to 2019 as well as countries' associated ranks and scores. The nitrogen balance data 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 32 countries, Canada ranks 3rd and receives a score of 92.4. Only Iceland and Australia have lower nitrogen surplus and perform better than Canada. Austria and Sweden together hold the 11th rank and receive a score of 86.1. With 23.3 kilograms of nitrogen surplus per hectare in the period from 2010 to 2019, Canada's performance is much better than the OECD average of 65.4 kilograms/hectare over the same period. The worst performer for this indicator is South Korea with 204.9 kilograms of nitrogen surplus.

Average use of pesticides measures average pesticide use per area of cropland (calculated in kg/hectare). As time series are inconsistent, the decadal averages from 2010 to 2019 were used. **Table 20** presents data, scores, and ranks for the 34 high-income OECD countries. With average use of 2.05 (kg per hectare) of pesticides, Canada ranks 14th out of 34 countries and receives a score of 87.1. Canada's average use of pesticides is well below the OECD average of 4.2 kilograms per hectare. Top

Table 19. Nitrogen use balance (surplus), 2010–2019, with corresponding ranks and scores

Rank	Country	Data (kg/ha)	Score	Rank	Country	Data (kg/ha)	Score
1	Iceland	8.28	100.00	16	Slovenia	49.70	78.93
2	Australia	17.70	95.21	17	Finland	50.70	78.42
3	**Canada**	**23.28**	**92.37**	18	New Zealand	51.13	78.20
4	Latvia	24.90	91.55	19	Greece	63.22	72.05
5	United States	29.00	89.46	20	Switzerland	65.10	71.09
6	Estonia	30.79	88.55	21	Italy	66.20	70.54
7	Hungary	32.44	87.71	22	Germany	76.60	65.24
8	Lithuania	33.30	87.27	23	Czech Republic	78.70	64.18
9	Spain	33.80	87.02	24	Denmark	86.00	60.46
10	France	34.10	86.86	25	United Kingdom	89.56	58.65
11	Austria	35.60	86.10	26	Norway	92.00	57.41
11	Sweden	35.60	86.10	27	Luxembourg	126.67	39.77
12	Slovak Republic	37.30	85.24	28	Belgium	136.44	34.80
13	Portugal	41.20	83.25	29	Japan	171.52	16.96
14	Ireland	42.80	82.44	30	Netherlands	177.60	13.86
15	Poland	47.90	79.84	31	Korea	204.85	0.00

Source: OECD, 2010–2019.

performers were Iceland with an average use of 0.02 kilograms per hectare, Sweden (0.66), Norway (0.88), Estonia (0.91), and Lithuania (1.12). The bottom five countries are Israel, Japan, South Korea, Netherlands, and New Zealand.

11. Ecosystem protection—fisheries

Fish 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 (EPI, 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

Table 20. Average use of pesticides, 2010–2019, with corresponding ranks and scores

Rank	Country	Data (kg/ha)	Score	Rank	Country	Data (kg/ha)	Score
1	Iceland	0.02	100.00	18	Austria	2.81	82.30
2	Sweden	0.66	95.96	19	United Kingdom	2.97	81.24
3	Norway	0.88	94.55	20	Spain	3.14	80.15
4	Estonia	0.91	94.36	21	France	3.51	77.79
5	Lithuania	1.12	93.03	22	Germany	3.77	76.15
6	Latvia	1.12	93.01	23	Slovenia	4.50	71.55
7	Slovakia	1.21	92.47	24	Switzerland	5.08	67.84
8	Denmark	1.36	91.52	25	Chile	5.68	64.05
9	Australia	1.73	89.13	26	Portugal	5.70	63.88
10	Czechia	1.84	88.47	27	Ireland	6.36	59.68
11	Finland	1.93	87.86	28	Italy	6.50	58.77
12	Hungary	1.97	87.62	29	Belgium	7.26	53.98
13	Poland	2.03	87.22	30	New Zealand	9.01	42.85
14	**Canada**	**2.05**	**87.10**	31	Netherlands	10.91	30.73
15	Luxembourg	2.30	85.52	32	South Korea	11.42	27.49
16	United States	2.53	84.07	33	Japan	11.79	25.18
17	Greece	2.61	83.54	34	Israel	15.74	0.00

Source: FAO, 2010–2019.

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.

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 (EPI, 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 (EPI, 2010). In this way, the Marine Trophic Index is a proxy for capturing 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 21 presents the change in the 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 a 10-year period from 2009 to 2018. No data were available for this indicator from the following 8 countries: Austria, Czech Republic, Hungary, Lithuania, Luxembourg, Slovak Republic, Switzerland, and the United States.

Out of 26 countries, Canada ranks 9th and receives a score of 56.8. The 0.0081 coefficient of trend line indicates that Canada's sustainability of fish resources slightly increased over the past decade. The top five performers that have also managed to improve their fish resources are Ireland, Slovenia, Norway, Portugal, and Latvia. Denmark is experiencing the highest decline in its sustainability of fish resources and accordingly receives a score of zero.

Table 21. Change in Marine Trophic Index, 2009–2018, with corresponding ranks and scores

Rank	Country	Slope	Score	Rank	Country	Slope	Score
1	Ireland	0.0313	100.00	14	Spain	**−0.0010**	39.89
2	Slovenia	0.0287	95.25	15	Israel	**−0.0018**	38.36
3	Norway	0.0212	81.24	16	Australia	−0.0021	37.74
4	Portugal	0.0138	67.34	17	Netherlands	−0.0027	36.61
5	Latvia	0.0136	67.01	18	Japan	**−0.0031**	35.93
6	Sweden	0.0127	65.42	19	Belgium	**−0.0036**	35.03
7	Estonia	0.0122	64.52	20	Italy	−0.0051	32.20
8	France	0.0093	59.10	21	Iceland	**−0.0060**	30.51
9	**Canada**	**0.0081**	**56.80**	22	Greece	−0.0078	27.23
10	Poland	0.0073	55.25	23	Chile	**−0.0085**	25.76
11	New Zealand	0.0058	52.54	24	Germany	**−0.0101**	22.88
12	United Kingdom	0.0052	51.30	25	South Korea	**−0.0105**	22.15
13	Finland	0.0035	48.25	26	Denmark	**−0.0224**	0.00

Source: Sea Around Us, 2009–2018.

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 14th out of 34 high-income OECD countries and receives an overall score of 69.9, compared to a top rank of 81.5 (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 19 indicators, weighting each one equally, to obtain an overall score ranging from zero to 100. Similar to the results presented in section 1 and in the first two editions of this report, with a score of 67.4 Canada performs well, ranking 13th out of 34 high-income OECD countries. Canada's score is well above the OECD average of 64.7. The top five performers are Sweden (with a score of 81.5), Finland (77.8), United Kingdom (74.9), Denmark (74.7), and Switzerland (74.3). Their scores not that much higher than Canada's. The five poorest performers are South Korea (with a score of 44.1), Israel (51.2), Japan (51.7), Hungary (53.4), and the Netherlands (55.2).

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

Rank	Country	Score	Rank	Country	Score
1	Sweden	81.52	18	Slovakia	65.27
2	Finland	77.77	19	Latvia	64.33
3	United Kingdom	74.92	20	Iceland	64.20
4	Denmark	74.69	21	Portugal	63.38
5	Switzerland	74.34	22	Lithuania	63.06
6	France	73.75	23	Germany	62.07
7	New Zealand	72.66	24	Italy	60.87
8	Luxembourg	71.70	25	Greece	58.54
9	Norway	71.02	26	Czech Republic	58.00
10	Ireland	70.21	27	Poland	57.49
11	United States	69.56	28	Chile	57.10
12	Austria	68.30	29	Belgium	56.71
13	**Canada**	**67.41**	30	Netherlands	55.22
14	Slovenia	66.97	31	Hungary	53.41
15	Estonia	66.66	32	Japan	51.75
16	Spain	66.06	33	Israel	51.19
17	Australia	66.04	34	South Korea	44.07

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