PACIFIC RESEARCH INSTITUTE FOR PUBLIC POLICY

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Index of Leading ENVIRONMENTAL Indicators

by

Steve Hayward & Laura Jones

With Boris DeWiel, Nicole Goranko, Rosemary Herbut-Fikus, Dana C. Joel, Erin Schiller and M. Danielle Smith

THE FRASER INSTITUTE

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Introduction

Modern public attention to the environment dates roughly from the first Earth Day in 1970. But despite a generation of concern, public opinion about environmental issues remains confused and contradictory, and as a consequence public policy on the environment is highly contentious and unsettled.

It is difficult to judge public sentiment about the environment accurately because the environment, taken as a whole, is a broad and all encompassing idea. "The environment" is an evocative term, suggestive of mankind's relationship to nature, and conveying connotations of eternity and our generation's bequest to succeeding generations. The environment, perhaps uniquely among public issues, invites citizens to engage in metaphysical speculations. Environmental issues comprise both narrow technical concerns, often measured in parts per billion, and broad emotional concerns, such as the symbolic value of a virgin forest.

The broad and amorphous nature of environmental issues works both for and against environmentalism. When pollsters ask specifically whether the environment is a serious problem, majorities answer strongly in the affirmative, and people are generally pessimistic about environmental trends. According to the most recent Wirthlin survey on environmental issues, 79 percent think that "problems regarding pollution and the environment will get worse during my lifetime" (Wirthlin Group 1997). The Wirthlin survey similarly finds that 76 percent agree with the statement that "protecting the environment is so important that requirements and standards cannot be too high, and continuing environmental improvements must be made regardless of cost."

On the other hand, if pollsters ask open-ended questions about what issues people regard as most important, the environment does very poorly, usually in the single digits. A 1995 Gallup Poll reported that only one percent of respondents ranked the environment as the "most important problem." Similarly participants of a 1994 Roper Survey that listed 20 public problems ranked the environment sixteenth, just above alcoholism. (The Gallup and Roper Surveys are included in Ladd and Bowman 1995.) [Crime, the economy, and education are usually picked as the most important public problems, with 40 to 60 percent being the typical range for respondents naming these as particular problems on open-ended or multiple-choice surveys.]

This is not to suggest that public concern about the environment is overstated or misunderstood. Contradiction within public opinion is not a new or remarkable phenomenon, and the environment is similar to many other public issues where the public often tells pollsters that the government does not spend enough money on the specific problem while also saying that the government as a whole is too big and spends too much. (If policymakers made policy according to the polls on an issue-by-issue basis, total government spending would soar.)

The fact that people rank the environment low on an open-ended ranking of public problems means that, while many people may have strong opinions on the environment in the abstract, the environment does not hold their immediate interest in the same way crime and education do. While public policy debates seldom command close public attention, citizens are more informed on high-profile issues such as crime and education than they are on environmental issues, and public preferences are more accurately and fully reflected in policy changes that are made on the high profile issues. (The movement for tougher prison sentencing for criminals, such as "three strikes," is a good example of strong and clear public preferences being translated into policy.)

How People Form an Opinion about the Environment

Given the fact that the public does not pay close attention to the details of environmental issues, it is not surprising that public opinion is not in harmony with the general facts. Even as polls show that people think the environment is getting worse, by most measures environmental quality has dramatically improved over the last generation and is continuing to improve.

There are three ways in which the public comes to form its opinions about the environment. First, because people are less likely to spend time following environmental issues in detail and because the environment ranks low on the list of public concerns, environmental issues and policy tend to be driven by the most highly motivated interest groups, typically environmental organizations. And, since democratic government is most responsive to an atmosphere of crisis, it is in the interest of environmental organizations to promote a sense of crisis much of the time. A feature series on environmental issues in the *New York Times* observed that environmental organizations might be "in danger of becoming the green equivalent of the military lobby, more interested in sowing fear and protecting wasteful programs than in devising a new course" (Schneider 1993: A1). Other critics have described some environmentalists as "crisis entrepreneurs."

Second, the news media aggravate this problem by promoting images of environmental threats. News about positive environmental progress is downplayed. In his magisterial book, *A Moment on the Earth,* environmental writer Gregg Easterbrook recounts how, in 1992, he was struck by finding the good-news story, "Air Found Cleaner in U.S. Cities," in "a small box buried on page A24 of the *New York Times.* The story went unmentioned in most other media outlets. "Surely," Easterbrook observed, "any news that air quality was in decline would have received front-page attention. The treatment suggested that the world was somehow disappointed by an inappropriately encouraging discovery" (Easterbrook 1995: xiii). This asymmetry in the way the media handle environmental issues further distorts public perception.

Third, public perception of environmental quality is powerfully driven by what economists call "the wealth effect." Several studies have shown a positive correlation between rising incomes and demand for environmental quality. As people become more affluent, their tolerance for risk of all kinds diminishes. This helps explain why citizens of wealthy nations believe their environment is getting worse even as the data show it is getting better.

The Effect of Public Opinion on Policy

Incorrect public perceptions about environmental trends can have important consequences for policy since, not only do they cause anxieties that may be unwarranted by facts or out of proportion to the true risks involved, but they can also lead to skewed policy priorities. In 1990, the United States Environmental Protection Agency's Science Advisory Board warned that current laws and regulations "are more reflective of public perceptions of risk than of scientific understanding of risk" (U.S. EPA Science Advisory Board 1990). And a 1993 report from the Center for Resource Economics found that EPA resources were allocated in amounts inversely proportional to genuine risk. "EPA's budget and staff resources are not allocated on the basis of risk," the report concluded. "Consequently, more than 80 percent of EPA's resources are spent on pollutants considered to be relatively low risk by federal scientists" (Smolensky, Dickson and Caplan 1993: 1).

To be sure, public perceptions are often wrong in many other areas of public policy. Plant closing and layoff announcements often generate waves of anxiety among the public and the media, and lower consumer confidence even when unemployment is falling and the economy is strong. In the fullness of time, however, public perception usually corrects itself as a clear sense of economic progress takes hold. One reason for this long term confidence in the economy is that economic journalism and economic policy are fully informed today by a number of well-understood measures (i.e., money supply, the employment cost index, inflation, interest rates, housing starts, and, of course, the composite *Index of Leading Economic Indicators*).

Lack of Reliable Measures of Environmental Quality

For the environment, however, we lack a series of good, clear measures of environmental quality and progress. In part, this is because our thinking about the environment is still in some ways in its infancy, which is reflected in the fact that the focus of environmental concern has so often shifted. Twenty-five years ago most environmental concern centered on problems of pollution and scarcity — the view that we were fouling our own nest and would quickly run out of natural resources. Today it is clear that anxieties about scarcity were unfounded, and concern has shifted to problems of global warming and "biodiversity," for which we lack uncontested scientific theory and objective data.

In equal part, the lack of good measures of environmental quality stem from the methodological difficulty of constructing such measures. As long ago as 1972, the President's Council on Environmental Quality (CEQ) wrote that "The process of developing dependable indices will be a long one," but the CEQ never got very far with the task. CEQ published a report on environmental trends only intermittently; the last *Environmental Trends* report was published in 1989.

State of the Environment: Things Are Improving

To fill this gap in public knowledge and perception about environmental progress, to separate the facts from alarmist misinformation, and to bring balance to the environmental debate, The Pacific Research Institute for Public Policy and the Fraser Institute have developed Environmental Indicators for the United States and Canada. The indicators are designed to help the public assess more accurately the state of the environment in several key areas: air quality, water quality, natural resources, land use and condition, solid wastes, energy, pesticides, toxic releases, and wildlife.

This report finds that, contrary to public opinion, objectives for protecting human health and the environment in most instances are being met, pollution and wastes are being controlled, and resources and land are being sustainably and effectively managed. Environmental quality in both the United States and Canada is *improving,* not deteriorating. Following are some salient points:

- Overall, environmental quality improved 18.6 percent in the United States and 10.8 percent in Canada relative to conditions in 1980.

- Air pollution from sulphur dioxide, nitrogen dioxide, carbon monoxide, particulates, and lead has decreased considerably in both the United States and Canada.

- The ambient level of sulphur dioxide decreased by 60.7 percent in the United States and 61.5 percent in Canada between 1975 and 1995.

- Ambient lead concentration fell 99.9 percent both in the United States and in Canada between 1976 and 1994.

- In 1994, over 90 percent of the lakes tested in the United States supported overall use.

- In 1995, Alberta and Saskatchewan met their water quality goals over 90 percent of the time; British Columbia and New Brunswick met their goals over 80 percent of the time; Manitoba met its goals over 70 percent of the time.

- DDE concentrations have fallen over 75 percent in Lake Michigan and Lake Superior, over 80 percent in Lake Erie and Lake Ontario, and 90 percent in Lake Huron since 1977.

- Forests are increasing as growth exceeds the harvesting of trees both in the United States and in Canada.

- The amount of land set aside for parks, wilderness, and wildlife is increasing in both the United States and Canada.

- The amounts of toxic chemicals exposed to the environment is decreasing.

- Critical wetland habitat is not declining.

The Role of Regulation

The significant improvement in several areas of environmental concern charted in this report will immediately be cited as evidence that federal environmental regulation works and that therefore, if some regulation is good, more regulation will be even better. However, the full picture is more complicated.

Although data for many kinds of pollution is patchy and unreliable before 1970, it appears that environmental quality was already improving before the passage of comprehensive environmental legislation and the founding of the EPA in the early 1970s. Paul Portney of Resources for the Future writes that "it is extremely difficult to isolate the effects of regulatory policies on air quality, as distinct from the effects of other potentially important factors," because "some measures of air quality were improving at an impressive rate before 1970" (Portney 1990). According to the historical data that are available, Portney point out, average ambient levels of particulates declined by more than 20 percent during the 1960s, while ambient levels of sulfur dioxide fell by almost 50 percent. Carbon monoxide also declined by more than 20 percent in urban areas. "[T]hese data," Portney concludes, "are important because they suggest that air quality was improving as fast or faster before the Clean Air Act…" (Portney 1990).

Similar improvements in water quality occurred before 1970. A. Myrick Freeman III concluded that "attributing all of the observed improvements (or prevention of degradation) to the 1972 [Clean Water] act might overstate its true accomplishments" (Freeman in Portney 1990).

There are two reasons for this seemingly counter-intuitive conclusion. First, some of the reduction in pollution levels can be attributed to state and local government regulatory efforts — a significant counterpoint to the enthusiasm for uniform, "one-size-fits-all" federal regulations. Second, and more important, much environmental improvement can be attributed to the "wealth effect" of a growing economy, i.e. the combination of increased economic efficiency through industrial modernization and the growing consumer preference for a clean environment as an amenity value. The competitive imperatives of raw material and energy conservation, both of which have the unintended by-product of less air and water pollution and solid waste. We revisit this theme with specific examples throughout this report. The point is: **economic growth is the main prerequisite for environmental improvement.**[1]

Objectives of the Study

This document is designed to give the reader an overview of national environmental quality in the United States and Canada. While the indicators include many local or regional environmental issues, such as the air quality of selected cities, the goal of this study is to provide a "big picture" of general, nationwide environmental trends in both countries. It does not attempt to develop indicators for global controversies such as tropical rainforest deforestation, climate change, and bio-diversity.

Most of the data in this report come from the Organization for Economic Cooperation and Development (OECD), *Environmental Data Compendium,* 1995. Where OECD survey results were unavailable, data were supplemented by information from the Environmental Protection Agency (EPA), Environment Canada, or other official government sources.

The indicators are divided into primary and secondary categories. Within each category, there are several subsections. Primary environmental indicators include information about air quality, water quality, natural resources, land use and condition, and solid wastes. These indicators provide direct information about environmental quality. The secondary indicators include often cited environmental measures such as carbon-dioxide emissions, oil spills, numbers of wildlife species, use of pesticides, and toxic releases. These indicators are considered "secondary" since they provide only indirect information about environmental quality. In the final section of the report, the trend in environmental performance for the primary environmental indicators is compiled into an index. The index shows considerable improvement in the environmental performance of both the United States and Canada.

Primary Environmental Indicators

Air Quality

Air quality in the United States and Canada shows the clearest trend of improvement among all environmental categories during the last two decades. This section examines the six air pollutants that regulations target. These include the following (for a summary of the discussion of each pollutant, see Table 1):

1) sulphur dioxide (SO_2)
2) nitrogen oxide (NO_x)
3) volatile organic compounds (VOCs)
4) carbon monoxide (CO)
5) total suspended particulates (TSPs)
6) lead (Pb)

Air quality can be measured in two ways: by considering either ambient levels or emissions.

Ambient levels. Ambient levels are the actual concentration of a pollutant in the air. They are usually reported in parts per million (ppm), parts per billion (ppb), or micrograms per cubic metre (mg/m3). Air-monitoring stations are maintained in most cities with populations greater than 100,000 where air pollution presents a potential problem. In the United States, 4,800 monitoring sites report air quality data for one or more of the six National Ambient Air Quality System pollutants to the Aerometric Information Retrieval System (U.S. EPA 1996a). The Canadian National Air Pollution Surveillance (NAPS) network began a comprehensive national program of tracking common air contaminants in the mid-1970s. By 1995, the network consisted of 140 monitoring stations using over 400 instruments in 52 urban centers across Canada (Environment Canada 1996b: 8).

Emissions. Emissions measure the pollution that human activities generate; they do not include releases of the pollutant from natural sources. Statistics for emissions are less reliable than ambient concentrations because they are estimates rather than actual measures. The U.S. Environmental Protection

Agency (EPA) and Environment Canada use models to estimate emissions. These models are based on many factors, including the level of industrial activity, changes in technology, fuel consumption rates, vehicle miles travelled (VMT), and other activities that cause air pollution.[1] Emissions are usually reported in kilograms or tons. Frequent revisions in the calculation methods used to estimate emissions make comparisons between years less meaningful than comparisons of annual ambient levels.

The data show that there is not a simple or predictable correlation between emissions caused by human activities and ambient air quality. For instance, the United States has about 10 times the population, industry, and pollution emissions of Canada and yet does not always have higher ambient levels. This is because natural sources and meteorological factors such as temperature, sunlight, air pressure, humidity, wind, rain, and topography affect ambient air quality. Hot summers, for example, cause higher ozone levels. The EPA is currently developing models that will adjust for such meteorological conditions.

Sulphur Dioxide

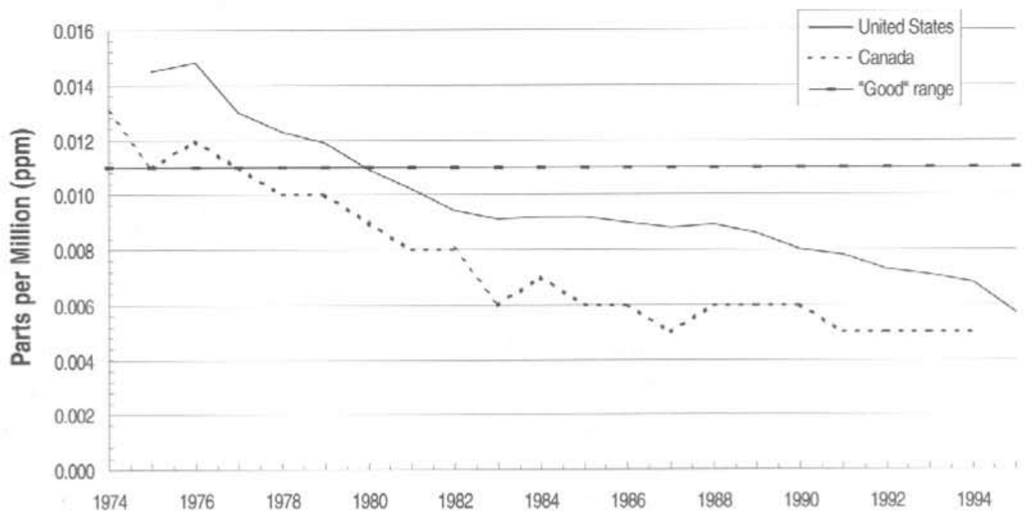
Description. Sulphur dioxide (SO_2) is a colorless gas that in sufficient concentrations has a pungent odor. The largest contributors to SO_2 emissions are industrial and manufacturing processes, particularly the generation of electrical power. Environmental factors such as temperature inversion, wind speed, and wind concentration affect measured levels.

SO_2 is a precursor to acid rain.[2] In large enough concentrations, acid rain can cause the acidification of lakes and streams, accelerate the corrosion of buildings and monuments, and impair visibility. It was originally thought to damage forests and crops as well as endanger wildlife and human health. After ten years of study, however, the U.S. National Acid Precipitation Assessment Program (NAPAP) concluded that acid rain has had no significant effects on wildlife, forests, crops, or human health (Bast, Hill and Rue 1994: 74-81). In fact, there have been cases in which acid rain has had a positive effect on soil and lakes, because it can enhance vital nutrients and reduce pH levels where alkalinity is a problem.

Trends. Figure 1 shows that the ambient level of SO_2 decreased by 60.7 percent in the United States between 1974 and 1995, and 61.5 percent in Canada between 1975 and 1994. The United States has met annual "good" objectives since 1981; Canada has met annual "good" objectives since 1978.[3]

In the case of emissions, Figure 2 shows that levels in the United States fell 41.2 percent between 1970 and 1995; Canadian emissions fell 60 percent between 1970 and 1994.

Figure 1: Sulphur Dioxide (Ambient Levels)

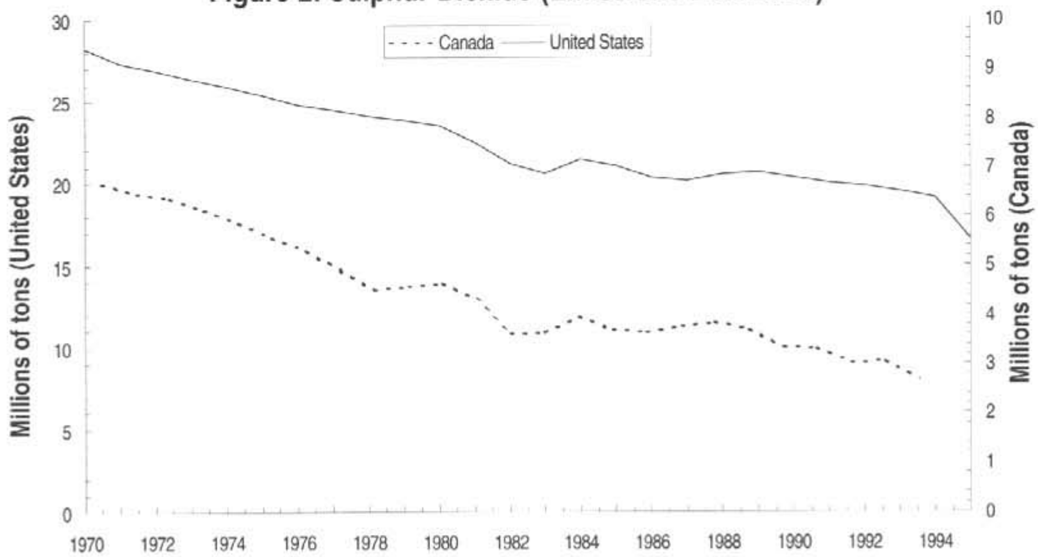


Sources: Environment Canada, 1996c; U.S. EPA, 1996a.

Analysis. The largest factor contributing to the decline in emissions has been the increased use of control devices by industry. Process improvements, smelter closures, acid-plant adoption, the use of low sulphur coal, the adoption of coal blending and washing procedures, and the conversion to cleaner fuels (e.g., natural gas and light oil) all have also contributed to the decline (U.S. EPA 1996a: 29). Federal environmental policy that mandates the use of scrubbers rather than permitting power generators to switch to low-sulphur coal may have impeded more dramatic emission improvements in the United States. [See Case Study p.11, "Regulations Run Amok: Discouraging the Adoption of Clean-burning Coal,.][4]

In spite of this record, Canada in 1991 signed the Canada/U.S. Air Quality Agreement for the reduction of SO_2 and NO_x emissions. Canada's obligations under this agreement include the establishment of a permanent national limit on SO_2 of 3.2 million tons by the year 2000 (U.S. EPA 1995d: ES-1). These reductions, warranted or not, may be achieved more cost effectively with methods other than increased regulation. For example, the 1990 U.S. Clean Air Act has allowed the introduction of tradable emissions permits. The Chicago Board of Trade now trades sulphur-dioxide pollution credits on the open market. Environmental groups can now further reduce emissions levels by purchasing these credits and retiring them.[5]

Figure 2: Sulphur Dioxide (Emissions Estimates)



Sources: U.S. EPA, 1995c, 1996a; Environment Canada, 1986, 1996c; OECD, 1997

Note: Environment Canada changed its calculation methodology in 1980.

CASE STUDY

Regulations Run Amok: Discouraging the Adoption of Clean-burning Coal

In addition to imposing enormous costs on society, government regulations can often produce negative consequences that run counter to the regulation's objectives. In the case of the New Source Performance Standards, the federal regulations imposed huge costs and failed to help reduce sulphur dioxide emissions in some regions of the U.S.

Under a provision of the 1977 amendments to the U.S. Clean Air Act, all new coal-fired power plants were required to install costly stack-gas scrubbers as part of a new "best available technology" standard. The problem with this requirement — in addition to the enormous costs — was that it discouraged plants from using clean-burning, low-sulphur coal, a cheaper and more effective alternative to scrubbers that was gradually being used by power plants throughout the country. This new standard was triggered by a powerful coalition of high-sulphur coal producers from the East coast who, threatened by the increased usage of the cleaner coal, successfully lobbied Washington to mandate scrubbers as a way to curb the purchase of the low-sulphur coal produced in the West.

As a result, new coal plants were forced to adopt the far costlier, less effective approach. Also, because the regulations were imposed on all new coal-fired plants, they discouraged the closing of old and dirty plants. This had the perverse effect of actually increasing sulphur dioxide emissions in some regions of the country.

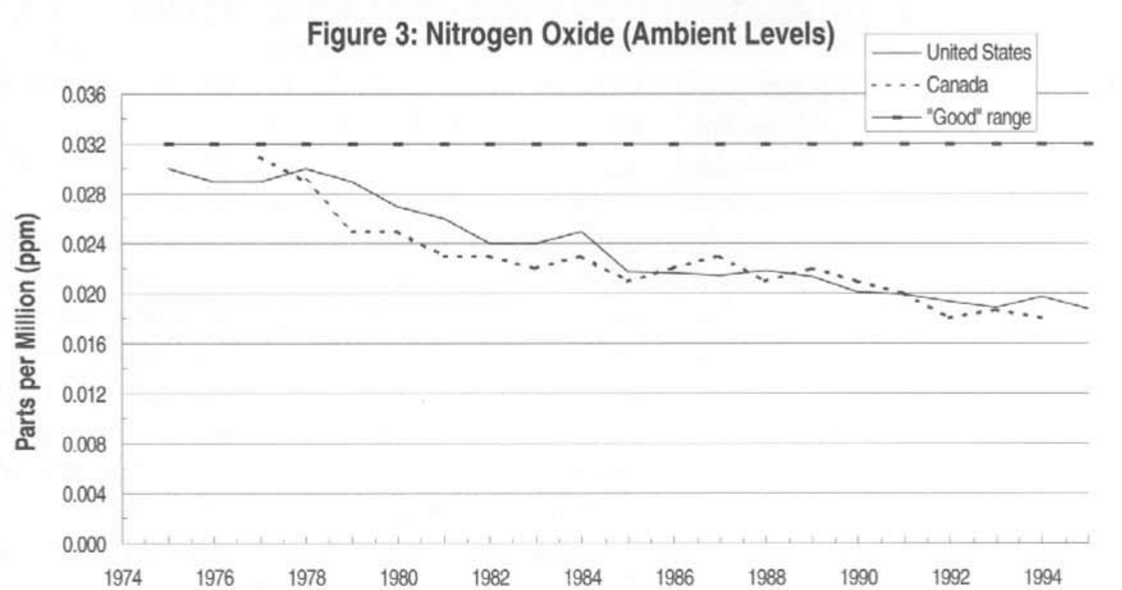
Nitrogen Oxides

Description. Nitrogen and oxygen combine naturally through bacterial action in soil, lightning, volcanic activity, and forest fires to form a variety of compounds referred to as nitrogen oxides (NO_x). The combustion of fossil fuels by automobiles, power plants, industry, and household activities also contributes to NO_x emissions. A reddish-brown gas called nitrogen dioxide (NO_2), a member of the NO_x family, is regularly tracked by environmental agencies since it combines with volatile organic compounds (VOCs) in the presence of sunlight to form ground-level ozone. Ozone contributes to the formation of urban smog.

Trends. The ambient level of NO_2 shows a 37.3 percent decrease in the United States between 1975 and 1995, and a 41.9 percent decrease in Canada between 1977 and 1994 (Figure 3). Both the United States and Canada have met annual "good" objectives since monitoring began in 1977 and 1975, respectively.[6]

Emissions data for NO_2 are unavailable. American emissions of the broader NO_x category, however, show an increase of 5.6 percent from 1970 to 1995, and Canadian emissions increased 50 percent from 1970 to 1994 (Figure 4).

Analysis. The increases in the emission of NO_x in Canada are puzzling in light of the reduction in ambient NO_2; the estimates may be inaccurate or the increase in other nitrogen-oxide emissions exceeded the reduction in nitrogen-dioxide emissions.



Sources: Environment Canada, 1996c; U.S. EPA, 1996a. Note: In 1986, the US EPA increased its monitoring sites from 48 to 216.

Figure 4: Nitrogen Oxide (Emissions Estimates)

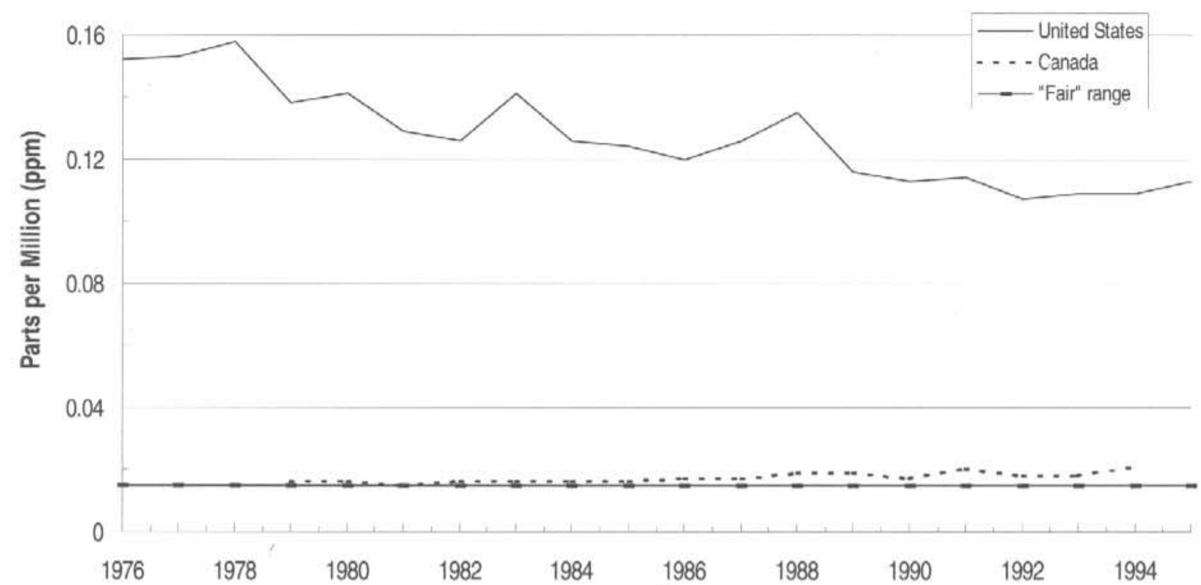
Sources: U.S. EPA, 1995c, 1996a; Environment Canada, 1986, 1996c; OECD, 1997
Note: Environment Canada changed its calculation methodology in 1980.

Volatile Organic Compounds

Description. Volatile organic compounds (VOCs) are a subgroup of hydrocarbons (HCs); they enter the atmosphere through evaporation from auto fuel tanks, paints, coatings, solvents, and consumer products, such as lighter fluid and perfume. VOCs also occur naturally as a result of photosynthesis. Under certain conditions, they combine with NO_2 to form ground level ozone, which contributes to urban smog. Regulators target VOC emissions to combat the secondary pollutant, ozone.

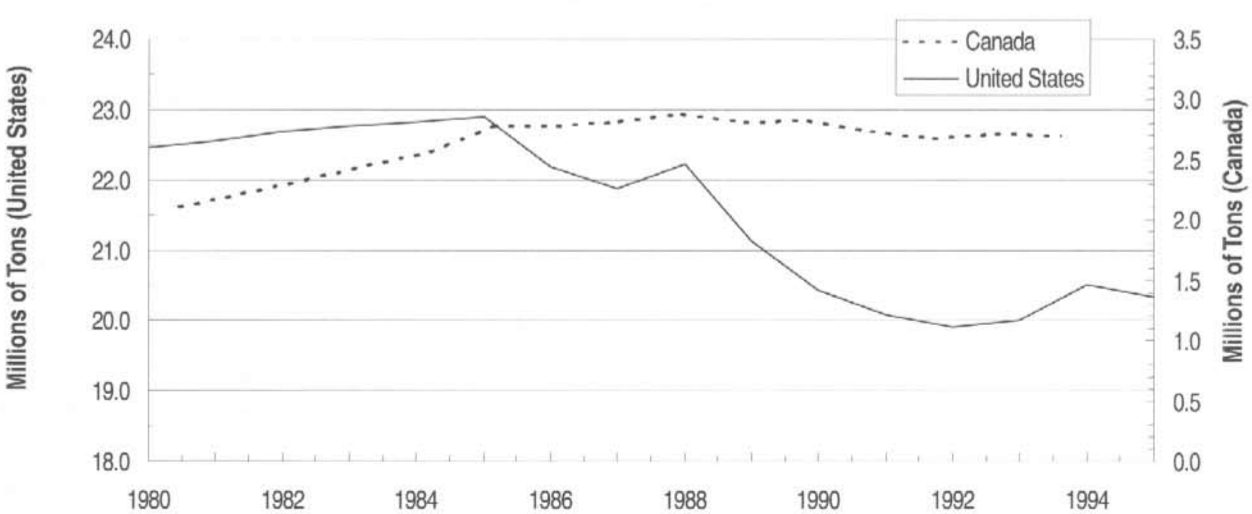
Trends. The level of ambient ozone decreased 25.7 percent in the United States between 1976 and 1995, but increased 31.3 percent in Canada between 1979 and 1994. Despite the improving trend in the U.S., levels still remain higher in the U.S. than in Canada. This may be due to a difference in naturally occurring VOC emissions but may also be due to differences in data collection: since ozone does not form in cold weather, Canadian data are collected from May to September, while U.S. data are compiled the year round. In addition, ozone concentrations vary considerably with meteorological factors such as temperature, wind speed, cloudiness, and precipitation, and physical factors, such as terrestrial relief (Figure 5).

Figure 5: Ozone (Ambient Levels)



Sources: Environment Canada, 1996c; U.S. EPA, 1995c, 1996a
Note: There is no annual guideline for "Good" range. Measures above "Fair" range are considered "Poor".

Figure 6: Volatile Organic Compounds (Emissions Estimates)



Sources: OECD, 1997. Note: No data for 1981-1984.

In the United States, VOC emissions declined 9.5 percent from 1980 to 1995; Canadian VOC emissions increased 28.7 percent between 1980 and 1994 (Figure 6).

Analysis. Ambient ozone levels do not directly or predictably reflect emissions. A 1991 National Academy Sciences report, *Rethinking the Ozone Problem in Urban and Regional Air Pollution,* concludes that current ozone reduction strategies may be misguided, partly because they do not account for naturally occurring VOCs.

Carbon Monoxide

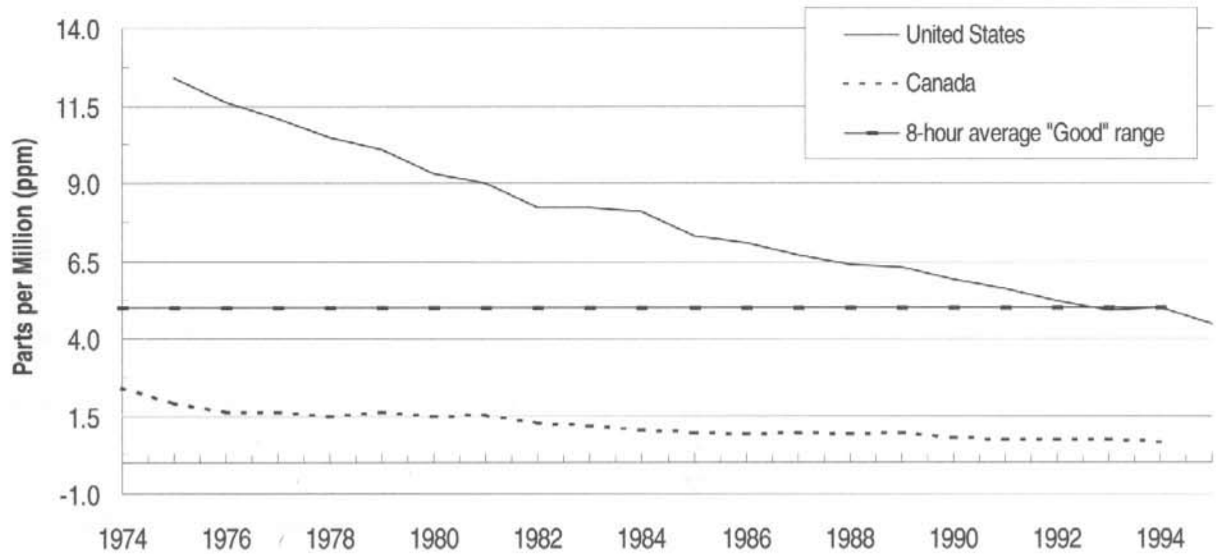
Description. When fuel and other substances containing carbon burn without sufficient oxygen, carbon monoxide (CO), a colorless, odorless gas, is produced. Trace amounts of CO occur naturally in the atmosphere, but most emissions come from automobiles.

Trends. Ambient levels of CO have improved significantly. In the United States, annual ambient CO concentrations in 1995 were 63.7 percent lower than in 1975; Canadian levels declined 73.3 percent between 1974 and 1994 (Figure 7).[7]

CO emissions declined 33 percent in the United States between 1970 and 1995. There was a 13 percent decline in Canadian CO emissions between 1970 and 1994 (Figure 8).

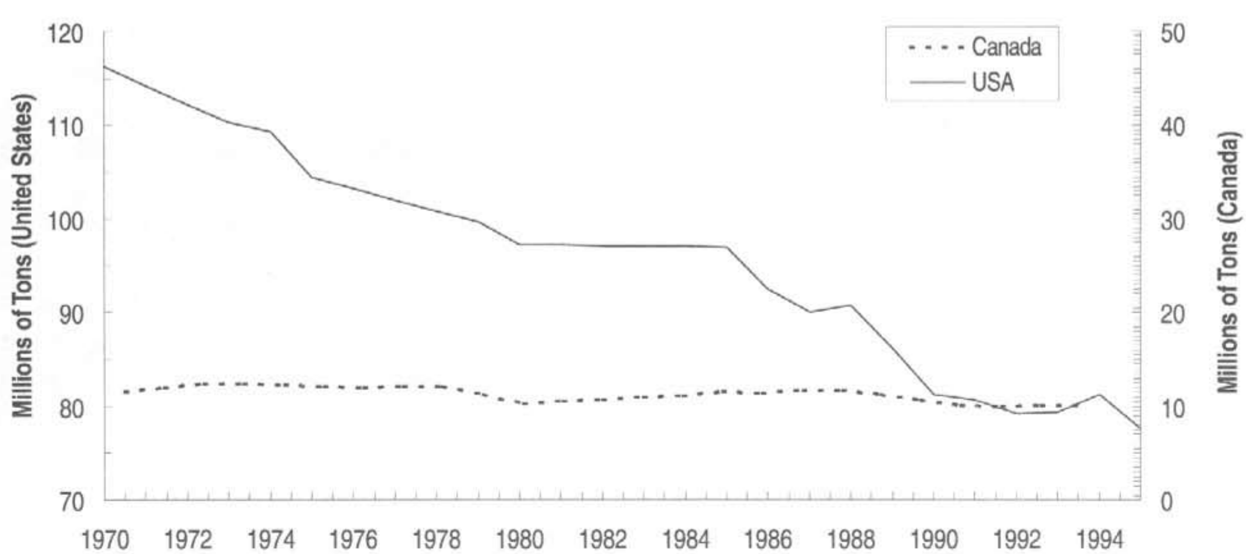
Analysis. These reductions can be attributed to cleaner automobiles (catalytic converters oxidize CO into non-poisonous CO_2) and more fuel-efficient industrial processes. To meet strict motor-vehicle regulations adopted in the early 1970s, exhaust gas recycling systems (EGRS) were installed and some older vehicles were retired. This has led to vastly reduced emissions per vehicle. For example, North American cars built in 1993 emitted 90 percent less NO_x, 97 percent less hydrocarbon, and 96 percent less carbon monoxide than cars built two decades earlier (Bast, Hill, and Rue 1994: 111). These reductions in emissions are expected to continue as more old cars are retired. The most cost-efficient way to continue reducing emissions may be to target poorly tuned, polluting vehicles for repair or replacement.[8]

Figure 7: Carbon Monoxide (Ambient Levels)



Sources: Environment Canada, 1996a; U.S. EPA, 1995c, 1996a. Note: There is no annual guideline for "Good" range. See text for explanation.

Figure 8: Carbon Monoxide (Emissions Estimates)



Sources: U.S. EPA, 1995b; Environment Canada, 1996, 1991c, 1995; OECD, 1997.
Note: Environment Canada changed its calculation methodology in 1985 and 1990.

CASE STUDY

Volunteer Programs Scrap Dirty, Polluting Cars

Part of the success in bringing down carbon monoxide (CO) emissions is due to voluntary programs that are removing some of the dirtiest polluters off the road. Such programs "scrap" old vehicles, which can emit 50 to 100 times the pollutants of new cars and trucks.

The best known of these programs is Eco-scrap of Brea, California, a wholly-owned subsidiary of Union Oil Company of California (Unocal). Under the program, Eco-scrap purchases old, dirty cars and removes them from the road. Its clients are typically companies that have been ordered by the EPA to reduce emissions. But instead of installing outrageously expensive equipment for their facilities, they pay Eco-scrap to buy and junk old cars, which effectively brings about the same pollution reduction as would reducing emissions at the client's facility. Eco-scrap has successfully removed 17,000 old vehicles off the road, and saved each client 50 to 60 percent on compliance costs.

Due to changes in Southern California's South Coast Air Quality Management District (AQMD) rules, Eco-scrap has ceased to exist. As of January 1, 1998, the AQMD only regulates companies with 250 employees or more. Previously, it regulated companies with 100 employees or more. The change in the law has driven down demand for Eco-scrap's services. The company will honor existing contracts but will not begin any new ones.

Other vehicle retirement programs, however, are still in effect. In Southern California, both the Old Vehicle Retirement Program and the Old Vehicle Clearinghouse continue to scrap old cars. An Illinois EPA pilot project has found that such a program would be cost effective for some firms in the Chicago area. In Phoenix, Arizona, 3,600 gas-powered lawn mowers have been junked in exchange for electric mowers, in a similar program jointly run by the Salt River Project, Phoenix's largest electric utility.

The efforts of such privately run programs undoubtedly play a productive role in emissions reductions, particularly carbon monoxide, which comes almost exclusively from transportation exhaust, especially from old vehicles. Not only do such programs make it easier for companies to comply with EPA regulations, but they make overall environmental compliance more cost effective.

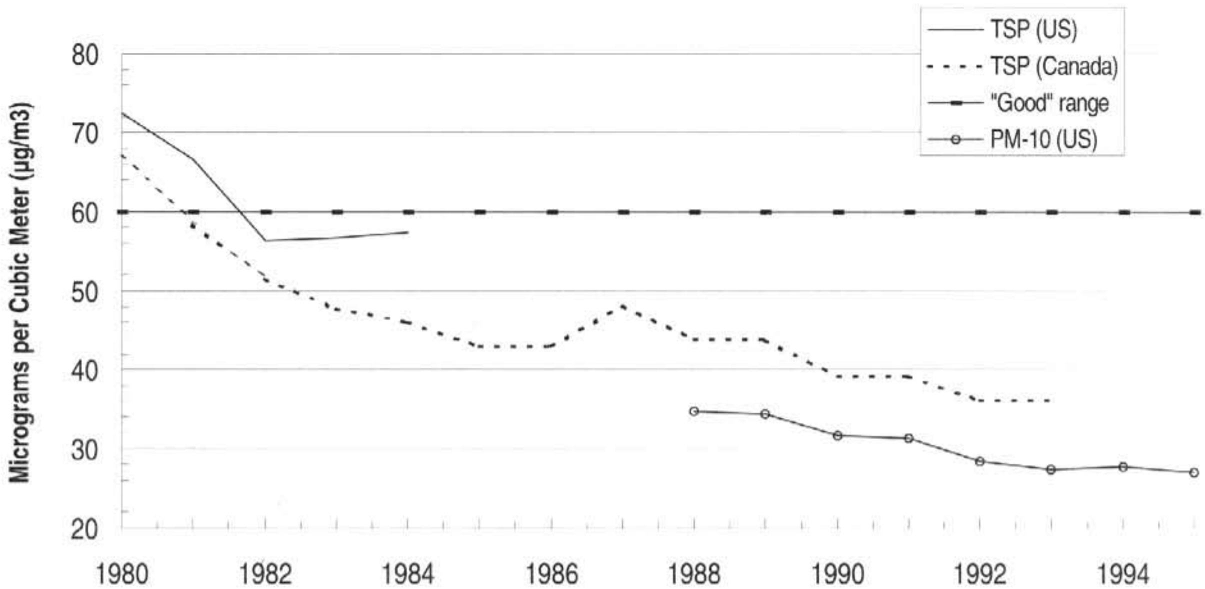
Total Suspended Particulates and PM_{10}

Description. Total suspended particulates (TSPs) are small pieces of dust, soot, dirt, ash, smoke, liquid vapor, and other matter in the atmosphere. Sources may include forest fires and volcanic ash, as well as emissions from power plants, motor vehicles, and waste incineration, as well as dust from mining. At high levels, particulates can be an irritant to lung tissue and may aggravate existing respiratory problems and cardiovascular diseases.

In 1987, the EPA changed its regulatory focus from TSPs to PM_{10}s, suspended particulates that are 10 micrometers or smaller (U.S. EPA 1995c: 2-16). In contrast, Environment Canada continues to use the broader category of TSPs. These regulatory differences make direct comparison of current particulate emissions difficult.

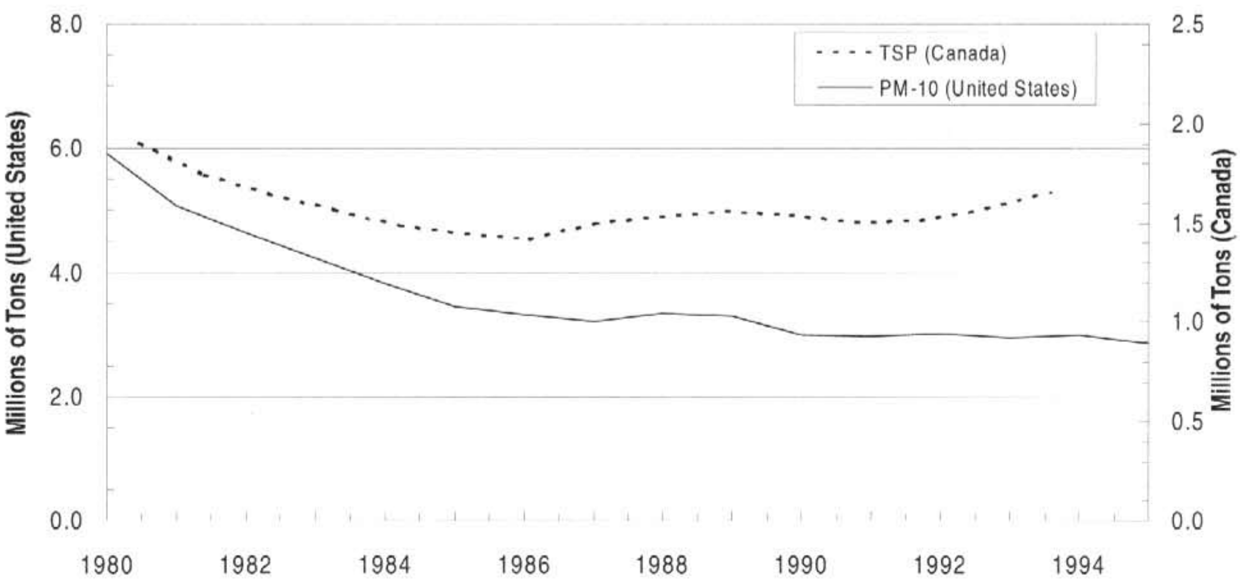
Trends. In the U.S., ambient PM_{10} levels fell 22 percent between 1988 and 1995; in Canada, ambient levels for TSPs fell 46.2 percent between 1980 and 1993 (Figure 9).

Figure 9: Suspended Particulates (Ambient Levels)



Source: U.S. EPA, 1995c; OECD, 1997. Note: TSP = total suspended particulates; PM-10 = (suspended) particulate matter < 10 micrometers; EPA no longer measures TSPs, but rather the narrower category of PM-10s.

Figure 10: Suspended Particulates (Emissions Estimates)



Source: OECD, 1997. Note: TSP = total suspended particulates; PM-10 = (suspended) particulate matter < 10 micrometers; EPA no longer measures TSPs, but rather the narrower category of PM-10s. No data for 1981-1984

PM_{10} emissions in the United States fell 51.9 percent from 1980 to 1995. In Canada, TSP levels declined 13.5 percent from 1980 to 1994 (Figure 10).[9] The switch from coal to fuels such as oil and natural gas that burn more cleanly and more frequent street cleaning are responsible for most of the reductions in emission levels.

PERSPECTIVE

"Richer is Cleaner"

Economic and technological growth are essential to controlling pollution. It is no secret that the wealthier a nation, the better its ability to protect its natural resources and control pollution. As explained by Indur M. Goklany, Manager of Science and Engineering in the Office of Policy Analysis at the U.S. Department of the Interior, and author of the chapter "Richer Is Cleaner," in *The True State of the Planet*, "...the wealthier a nation is, the more it values and the more it can afford to pay for a healthier environment and environmental amenities." This statement is supported by extensive research, including research conducted by the World Bank. After studying pollutants and income levels in numerous countries, the World Bank concluded in its 1992 *World Development Report* that sulphur dioxide pollutants start to decline when a country's per capita income reaches $3,670, while smoke and particulate matter begin to decline when per capita income reaches $3,280. This "richer is cleaner" rule explains much of the progress in environmental quality in the U.S. and Canada over the last few decades.

One example of the strong correlation between affluence and a healthy environment applies to indoor air quality in the home, such as the level of particulate matter, PM_{10} and $PM_{2.5}$. The largest effect on indoor air over the decades has been rising family incomes and families' ability to voluntarily pay for these air quality improvements. Again, as explained by Goklany:

> Improvements in indoor air quality...probably constitute the greatest reduction in the general population's exposure to traditional air pollutants and began decades before the promulgation of federal legislation. When the need is obvious and cause and effect determinable with confidence, people will voluntarily take measures to improve their personal environment without the government's intervention and at some expense to themselves.

Unfortunately, the ones who continue to battle the highest levels of particulate matter in the home are low-income families. Research in the U.S. has found that families on the lower end of the socio-economic scale are more likely to use cheaper energy sources such as coal or wood, rather than cleaner-burning oil and natural gas, compared to families with relatively high incomes. Also, many low-income families are less apt to buy air conditioning, another prerequisite to cleaner indoor air. Sadly, regulations have the perverse effect of reducing income levels, and the ones typically hurt the most by these regulations are low-income families.

DID YOU KNOW?

Falling Emission Levels Pre-date Regulations

Emission levels for some air pollutants in the U.S. were actually falling long before the Clean Air Act was enacted in 1970. This was largely due to voluntary actions to convert to cleaner energy sources, fueled by improving combustion technology and rising incomes. Consider the following:

- Carbon monoxide (CO) emissions fell 4 percent between 1940 and 1992, or 53 percent in per capita terms.
- Particulate matter (PM_{10}) emissions fell 62 percent between 1940 and 1992, or 79 percent in per capita terms.
- Sulphur dioxide (SO_2) emissions fell 60 percent in per capita terms between 1920 and 1992.

Source: U.S. EPA, *National Air Pollutant Emission Trends*, 1990-1992, in Goklany, "Richer Is Cleaner: Long term Trends in Global Air Quality," *The True State of the Planet.*

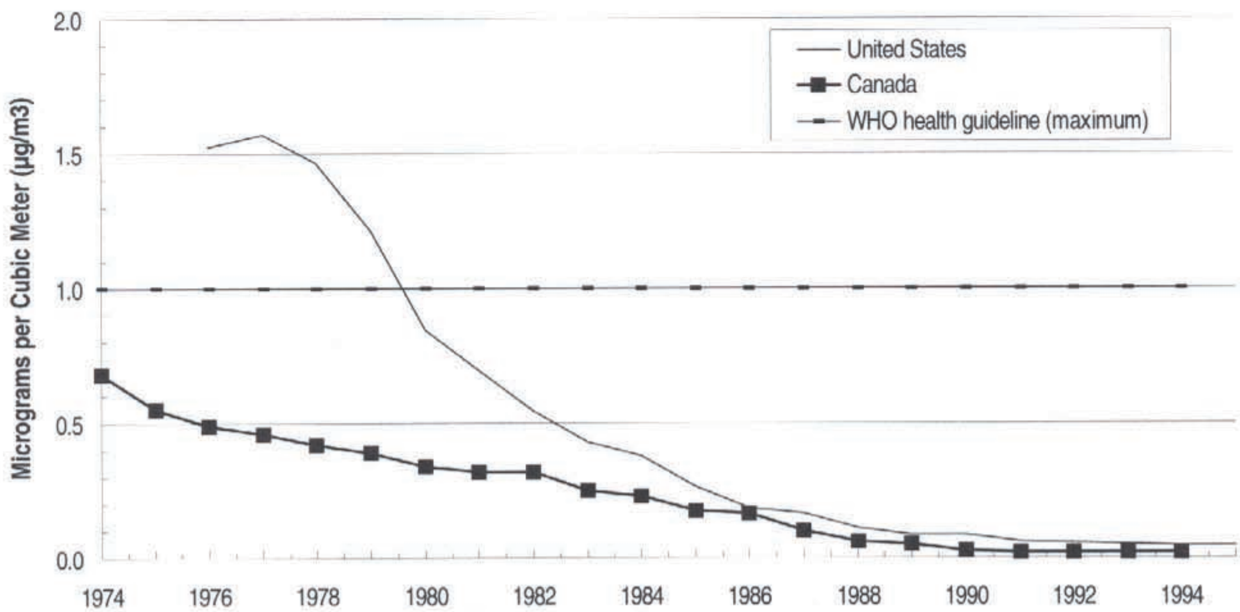
Lead

Description. Lead is a soft, dense, bluish-grey metal. Its high density, softness, low melting point, and resistance to corrosion make it a valuable industrial resource. It is used in the production of piping, batteries, weights, gunshot, and crystal. Until recently, automobiles were the source of most lead emissions, although small quantities of lead are naturally present in the environment. Lead is the most toxic of the main air pollutants. When it is ingested, it accumulates in the body's tissues. In high concentrations it can cause damage to the nervous system and trigger seizures, behavioral disorders, and brain damage.

Trends. The decline in ambient lead concentration and in lead emissions is the greatest success story in the efforts to reduce air pollution. Ambient lead concentration fell 97.2 percent in the United States between 1976 and 1995, and 97 percent in Canada between 1974 and 1994 (Figure 11). The United States has met WHO's health objectives since 1980, and Canada has met them since monitoring began in 1974.

Lead emissions in the United States fell 97.7 percent between 1970 and 1995 (Figure 12). In Canada, total emissions fell 73.9 percent from 1978 to 1995, and automobile emissions fell 87.8 percent from 1973 to 1988. Most of this dramatic reduction was due to the introduction of unleaded gasoline and the elimination of lead compounds in paints and coatings.

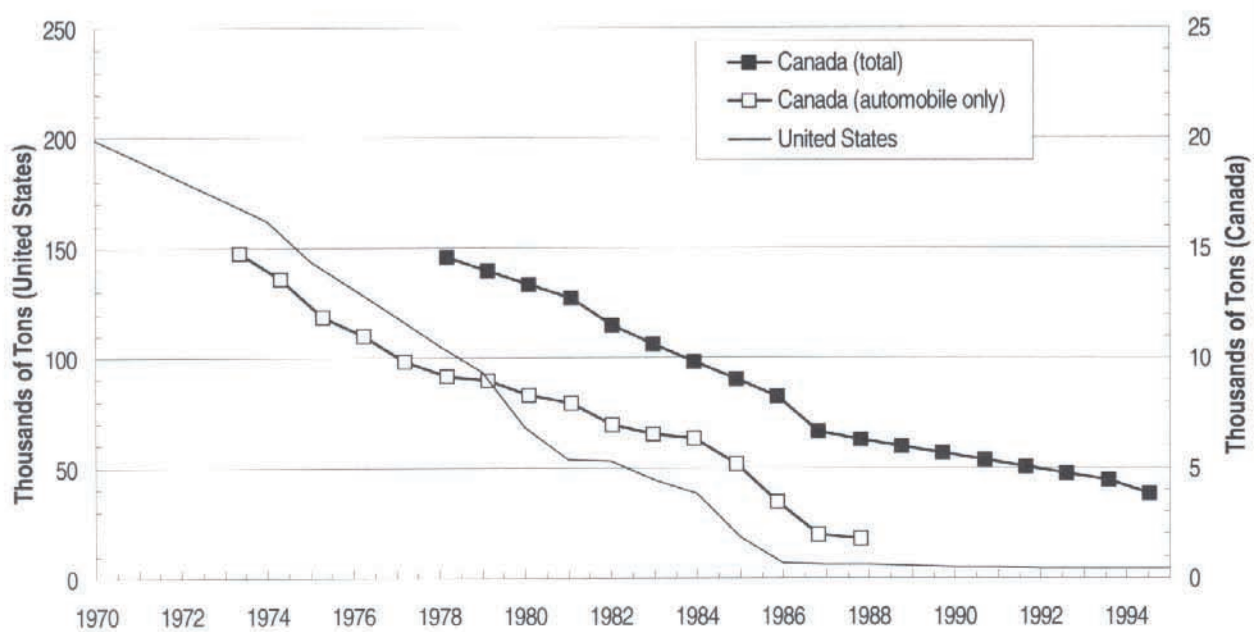
Figure 11: Lead (Ambient Levels)



Sources: Environment Canada, 1996a; U.S. EPA, 1995c, 1996a.

Note: There are no Environment Canada Guidelines for lead. See text for explanation.

Figure 12: Lead (Emissions Estimates)



Sources: U.S. EPA, 1995b, 1996a; Environment Canada, 1991c, 1996c.

Ground-level Ozone

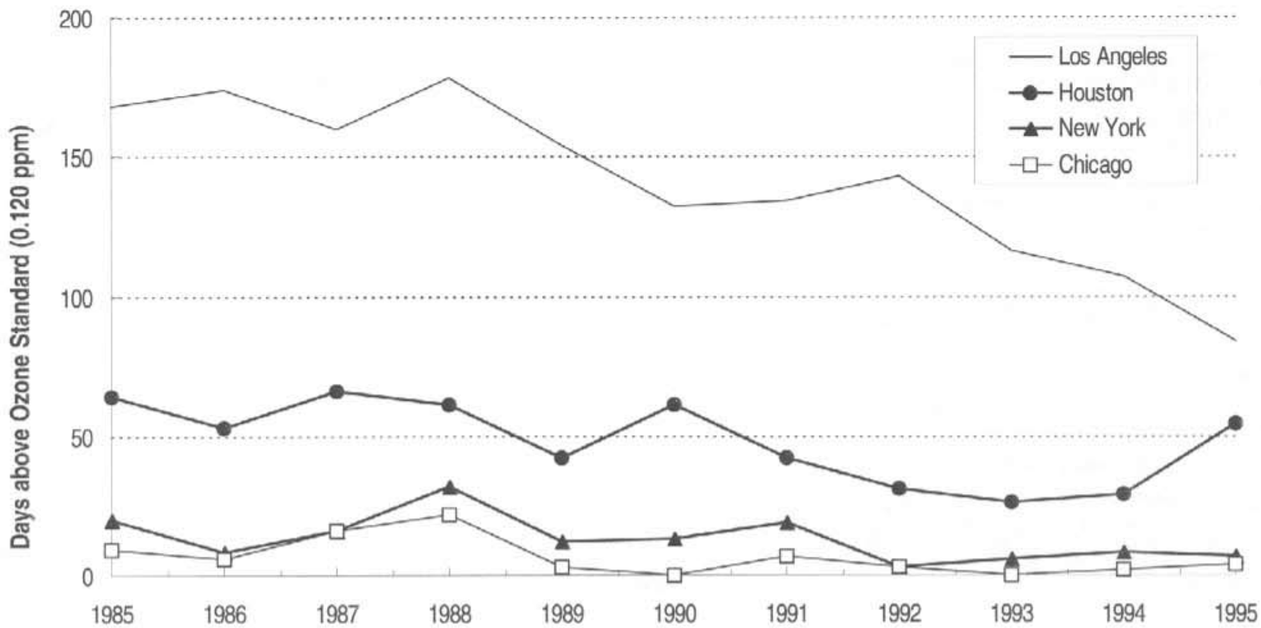
Description. Sulphur, nitrogen, carbon, and fine particulate matter, as well as ground-level ozone, contribute to the formation of urban smog. Since ozone measures are relatively constant over large areas, it is often used as an indicator of overall urban air quality (U.S. EPA 1995c: 6-1).

Trends. Ozone problems occur most often on warm, clear, windless afternoons. Figures 13 and 14 show that the number of days when ozone objectives were exceeded in different cities tend to peak and decline in the same years. This strongly suggests meteorological influences. When analyzing this measure, it is important to understand that, when a single monitoring station registers one one-hour episode above the hourly standard, this is considered a day above the ozone standard. It does not mean, however, that the standard was exceeded for the entire 24-hour period.

In many cities, days when ozone objectives are exceeded have become infrequent although in some areas, and especially in Los Angeles, smog remains a problem. But even in Los Angeles, ozone levels are improving (Figure 13): between 1985 and 1995, the number of days exceeding the ozone standard fell 50 percent. New York also saw a major reduction during the same period when exceedances fell 65 percent between 1985 and 1995.

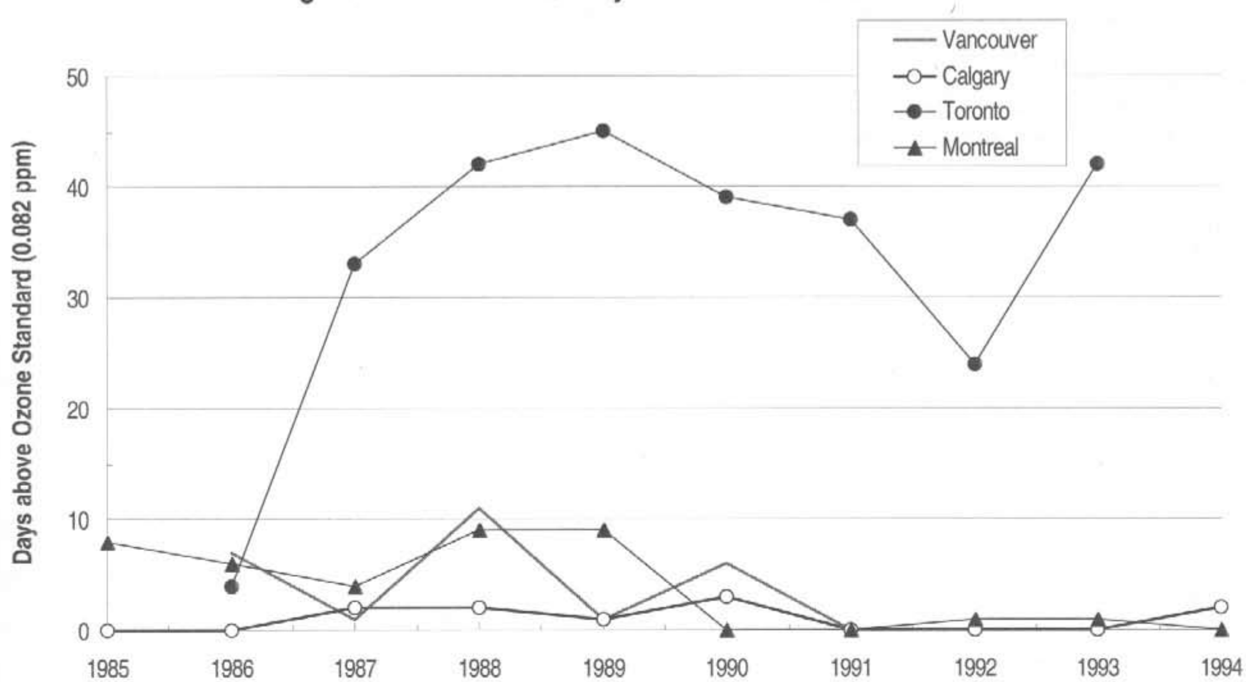
In Canadian cities, the number of days when ozone standards are exceeded have not matched the worst American cases. This is largely due to Canada's colder climate. Ozone pollution is recorded almost exclusively in the summer months from May to September. Data show that ozone levels in Toronto and Montreal are low but variable; Calgary's levels are consistently low, and Vancouver's ozone levels are low and show a decreasing trend. Vancouver did not exceed the ozone standard at all in 1993 (Figure 14).[10] The data show that the number of days when ozone levels are exceeded in Canadian cities is not increasing despite the overall growth in ambient ozone concentrations in Canada. While the major urban centers demonstrate relatively few ozone episodes, southwestern rural Ontario records the highest number of days exceeding the ozone standard.[11]

Figure 13: Urban Air Quality in Selected American Cities



Sources: U.S. EPA, 1996a. See text for explanation.

Figure 14: Urban Air Quality in Selected Canadian Cities



Source: Tom Dann, personal communication.

Table 1: Summary of Air Quality as Environmental Indicator

General comments	Performance record: U.S.	Performance record: Canada
General comments on air quality • Ambient level refers to the actual concentration of a pollutant in the air. • Emissions are estimates of pollution caused by human activity. • There is not a simple or predictable correlation between emissions caused by human activities and ambient air quality. • Natural sources and meteorological factors such as temperature, sunlight, air pressure, humidity, wind, and rain greatly affect measurable levels. • Pollution levels within the good to fair range provide adequate protection for people and the environment.	• Ambient pollution in all categories has declined since the 1970s.	• Ambient pollution decreased in all but one of the categories (ozone).
Sulphur dioxide (SO_2) • SO_2 is a component of acid rain. • Acid rain has not damaged forests or crops in either the U.S. or Canada and has had no observable effect on human health. • Ambient levels are affected by meteorological factors.	• Has met annual "good" objectives since 1980. • Ambient level decreased 60.7% from 1975 to 1994.	• Has met annual "good" objectives since 1977. • Ambient level decreased 61.5% from 1974 to 1994.
Nitrogen dioxide (NO_2) • NO_2 is a component of acid rain. • NO_2 combines with VOCs to form ground-level ozone (main component of urban smog); ozone levels vary considerably, however, with natural and meteorological factors.	• Has met annual "good" objectives since monitoring began in 1975. • Ambient level decreased 37.3% from 1975 to 1995.	• Has met annual "good" objectives since monitoring began in 1977. • Ambient level decreased 41.9% from 1977 to 1994.
Ozone • VOCs and NO_2 combine to form ground-level ozone. • Regulations target VOC emissions as the primary means to combat ozone. • Ambient ozone levels do not directly or predictably reflect emissions because of their failure to account for naturally occurring VOCs and meteorological factors.	• Exceeds annual "fair" objectives. • Ambient level decreased 25.7% from 1976 to 1995.	• Exceeds annual "fair" objectives. • Ambient level increased 31.3% from 1979 to 1994.
Carbon monoxide (CO_2) • North American cars built in 1993 emit 90% less NO_X, 97% less hydrocarbons and 96% less carbon monoxide than cars built two decades earlier.	• Ambient level decreased 63.7% from 1975 to 1995.	• Ambient level decreased 73.3% from 1974 to 1994.
Particulates • Particulates come from a variety of natural sources.	• Ambient level decreased 22% from 1988 to 1995.	• Has met annual "good" objectives since 1981. • Ambient level decreased 46.2% from 1980 to 1993.
Lead • Natural sources contribute small quantities. • Leaded gasoline was phased out once the adverse health effects of lead were discovered.	• Has met WHO health guidelines since 1980. • Ambient level decreased 97.2% from 1976 to 1995.	• Has met who health guidelines since monitoring began in 1974. • Ambient level decreased 97% from 1974 to 1994.

Water Quality

Assessing Water Quality

The quality of our lakes, rivers, and streams is among the most difficult environmental areas to assess on a nationwide basis. The data used in this section do not represent complete ambient water-quality information due to the lack of available data and the magnitude and complexity of measuring water quality. American estimates indicate that taxpayers and the private sector have spent over $500 billion on water pollution control since the enactment of the Federal Water Pollution Control Act (1972). Despite this expenditure, there is still no adequate national database of water quality to evaluate the results of such efforts.

The effects of both natural and manufactured contaminants upon water quality vary with water conditions (source, velocity, volume, depth, pH level), photosynthetic activity, and variations within a day as well as from season to season. In addition, inconsistencies in data collection are apt to occur due to overlapping jurisdictions and budget considerations.

Limits in Research. There appears to be an unfortunate trend. Those in the field of data collection and analysis have begun to feel a constant pressure to produce results that justify the budgetary expense of their department. This, coupled with dwindling resources, has resulted in an emphasis on crisis management; site-specific studies are, thus, often given priority over systematic and consistent monitoring. Data analysis becomes very difficult without a solid database from monitoring stations. One technician articulates clearly the problem that occurs when scientific research is strangled by bureaucracy: "If you are not monitoring, you are not managing."

Currently, there are attempts in both the United States and Canada to start national indexes of water quality; some regional representatives, however, are resisting the setting of national standards by a central planning committee. Due to the enormous geographic size of both countries, water quality cannot be quantified effectively with one or two general measures because there are different parameters for different regions. For example, in Canada the Canadian Council of Ministers of the Environment (CCME) has decided that a Water Quality Index should be constructed by technical subgroups, one from each province and one from the federal government. In discussion, the CCME established general parameters for developing a national index of water quality in Canada.

Defining Water Pollutants

There are two sources of water pollution: point and non-point sources.[12] Point sources refer to industrial release pipes and municipal sewer outlets that discharge pollutants directly into the aquatic ecosystem. Non-point sources refer to indirect sources of pollution such as run-off from agriculture, forestry, urban, and industrial activities, as well as landfill leachates and air-borne matter. Water quality also varies naturally. Some bodies of water are of poor quality due to inherent chemical, physical, and biological characteristics.

Water pollution from human activities includes nutrients, heavy metals, persistent pesticides, and other toxins. These are described below:

> **Nutrients.** Nutrients like phosphorus and nitrogen can cause significant degradation of water quality by accelerating eutrophication,[13] which depletes levels of dissolved oxygen. Phosphorus and nitrogen are found in fertilizers and livestock manure (Environment Canada 1991c: [9]26). Government regulation stipulates a reduction in the amount of phosphate in detergents in an effort to improve water quality. Lower phosphate levels in lakes and streams, however, do not always result in higher levels of dissolved oxygen and improved water quality as plants continually recycle phosphorus from sediments.
>
> **Heavy metals.** Heavy metals occur in water from the weathering of rocks. They also reach the water system directly from industrial and mining activity. The most severe cases of metal contamination are caused by abandoned mines. Non-point sources such as urban storm-water and agricultural run-off also contribute to metal contamination. High concentrations of heavy metals can affect the quality of drinking water and harm aquatic life as the metals accumulate in organs and tissues (bioaccumulation).[14]
>
> **Pesticides.** Pesticides and toxins like polychlorinated synthetic compounds (DDT and PCBs) can also accumulate in biological organisms. The effects of these compounds on animals such as birds include growth retardation, reduced reproductive capacity, diminished resistance to disease, and birth deformities.

Water Treatment

Industrial and municipal sewage is usually treated before being released into rivers, lakes, streams, or oceans. Primary wastewater treatment removes solid waste mechanically; secondary treatment employs biological processes to break down dissolved organic material; tertiary treatment removes additional contaminants, including heavy metals and dissolved solids.

Therefore, most industrial — or point source — pollution has been brought under control. Since 1992, "all sewage generated in the U.S. [has been] treated before discharge." (Easterbrook 1995: 682) This has helped to reduce the release of organic wastes by 46 percent, toxic organics by 99 percent, and toxic metals by 98 percent. Non-point sources, however, continue to be a problem. The EPA notes that non-point sources "are clearly the leading reason for impediment in surface waters" (U.S. EPA 1993:18). Efforts to reduce non-point sources increased in 1987 when amendments were made to the Clean Water Act. Further reforms should loosen federal control to give state and local governments more flexibility in handling non-point sources.

In Canada, the proportion of wastewater receiving treatment increased from 72 percent in 1983 to 93 percent in 1994 (Environment Canada 1996d, 1996e). Canada's Wastewater Technology Centre recently shifted its focus from industrial research to end-of-pipe, pollution-prevention technologies (Environment Canada 1996b: 10). For example, the Centre is developing technology to reduce phosphorus and ammonia in wastewater, to control and manage sewer overflows and storm-water discharges, and to improve contaminated sites.

National Water Quality

Because the United States and Canada monitor water quality differently, the Index considers each country separately. Information on water quality and wildlife indicators for the Great Lakes are also presented to provide a case study of North America's internationally important freshwater resources.

The United States

In 1972, the EPA instituted a National Water Quality Inventory (NWQI) under the Clean Water Act. The EPA, in conjunction with the United States Geological Survey, reports to Congress on the criteria for water quality and pollution. Each state must meet the minimum federal criteria and may set additional objectives to address particular local problems. They must also submit biennial "305b" reports to their regional EPA office (there are 10 regions) stating whether they met or exceeded the minimum federal levels. The regional EPA offices amalgamate each state's report to produce the biennial EPA *Report to Congress on Water Quality.*

The NWQI assesses rivers, lakes, and estuaries based on nine standards concerning their beneficial uses. These include: support of aquatic life, fish consumption, shellfish harvesting, supply of drinking water, primary contact (swimming), secondary contact (recreation), agriculture, recharge of groundwater supply, and wildlife habitat. This inventory provides a "snapshot" of water quality.

According to the NWQI, 17 percent of rivers; 42 percent of lakes, ponds, and reservoirs; and 78 percent of estuaries have been assessed to date (U.S. EPA 1995e: Executive Summary). Table 2 reports the results for 1994, the last year for which data are available.

Table 2: United States National Water Quality Inventory (1994) Showing Levels for Overall Use

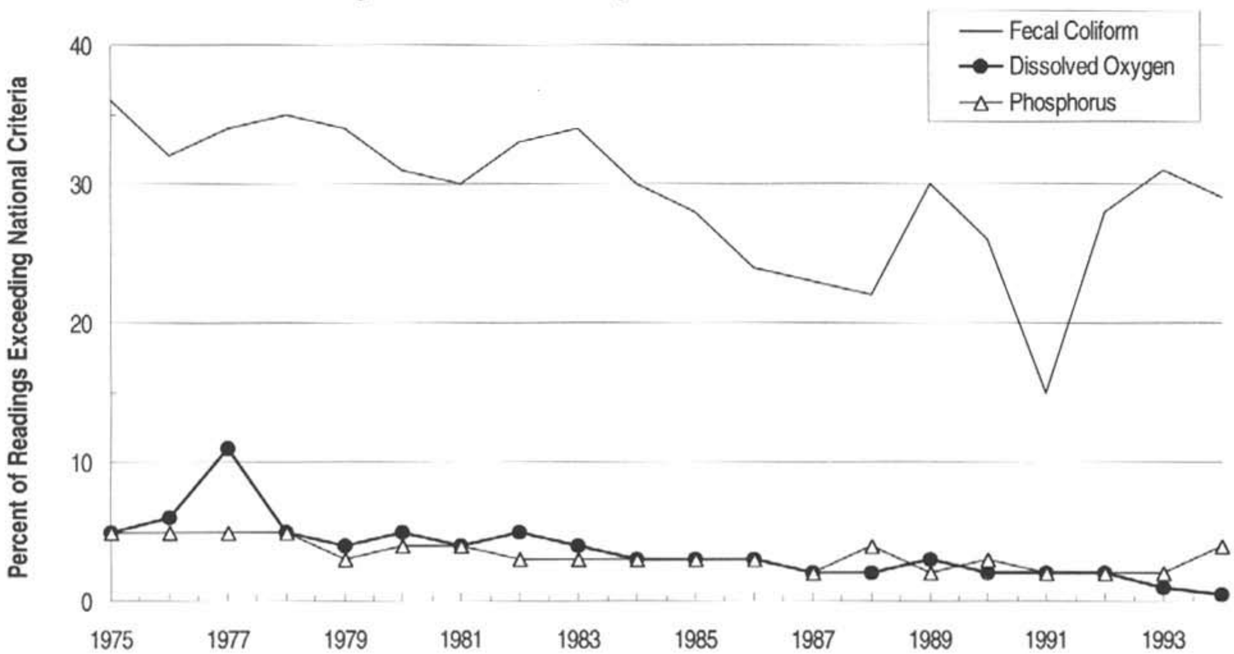
	Good		Fair	Poor	
	Fully Supporting	Threatened	Partially Supporting	Not Supporting	Not Attainable
Rivers (615,806 miles)	57%	7%	22%	14%	<1%
Lakes (17.1 million acres)	50%	13%	28%	9%	<1%
Estuaries (34,388 miles)	2%	1%	34%	63%	0%

Difficulties in analyzing data. There are several problems with the NWQI data. For one thing, meaningful time-series analysis of the data is not possible due to annual changes in the water bodies being assessed, differing methodologies and reporting techniques, and incomplete data. In addition, the percentages reported in Table 2 may actually underestimate water quality since states have a bureaucratic incentive to assess those waters where problems are most likely to be found. The EPA itself notes that "it is likely that unassessed waters are not as polluted as assessed waters" (U.S. EPA 1989: XI).

Several efforts are underway to improve the data on water quality. The National Water Quality Surveillance System (NWQSS) and the U.S. Geological Survey's National Stream Quality Accounting Network (NASQAN) provide limited but consistent data. The 420 monitoring stations in this network, located on major American rivers, are useful in tracking the progress of prominent point-source controls, especially municipal sewage treatment plants. This network, it must be emphasized, is not designed to provide a statistical sample of the water quality of streams throughout the nation.

Analysis of data. Figure 15 shows that the percent of readings exceeding the local clean-water standard for both phosphorus and fecal coliform have declined from their peaks in 1975. This indicates a clear success of wastewater treatment. There has not, however, been a significant increase in the dissolved oxygen content of water. In fact, "the most noteworthy finding from national-level monitoring is that heavy investment in point-source pollution control has produced no statistically discernible pattern of increases in the water's dissolved oxygen content during the last 15 years" (Knopman and Smith 1993; Smith, Alexander, and Wolman 1987).

Figure 15: Water Quality in the United States



Source: U.S. Geological Survey cited in U.S. Bureau of the Census, 1997.

The EPA's NWQI 1994 *Report to Congress* compiles assessments of data on minimum-requirement water quality collected during 1992 and 1993 by 61 states, American Indian tribes, territories, Interstate Water Commissions, and the District of Columbia. Data from these many varied geographies administered by multiple layers of bureaucracy must be collected and analyzed. Making it even more difficult to assess data is the fact that states, tribes, and other jurisdictions do not use identical survey methods and criteria to rate their water quality. The EPA admits that caution must be the rule in attempting to compare data submitted by different states and jurisdictions in one reporting period, or by the same jurisdictions over more than one reporting period because survey methodology is neither spatially nor temporally standardized (U.S. EPA 1995e: ES-2).

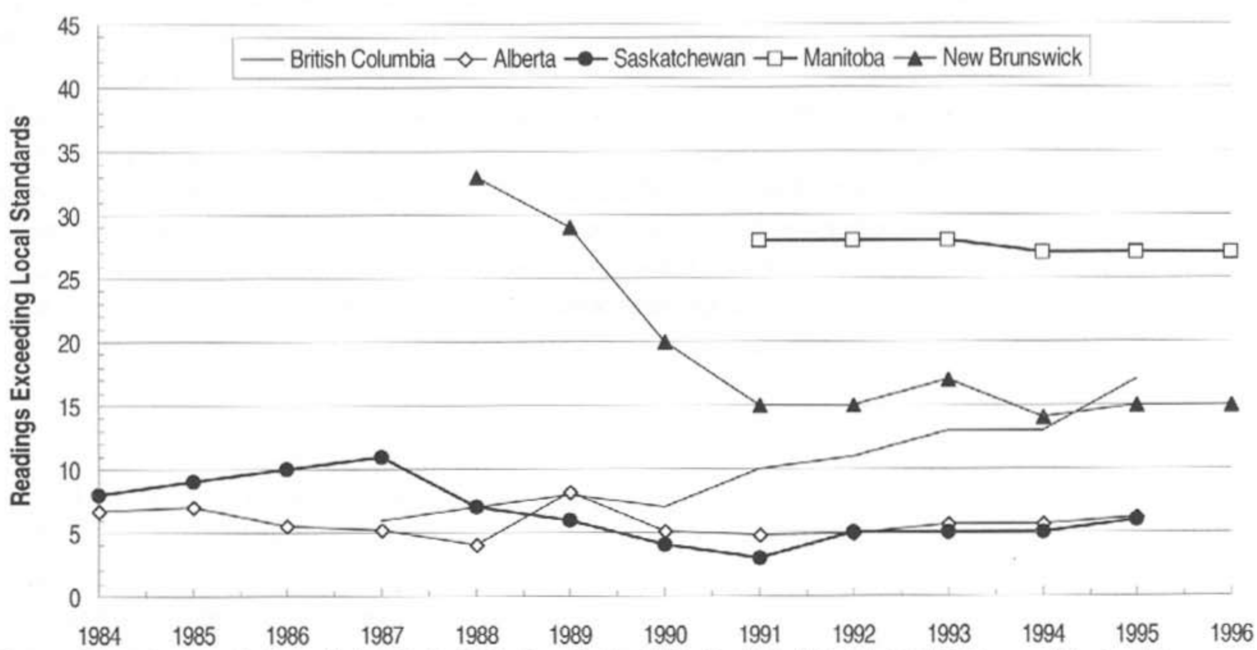
Canada

Canada does not have legislated water-quality objectives. The Canadian Council of Ministers of the Environment (CCME) established the Canadian Water Quality Guidelines in 1985 to provide a basis for designing site-specific water-quality objectives. The guidelines recommend concentrations for supporting and maintaining several categories of water use including aquatic life, drinking, recreational, agricultural, and industrial use. Water must meet requirements for biological (bacteria, viruses, protozoan), radiological (radioactive isotopes), physical (taste, odor, temperature, turbidity, colour), and chemical factors.

In Canada, provincial governments legislate standards and regulations for water quality although the federal government offers advice and leadership. Municipalities are responsible for testing drinking water for coliforms and residual chlorine.

Detailed site-specific reports on water quality provide "snapshot" evidence that Canadian drinking water is generally good. Most Canadian municipalities treat drinking water through chlorination, ozone treatment, or ultraviolet radiation. Environment Canada conducted a four-year study on the quality of drinking water in the Atlantic provinces, which revealed that of the 150 substances tested, none was present in levels that exceeded the maximum acceptable guidelines (Environment Canada 1990). A study carried out in 1986 by the Canadian Public Health Association showed that levels of very few of the 161 substances measured in treated tap water from the Great Lakes exceeded the guidelines Canadian Public Health Association 1986). Further, a 1990 study of the Great Lakes by the Toronto Board of Health could detect only 42 of the substances for which they were testing; none was present in levels that exceeded the guidelines Kendall 1990).

Figure 16: Water Quality in Canada



Sources: Personal communications with L.G. Swain (B.C.), Karen Saffran (Alta), Kim Hollard (Sask.), Dwight Williamson (Man.), and Jerry Choate (N.B.), 1997. Note: Data from other Canadian provinces are not available.

Although raw data on Canadian water quality exist in a federal database, the information is not in a format that can be used to evaluate water quality on a national level. The provinces, however, are taking a greater role in monitoring water quality. British Columbia, Alberta, Saskatchewan, Manitoba, and New Brunswick have developed site-specific objectives and maintain a record of goal attainment. These data provide only a snapshot of Canada's water quality.

Canada, like the United States, tests water at sites located upstream or downstream from urban centers and industrial facilities, on transboundary rivers and streams, and on bodies of water that are used for recreation. Figure 16 illustrates the success of British Columbia, Alberta, Saskatchewan, and Manitoba in attaining water quality objectives. New Brunswick's record shows a considerable decrease in the percentage of sites exceeding objectives. It should be noted that the number and type of bodies of water tested, and of pollutants examined, varies from province to province.

The Great Lakes

The Great Lakes (include from west to east, Lakes Superior, Michigan, Huron, St. Clair, Erie, and Ontario) contain one-fifth of the world's freshwater. Over 23 million people depend on the Great Lakes for drinking water. They provide tremendous economic and ecological benefits to the surrounding area. One quarter of all U.S. industry, and 70 percent of U.S. and 69 percent of Canadian steel mills are located in the Great Lakes Basin (EPA 1995e: 496). The Great Lakes are exposed to many sources of point and non-point pollution but, for many years, it was thought that the Great Lakes were too big to have serious pollution problems. By the 1960s, however, sewage, fertilizer run-off, and chemical wastes had caused serious degradation to Lake Erie, and the other lakes showed signs of similar trouble.

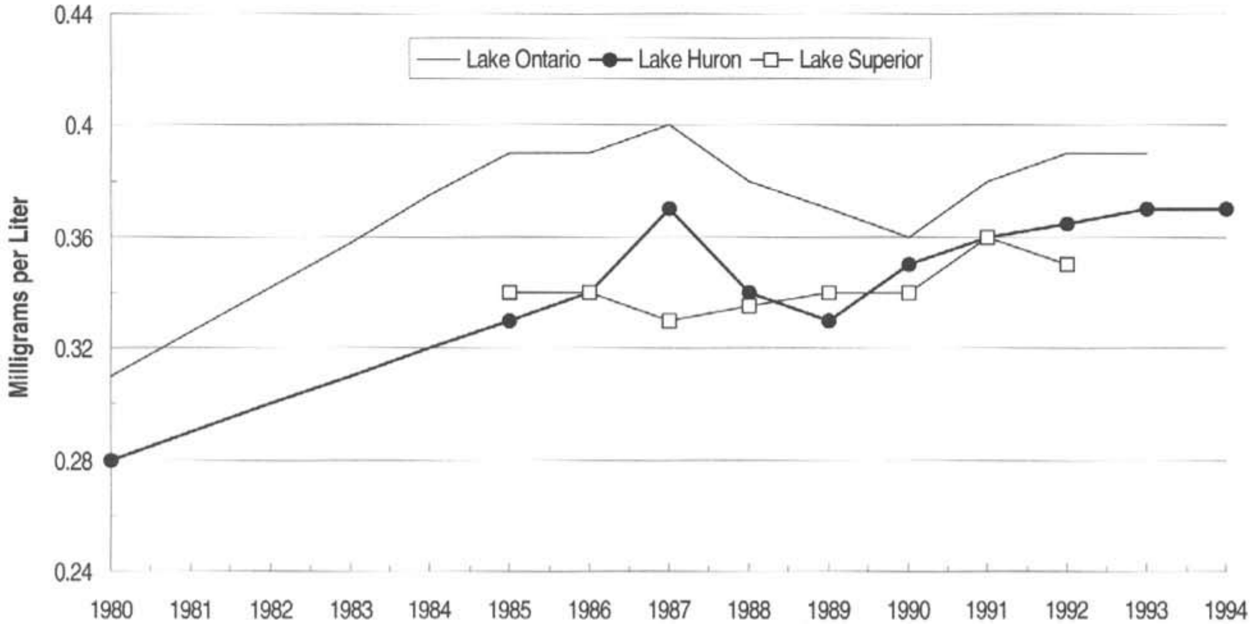
Trends. As a result, over the last 20 years, the United States and Canada have spent over $9 billion to clean up Lake Erie (Hayward 1994: 23). These efforts have improved water quality. Although discharges from waste-water treatment plants have increased due to population growth and industrial development, levels of dissolved oxygen have steadily improved, resulting in cleaner discharge. There have been noteworthy reductions in organic material, solids, and phosphorus as well. Fish have returned to some harbors from which they had all but disappeared, and the number of double-crested cormorants, a water bird that all but vanished from the Great Lakes in the 1970s, has climbed to 12,000 nesting pairs (U.S. EPA 1995e: 497).

The data reveal several encouraging trends in the water quality of the Great Lakes, particularly for harmful chlorine compounds. Nitrogen levels have increased but are still well below the threshold of 10 milligrams per litre for safe drinking water (Figure 17). Phosphorus levels have declined by one-third in Lake Ontario, 80 percent in Lake Huron, and have remained stable in Lake Superior (Figure 18). Phosphorus targets have been consistently met in Lake Michigan since 1981 and Lake Superior since 1985; for the most part Lakes Huron, Erie, and Ontario have also met their targets since 1986, 1987, and 1988 respectively (Figure 19).[15]

Drastic measures introduced, despite successful cleanup. Despite these improvements, the International Joint Commission (IJC), an advisory group in the U.S. and Canada, remains pessimistic about water quality in the Great Lakes. They recently recommended an extreme measure: a ban throughout North America on the production of products using chlorine chemicals.

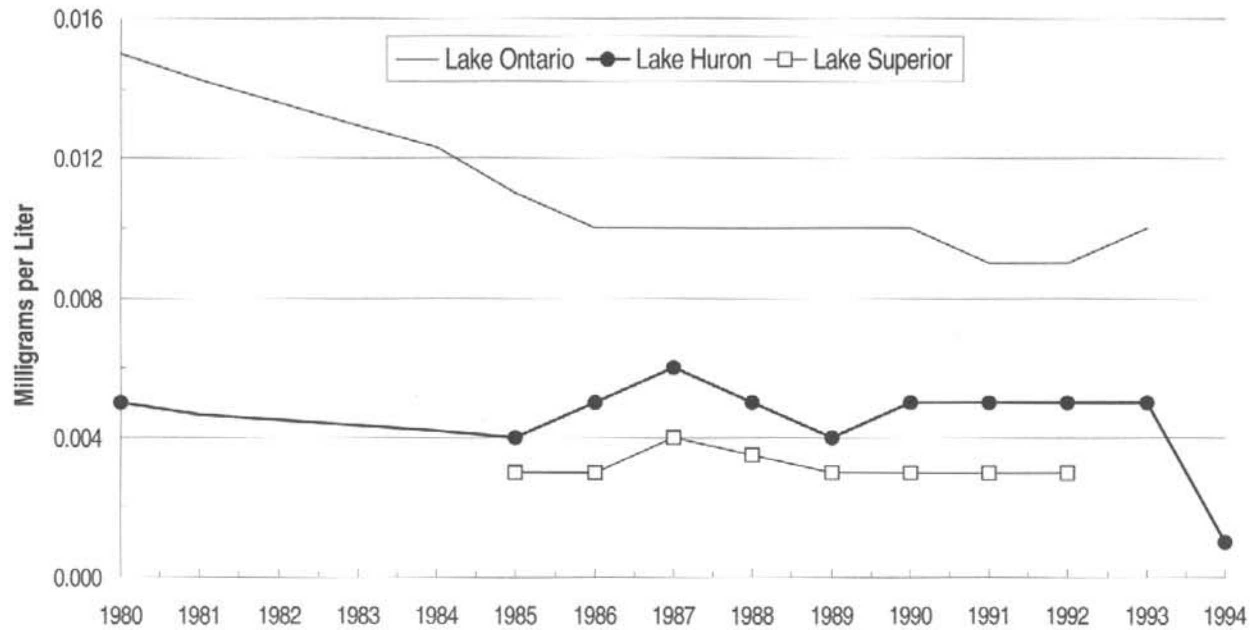
Another important indicator of water quality in the Great Lakes is the pesticide contamination found in birds' eggs. The contamination of herring gull eggs fell considerably between 1974 and 1991. Levels of Dichloro-diphenyl-dichloro-ethylene (DDE)[16] fell 90.2 percent in Lake Ontario and 89.2 percent in Lake Superior from peak levels in 1975 (Figure 20). Available data also indicate a decrease in the already low levels of the pesticides Dieldrin and Mirex in herring gull eggs. Polychlorinated biphenyls (PCBs)[17] fell 91.1 percent in Lake Ontario, 87.4 percent in Lake Huron, 85.4 percent in Lake Superior, 80.3 percent in Lake Michigan, and 67.5 percent in Lake Erie from their highest recorded levels (Figure 21). The level of hexachloro-benzenes (HCBs)[18] peaked in 1977 and fell 97.5 percent in Lake Ontario, 91.9 percent in Lake Erie, and 87.5 percent in Lake Michigan by 1995. Lakes Superior and Huron fell 92.3 percent and 92.1 percent respectively between 1974 and 1995 (Figure 22). These favorable trends can be observed in others of the Great Lakes as well (Council on Environmental Quality 1996).

Figure 17: Water Quality in the Great Lakes (Nitrogen)



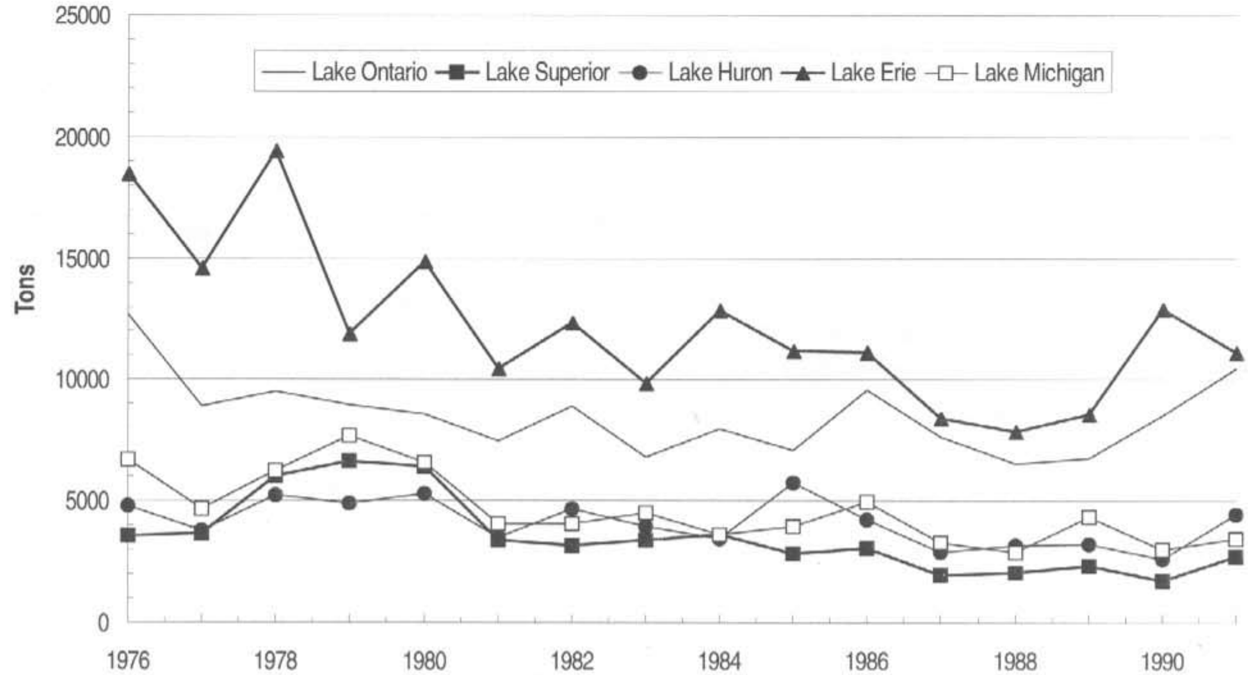
Source: OECD, 1997. Note: No data for 1981-1984. Data are not available for Lakes Erie and Michigan.

Figure 18: Water Quality in the Great Lakes (Phosphorus)



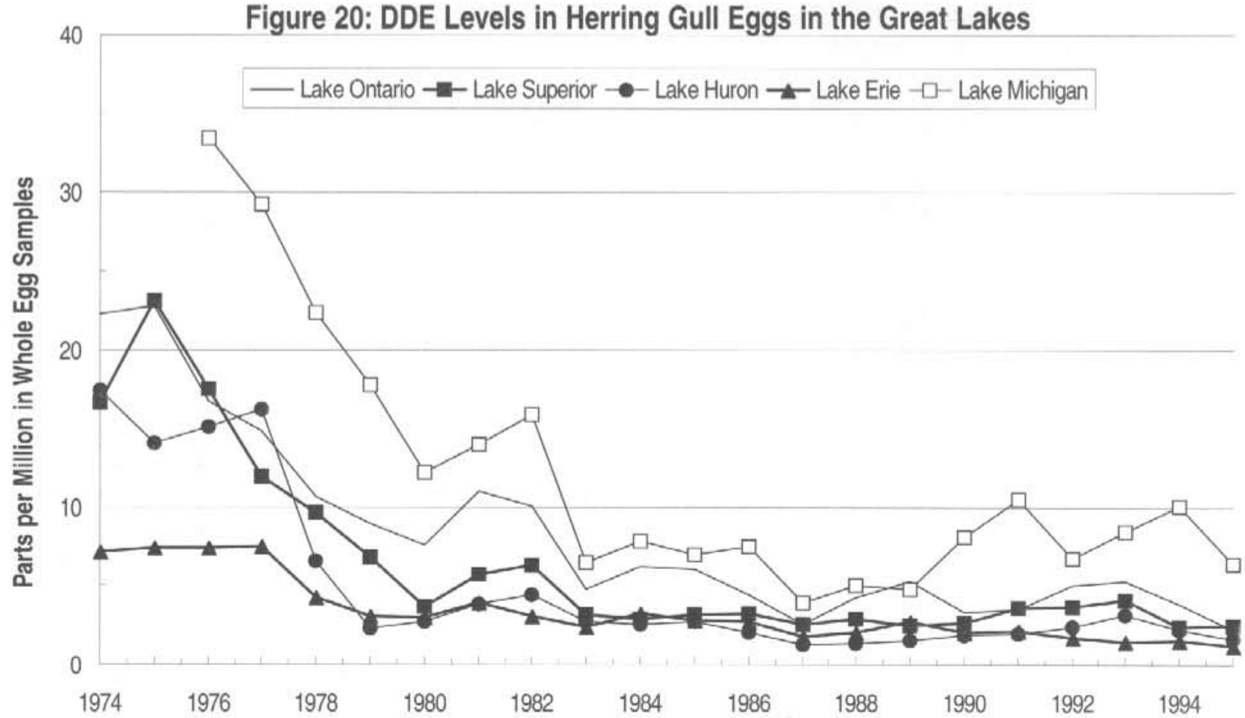
Sources: Personal communications with L.G. Swain (B.C.), Karen Saffran (Alta), Kim Hollard (Sask.), Dwight Williamson (Man.), and Jerry Choate (N.B.), 1997. Note: Data from other Canadian provinces are not available.

Figure 19: Industrial Discharge of Phosphorus into the Great Lakes



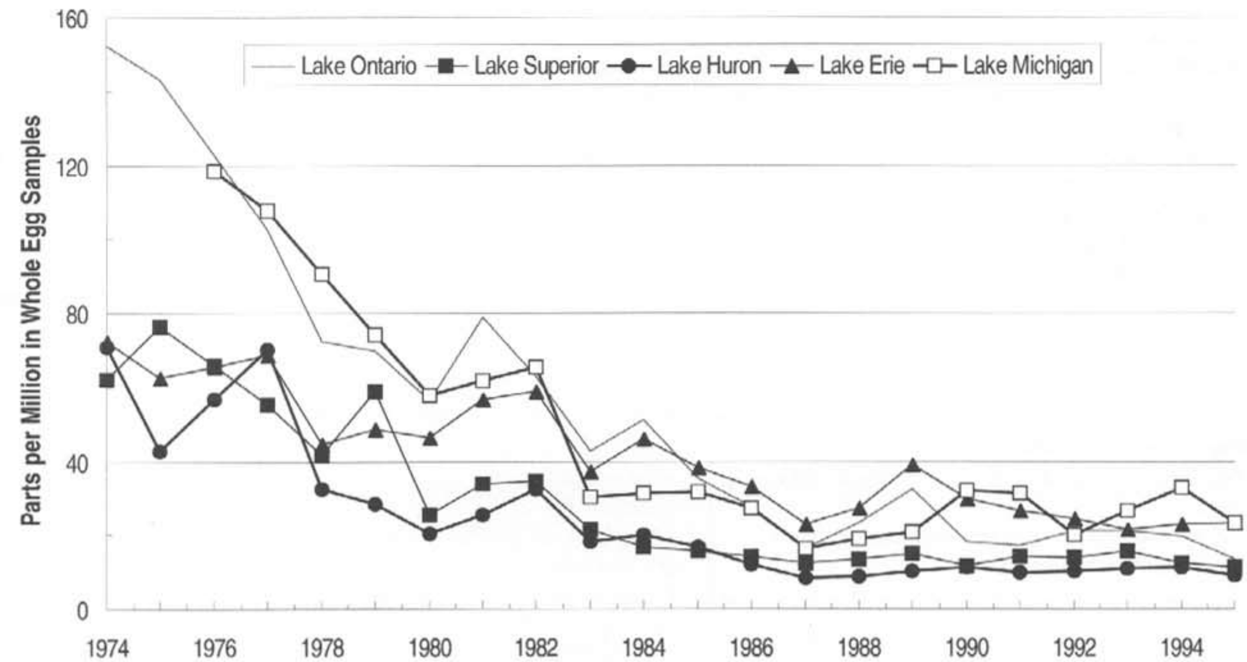
Source: Council on Environmental Quality, 1996.

Figure 20: DDE Levels in Herring Gull Eggs in the Great Lakes



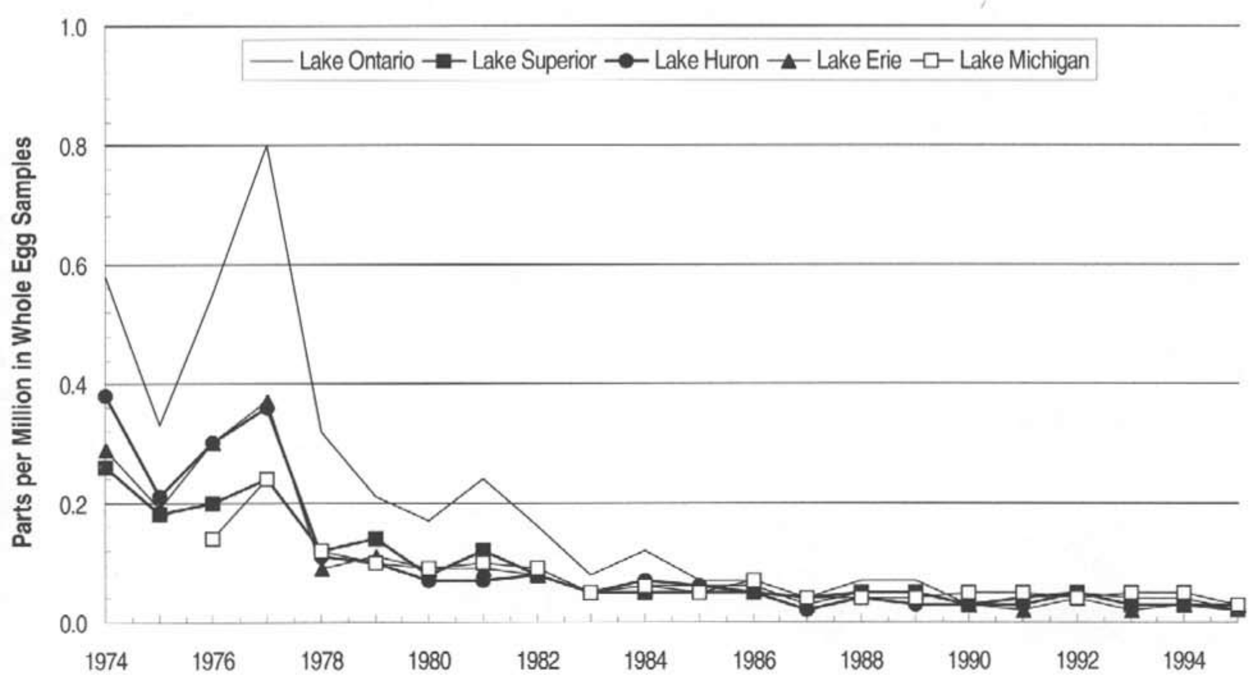
Source: Council on Environmental Quality, 1996. DDE = dichloro-diphenyl-dichloro-ethylene.

Figure 21: PCB Levels in Herring Gull Eggs in the Great Lakes



Source: Council on Environmental Quality, 1996. PCBs = Polychlorinated biphenyls.

Figure 22: HCB Levels in Herring Gull Eggs in the Great Lakes



Source: Council on Environmental Quality, 1996. HCB = hexachloro-benzene.

Table 3: Summary of Water Quality as Environmental Indicator

General comments	Performance record: U.S.	Performance record: Canada
National water quality • National water quality is difficult to assess due to inconsistent, incomplete data. • Water pollutants include nutrients, heavy metals, persistent pesticides, and other toxic substances. • Industrial and municipal sewage normally undergo some treatment to remove these substances. • The U.S. and Canada target different aspects of water quality as priorities.	• Measures of phosphorus, fecal coliform, and dissolved oxygen exceeding local standards (in rivers and streams only) decreased between 1975 to 1994. • In 1994, 86% of rivers and streams, 91% of lakes, and 37% of estuaries supported overall use.	• Objective-attainment records are only available for British Columbia, Alberta, Saskatchewan, Manitoba and New Brunswick. • In 1995, Alberta and Saskatchewan met their goals over 90% of the time. British Columbia and New Brunswick met their goals over 80% of the time. Manitoba met its goals over 70% of the time.
Water in the Great Lakes • The Great Lakes contain one-fifth of the world's water. • Nitrogen and phosphorus are given priority when water quality is evaluated.	• Measures of nitrogen have increased, but are well below the 10 mg per litre threshold for safe drinking water. • Phosphorus levels have declined by one-third in Lake Ontario and remained stable in Lake Huron and Lake Superior. • Targets for phosphorus discharges have been met in Lake Michigan since 1981; in Lake Superior since 1985; in Lake Huron since 1986; in Lake Erie since 1987; in Lake Ontario since 1988.	• Measures of nitrogen have increased, but are well below the 10 mg per litre threshold for safe drinking water. • Phosphorus levels have declined by one-third in Lake Ontario and remained stable in Lake Huron and Lake Superior. • Targets for phosphorus discharges have been met in Lake Michigan since 1981; in Lake Superior since 1985; in Lake Huron since 1986; in Lake Erie since 1987; in Lake Ontario since 1988.
Wildlife in and around the Great Lakes • Bioaccumulation occurs when persistent, fat soluble, contaminants are ingested by an organism and accumulate over time in tissue. Levels of DDE, PCBs and HCBs are monitored in herring gull eggs. The use of DDT has been banned and PCBs are severely restricted.	• The levels of these contaminants in herring gull eggs fell considerably between 1974 and 1995. • DDE fell 78% in Lake Michigan, 79% in Lake Superior, 84% in Lake Erie, 85% in Lake Ontario, and 90% in Lake Huron between 1977 and 1995. • PCBs fell 66% in Lake Erie, nearly 80% in Lakes Michigan and Superior, and 87% in Lakes Ontario and Huron. • The Great Lakes' mean level of HCBs peaked in 1977 and fell 94% by 1995.	• The levels of these contaminants in herring gull eggs fell considerably between 1974 and 1995. • DDE fell 78% in Lake Michigan, 79% in Lake Superior, 84% in Lake Erie, 85% in Lake Ontario, and 90% in Lake Huron between 1977 and 1995. • PCBs fell 66% in Lake Erie, nearly 80% in Lakes Michigan and Superior, and 87% in Lakes Ontario and Huron. • The Great Lakes' mean level of HCBs peaked in 1977 and fell 94% by 1995.

Natural Resources

Forests

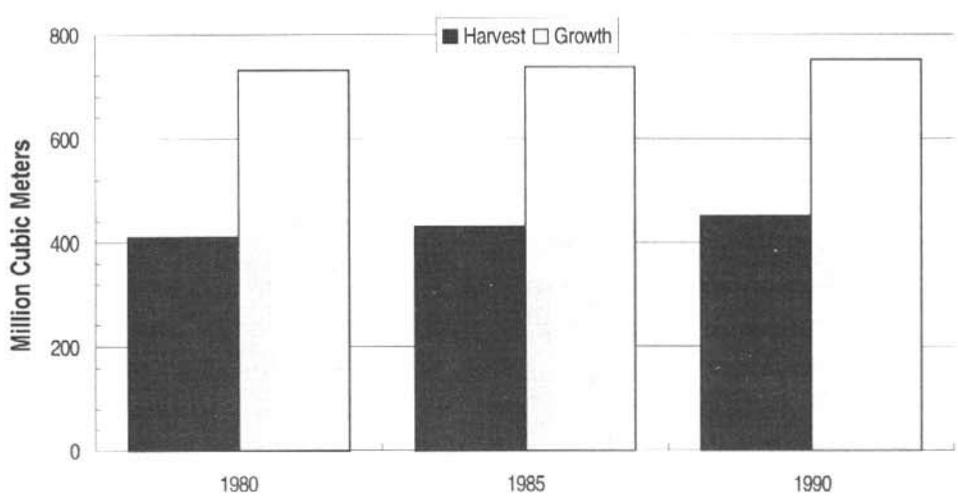
North America's forests are the subject of some of the most emotionally charged environmental controversies. The fear that we shall run out of trees dates back more than a century in the United States. In his address to Congress in 1905, President Theodore Roosevelt warned that "a timber famine is inevitable and the *New York Times* ran headlines in 1908 proclaiming, "The End of the Lumber Supply" and "Supply of Wood Nears End: Much Wasted and There's No Substitute."

"Although the United States has been the world's number one timber producer since World War II, U.S. forests have experienced an increase in volume in the past 50 years and have maintained roughly the same area over the past 75 years."
—Roger A. Sedjo in *True State of the Planet*

North America's diverse forest resources include over 130 species of trees and sustain a wide variety of plants and animals (Environment Canada 1991c: [10]4). Forests provide habitat, purify air, prevent run-off, and inhibit erosion by anchoring topsoil. Forests release water vapor into the air and play a critical role in the carbon cycle by absorbing CO_2, storing the carbon, and releasing the oxygen.

The United States and Canada play a significant role in world timber markets. In 1995, American and Canadian production provided over 50 percent of global wood pulp, over 25 percent of paper and paperboard, over 15 percent of wood-based panels, and almost 40 percent of other wood products.[19] Despite the Asian financial crisis, the global demand for North American forest products is large and is likely to remain so. The industry is a primary contributor to regional economies: one in 15 workers in Canada is employed directly or indirectly by the forestry sector (Environment Canada 1996c).

Figure 23: Forest Harvest and Growth in the United States



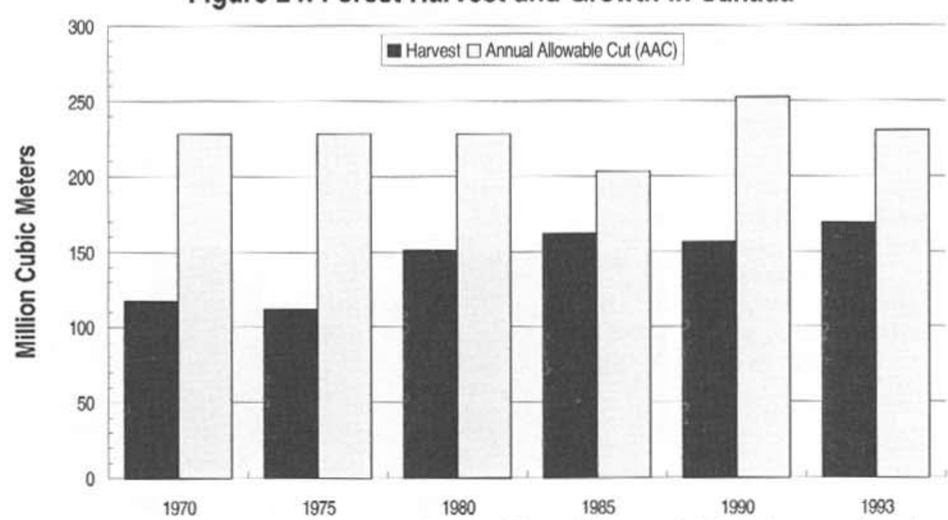
Source: OECD, 1997.

Seeing the forests through the trees. Despite this strong commercial reliance, only a small portion of total forest resources are harvested each year. A survey by the Organization for Economic Cooperation and Development (OECD) shows that the United States consistently harvests less than the amount of annual new growth (Figure 23). The United States harvested 56 percent of the annual new growth in 1980, 59 percent in 1985, and 60 percent in early 1990s. Similarly, Environment Canada reports that of the country's 418 million hectares of forestland, 119 million hectares are accessible and actively managed for timber production. A mere 0.8 percent of managed forests are harvested per year, averaging 165 million cubic meters of harvested timber, with each cubic metre contributing $95 to the Gross Domestic Product of Canada (Environment Canada 1996c).

"In recent years, private forest lands have accounted for 85 percent of total tree planting and seeding in the United States."
—Roger A. Sedjo in *True State of the Planet*

In the United States, governments (federal, state, and local) control 131.5 million acres of the 489.6 million timber-producing acres (U.S. Bureau of the Census 1996), more than 27 percent. In Canada, various levels of governments own and control as much as 94 percent of forested land (Environment Canada 1996c). Governments decide how much can be harvested based on the annual allowable cut (AAC), which is calculated by considering the quantity and quality of species, accessibility of the trees, growth rates, site sensitivity, and competing uses. The AAC calculation is not a measure of total new growth; it is a measure of growth available for commercial harvesting. The proportion of the AAC harvested was 66.1 percent in 1980; it climbed to 79.8 percent in 1985 and fell to 73.4 percent in 1993 (Figure 24).

Figure 24: Forest Harvest and Growth in Canada



Source: National Forestry Database, Canadian Council of Forest Ministers, cited in Environment, Canada, 1996c. Note: See text for explanation of Annual Allowable Cut (AAC).

For the most part, forest land historically was cleared for agricultural use. Some land, however, was proven unsuitable for farming and has been reverting back to forest cover. In southern Ontario, forest cover has actually increased from 25 percent to 29 percent since the mid-1960s (Armson 1989). Reforestation efforts in Maine have increased wooded areas from 74 percent to over 90 percent of the state (Ray 1993: 113; Sedjo 1995: 178-209).

"The expansion of American forests has been made possible by improved tree-growing technology, the advent of tree plantations, improved control over wildfire, and the reversion of many agricultural lands, especially in the South and East, to forest."
—Roger A. Sedjo in *True State of the Planet*

A local issue. The serious environmental debates surrounding forests and harvesting practices tend to be local in nature; examples of such debates are those about the preservation of old-growth stands and the practice of clear-cutting. Old-growth forests are those stands that are over 140 years old, have over a specified number of trees, and have experienced minimal human disturbance. They have considerable commercial and environmental value. Today's commercial cutting cycle of 50 to 80 years means that once they are harvested, old-growth ecosystems will not be re-established. Second-growth forests, however, also provide commercial and environmental benefits.

Even forests that have been clear-cut and replanted support diverse wildlife populations and contain trees of various ages, sizes, and species. The beautiful wilderness scenes in the popular movie *Last of the Mohicans,* for example, were filmed in a formerly clear-cut commercial forest, not a natural forest. (Bast, Hill, and Rue 1994: 24)

Clear-cutting remains a popular method of harvesting. In Canada, almost 90 percent of trees logged are harvested by this means. There are two reasons for this: First, it is economically viable; second, it simplifies reforestation. It allows easy preparation of the site for the re-establishment and tending of a new forest, and the open area provides the heat and sunlight needed for the new trees to grow. In addition, dead stumps support an extraordinary number of species, including fungi, spiders, beetles, and centipedes. Finally, leaves and branches contain plant nutrients and are often left as humus to replenish the soil. When clear-cutting is not performed properly, however, it can damage sensitive watersheds and the ecosystems of rivers. Overall, it is important to bear in mind that the area harvested nationally is minimal in comparison to the annual extent of natural disturbances (Environment Canada 1996c).

In the United States, the USDA Natural Resources Conservation Service runs the Agricultural Conservation Program that uses incentives to encourage private landowners to apply good forest practices on their lands. Through its cooperative state and private forestry programs, the Forest Service offers financial and technical assistance to protect and improve forests on non-federal lands. In 1995, the USDA spent 9.3 million dollars planting 141,194 acres of trees, improving 22,540 acres, and preparing 1,845 acres for natural generation (U.S. Bureau of the Census 1996).

CASE STUDY

North Maine Woods

Among the most promising approaches to protecting forest lands is through the private ownership and management of forests.

One example is the North Maine Woods, a private operation managing roughly 3 million acres of forests that have remained unchanged for more than a century. The operation is owned by a private consortium of 25 timber and paper companies. Hikers and other visitors pay a user fee which helps to finance the management of the forest. As described by Collette Ridgeway, a researcher who traveled throughout the country visiting national and privately-managed parks, "There are no visitor centers with park rangers, not gas stations or even paved roads. It is one of the few places where you can find true solitude. We would often spend days at a time with only moose, black bears, and beavers for company."

Source: Collette Ridgeway, "Privately Protected Places," *Cato Policy Report*, Cato Institute, March/April 1996, Vol. XVIII, No.2.

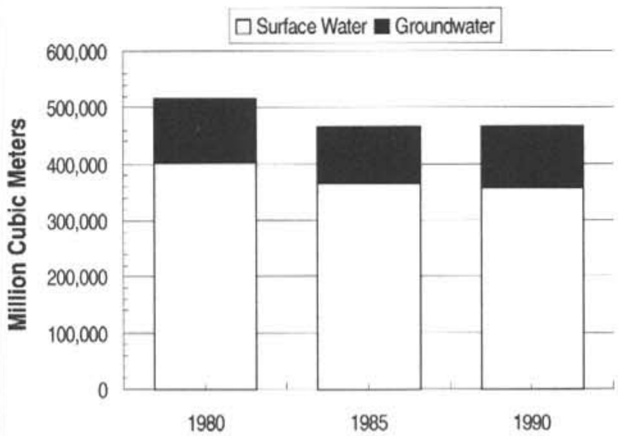
Fresh Water

Only 2.7 percent of the earth's water is fresh water (Environment Canada 1991c). Sources of fresh water include: snow, glaciers, and polar ice (77 percent); underground (22 percent); lakes and wetlands (0.35 percent); atmosphere (0.04 percent); and streams (0.001 percent) (White 1984: 252). Only about 0.01 percent of this fresh water is actually accessible from lakes, rivers, soil, and the atmosphere.

The cooling of power-generating plants uses the most fresh water, accounting for 38.6 percent in the United States and 59.7 percent in Canada. Total industry uses of freshwater account for only 5.7 percent of total water use in the United States, and 7.9 percent in Canada. The public uses 11.3 percent in the United States, and 11.4 percent of in Canada. Finally, irrigation accounts for 40.2 percent of freshwater use in the United States, due to its large agricultural base; in Canada, irrigation uses only 7.1 percent of the total (OECD 1997: 68-71). Approximately 90 percent of water withdrawn by Canadians is returned to its source after use or treatment (Environment Canada 1991a: 82). Only about one-quarter of agricultural water is returned to its source.

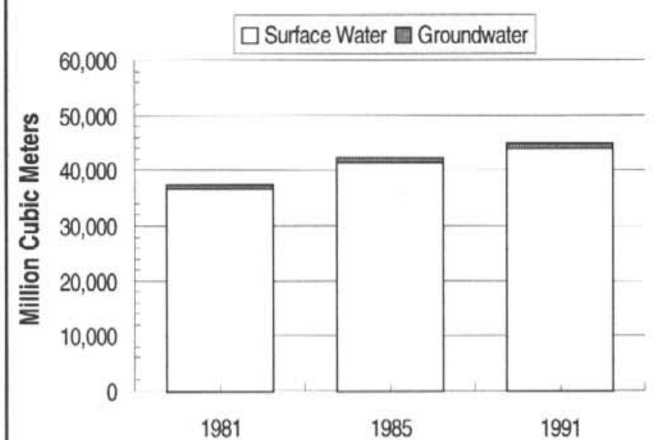
North American water prices are relatively low. The cost per thousand liters is \$0.40 in the United States and \$0.35 in Canada. Prices can be up to three times higher in European nations. For example, the price per thousand liters is \$0.65 in the United Kingdom, \$0.77 in Sweden, \$0.85 in France and \$1.30 in Germany. It is interesting to note that, on average, bottled water costs

Figure 25: Freshwater Withdrawals in the United States



Source: OECD, 1997. Note that freshwater withdrawals refer to the use of ground water (water below the surface and supplying wells and spring) and of surface water (rivers, lakes, streams, and estuaries).

Figure 26: Freshwater Withdrawals in Canada



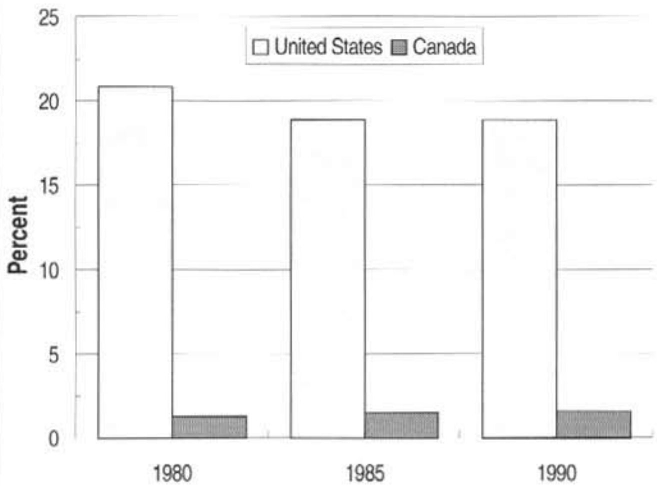
Source: OECD, 1997. Note that freshwater withdrawals refer to the use of ground water (water below the surface and supplying wells and spring) and of surface water (rivers, lakes, streams, and estuaries).

about $497 per thousand liters.[20] As expected, lower prices tend to lead to higher levels of freshwater consumption, and North Americans are the largest consumers of fresh water in the world. The average daily household use is about 420 liters in the United States and 360 liters in Canada. This is more than double the rate of water use in many European countries (Environment Canada 1991c: [3]8).

An OECD survey indicates that total water use decreased 9.5 percent in the United States between 1980 and 1990 (Figure 25), but increased 20 percent in Canada between 1980 and 1995 (Figure 26). The United States has 2.5 trillion cubic meters of renewable freshwater resources and used 20.9 percent in 1980, and 18.9 percent in both 1985 and 1990 (Figure 27).[21] Canada has approximately 2.8 trillion cubic meters of renewable freshwater resources and used 1.3 percent in 1980, 1.5 percent in 1985, and 1.6 percent in both 1990 and 1993.

Subsidies create inefficiencies in usage. While this abundance contributes to lower prices, government subsidies artificially suppress prices. Several municipalities charge a flat rate for water use, with governments subsidizing irrigation. In Canada, the provinces pay an average of 85 percent of the total cost of water use (Environment Canada 1996c). Subsidization policies eliminate the incentive for efficient use of water resources. Subsidies lead to inefficient agricultural use, less water recycling, and a greater need for wastewater treatment facilities. This places further pressure on water sources and increases the demand for new dam construction and water diversion projects.

Figure 27: Withdrawals as a Percentage of Renewable Freshwater Resources



Source: OECD, 1997.

To eliminate the difference between the real cost and the actual price of water, Environment Canada recommends in their *State of the Environment Report* that "we should pay a fair price that will recover the full cost of water delivered to the tap, one that is based on actual quantity used" (Environment Canada 1996c).

Although the U.S. and Canada use only a small portion of renewable fresh water, regional water shortages continue to be a problem. In parts of the United States where water is scarce, farmers have responded by changing irrigation technology and cropping practices, and by using recycled municipal wastewater for agricultural purposes (Avery 1995: 68-9).

Energy Resources

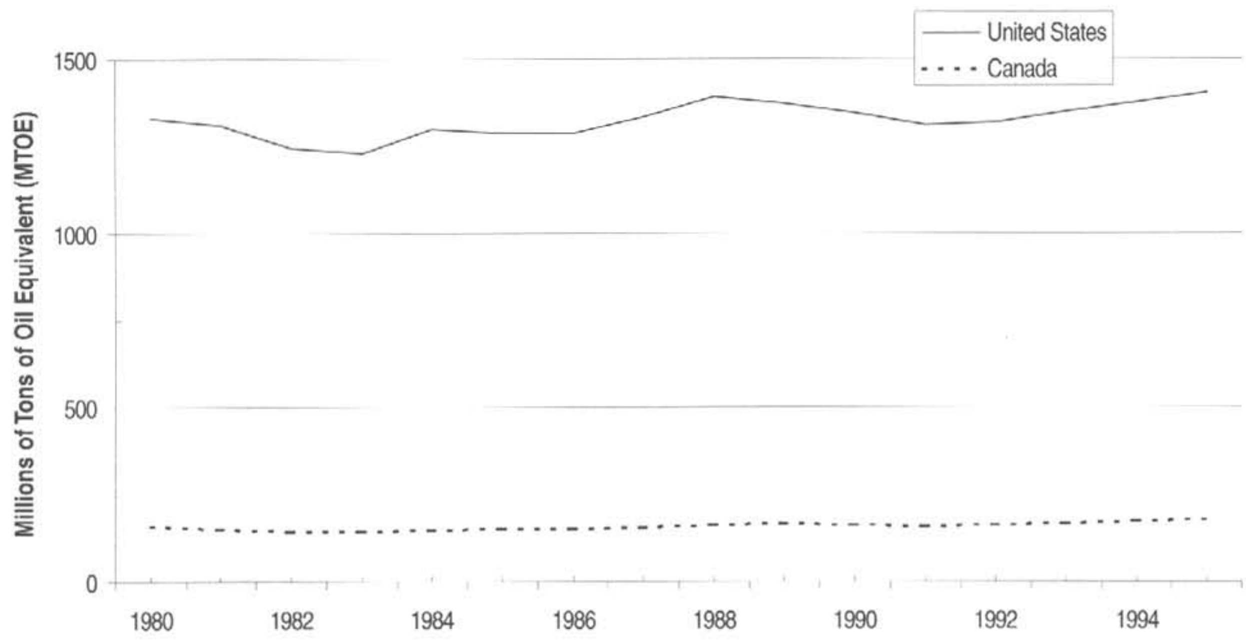
Despite the fact that the United States and Canada are among the world's largest users of energy resources (due to their highly industrialized economies, widely dispersed populations, and large land masses), these countries are extremely efficient users of energy. Today, less energy is being used per capita than in the past.

Figure 28 shows that total energy consumption is rising in the United States and Canada. The better measure of energy use, however, is per-capita consumption (Figure 29). While per-capita energy use rose steadily before the end of the 1970s, it has since levelled off. For example, in 1995 the United States and Canada both used less energy per capita than they did in 1979. The reduction in the use of energy per capita reflects improvements in energy efficiency.[22]

DID YOU KNOW?

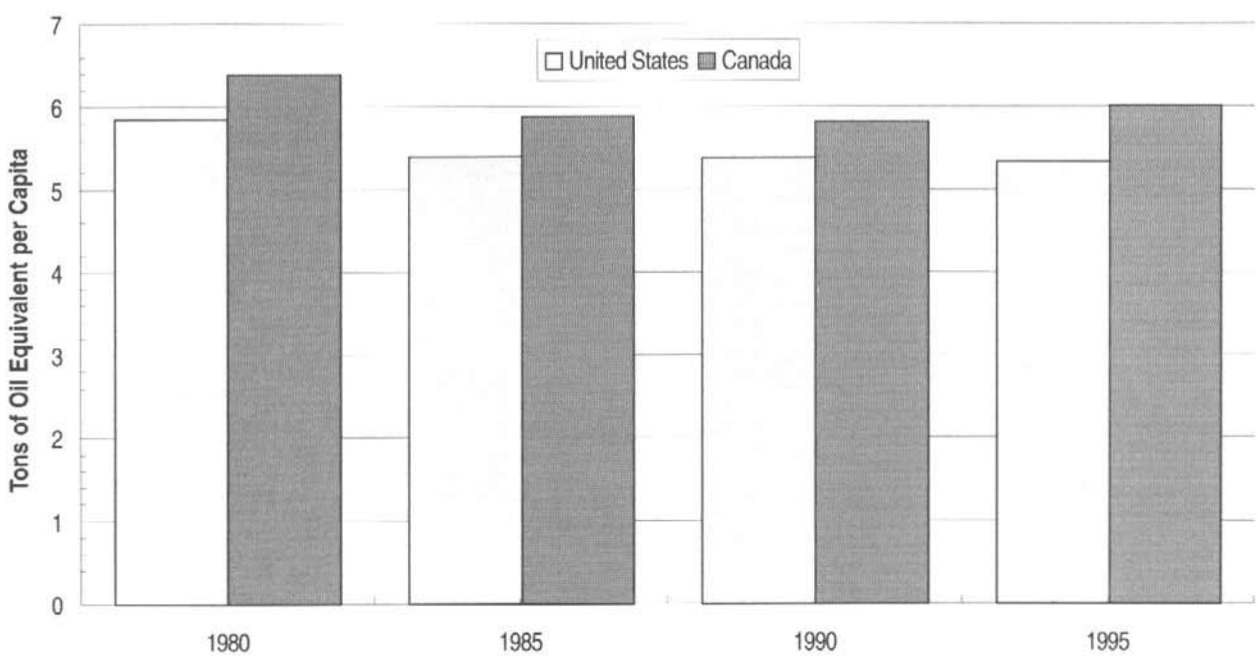
If the world were close to running out of energy, as some believe, one would expect to see a decline in production and an increase in prices in recent years. Instead, the opposite is true. Although total consumption in the United States increased between 1980 and 1995, consumption as a percentage of production has been fairly stable (about 85 percent). In Canada, consumption as a percentage of production decreased from 76 percent in 1980 to 50.8 percent in 1995. Both countries are producing more energy than they are consuming. Figure 30 shows that Canada and the United States are net exporters of energy.

Figure 28: Total Annual Consumption of Energy



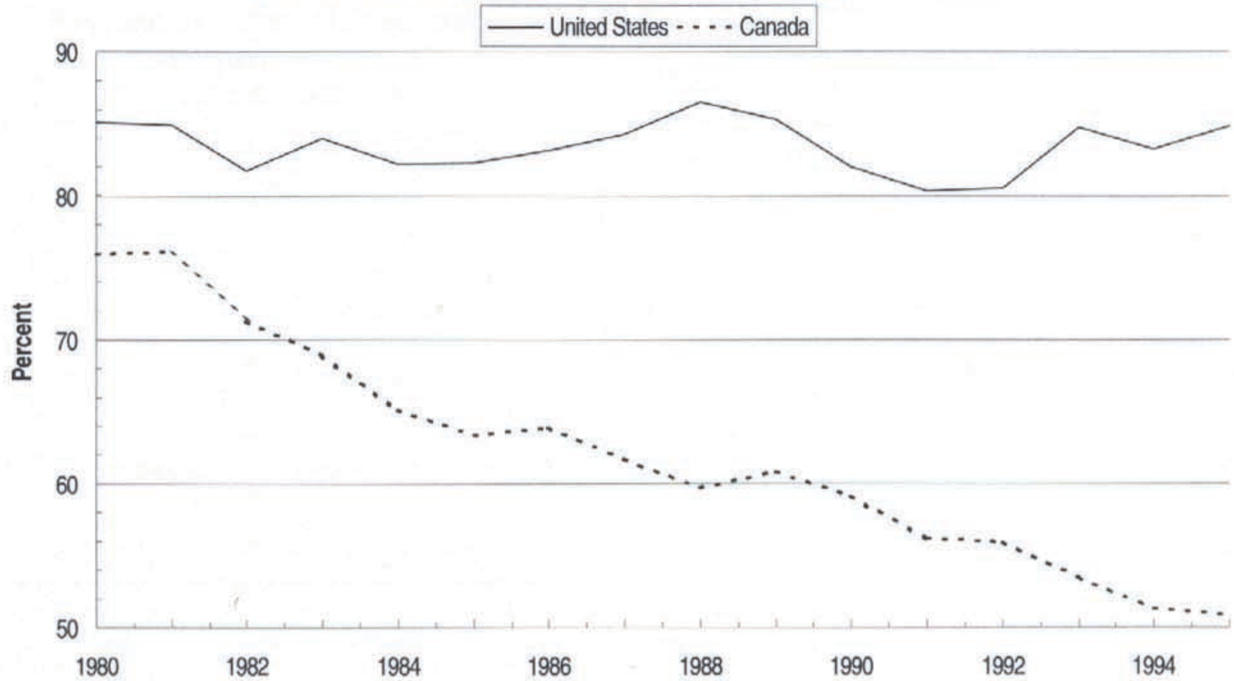
Source: OECD, 1997.

Figure 29: Annual Consumption Per Capita of Energy



Source: OECD, 1997

Figure 30: Consumption of Energy as a Percentage of Production



Source: OECD, 1997.

Table 4: Summary of Use of Natural Resources as Environmental Indicator

General comments	Performance record: U.S.	Performance record: Canada
Forest • Forest resources have remained relatively stable for the past fifty years. • Forests replanted after clear-cutting support diverse wildlife populations and contain trees of various ages, sizes, and species. • Forestry companies have taken increasing responsibility for forest management, including reforestation.	• Each year the U.S. harvests less than total new growth. • Only about 60% of new growth is harvested.	• Each year Canadian forestry companies harvest less commercial growth than governments allow. • Only 73.4% of the Annual Allowable Cut (AAC) was harvested in 1993.
Fresh water • North American water prices are relatively low; prices in Europe are up to three times higher. • While abundant supplies contribute to lower prices, government subsidies artificially suppress prices. • Lower prices lead to higher levels of fresh water consumption.	• The U.S. consumes only about 20% of total available renewable freshwater resources.	• Canada consumes about 1.5% of total available renewable freshwater resources.
Energy resources • Energy supplies are abundant. • There have been great improvements in energy efficiency. • Higher energy prices encourage conservation, technological innovations and increased exploration.	• The U.S. consistently consumes only about 85% of the energy it produces.	• Canada's consumption of energy as percentage of production declined from 76% to 50.8% between 1980 and 1995.

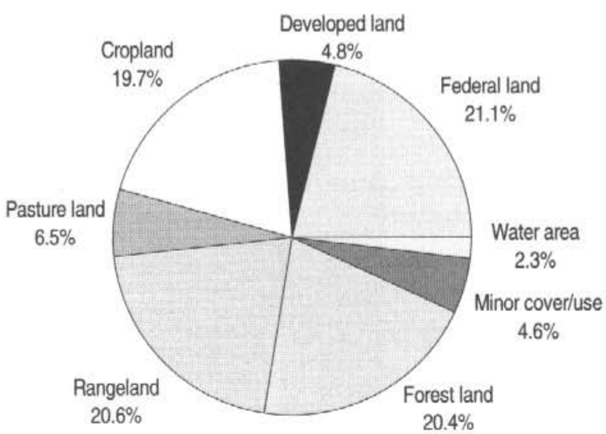
Land Use and Condition

Land cover in the United States and Canada is illustrated in Figures 31 and 32. This section discusses land use and condition in each country. Wetlands, urban sprawl, and soil erosion are the three concerns examined.

Wetlands Wetlands are areas of land that are sufficiently saturated with water to promote aquatic processes. They include marshes, swamps, and bogs. Wetlands protect land from flooding and shorelines from erosion, and act as filtration systems by breaking down nutrients and neutralizing disease-causing pathogens. They also provide habitat for a wide range of species. Canadian prairie wetland, for instance, provides habitat for 50 percent of North America's waterfowl (Environment Canada 1991c: [17]10).

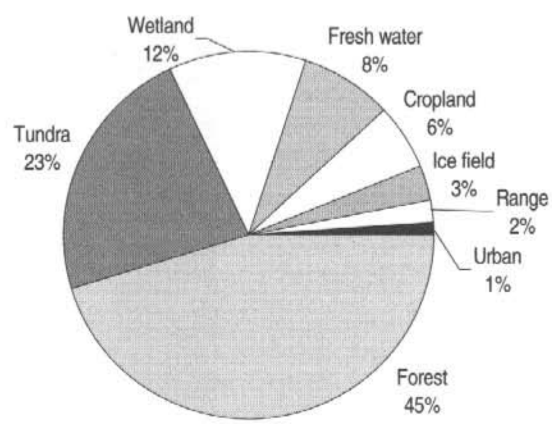
In the past, wetlands were considered waste areas to be drained and converted to economically productive uses. Farming subsidies contributed to the destruction of this sensitive habitat. In the United States, over 80 percent of natural wetlands were converted to agricultural use (U.S. EPA 1988: 6). The Canadian Wheat Board Act determines grain delivery quotas based on the total area seeded and were left fallow. This encouraged farmers to cultivate marginal land rather than leave it in its natural form (Environment Canada 1991c: [26]6). In addition, the Maritime Marshland Rehabilitation Act (1943) was designed to discourage reversion of arable land to original wetland coverage (Environment Canada 1991c: [20]6). This trend seems to be reversing, however, as recent studies show that wetland loss from agricultural conversion has dropped sharply (Tolman 1994).

Figure 31: Land Cover in the United States



Source: United States Department of Agriculture, cited in U.S. Bureau of the Census 1996. Note the developed land includes urban, built-up, and rural transport lands.

Figure 32: Land Cover in Canada

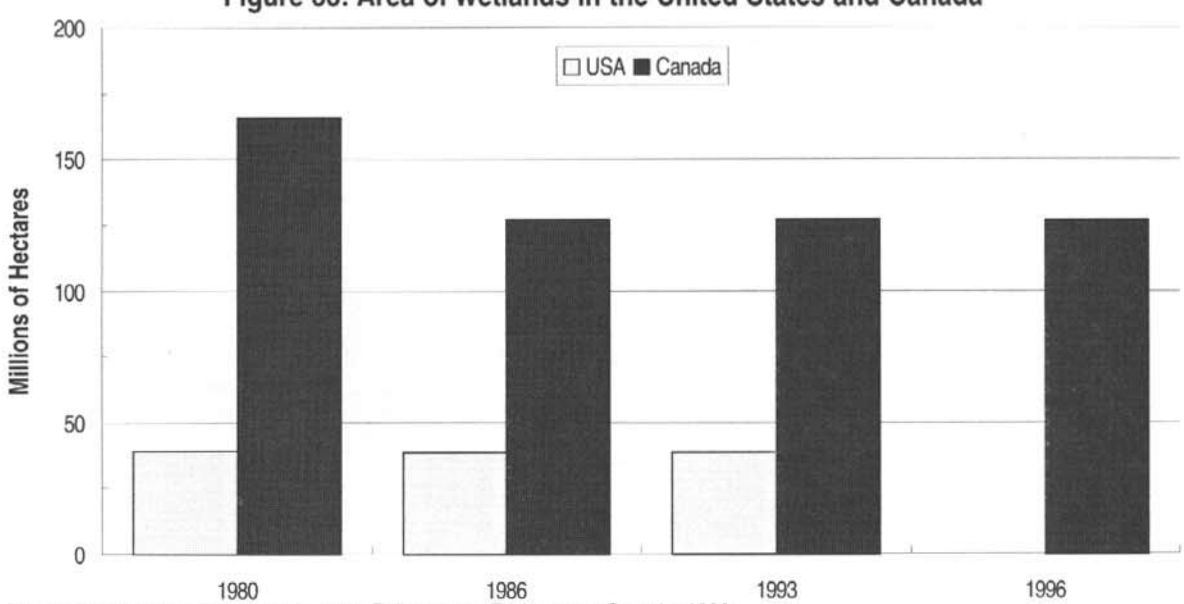


Source: Statistics Canada, 1996

The human impact on wetlands is difficult to quantify as areas of wetlands fluctuate dramatically in size and number between wet and dry years. In addition, estimates from different studies vary depending on survey techniques, time frame, region, and definition of wetlands. For example, estimates of the loss of prairie wetlands in two Canadian studies range from 40 percent to 71 percent (Tolman 1994). In 1996, the U.S. EPA's Water Program was implemented, and wetlands management was added as a program priority. The U.S. federal government is currently implementing a 40-point plan to enhance wetlands protection, make the regulation of wetlands more fair and flexible, and move towards achieving the goal of no net loss of wetlands (U.S. EPA 1996b).

Wetlands are more extensive in Canada than in the United States. According to the Ramsar Convention, Canada contains 13,030,200 hectares of internationally important wetlands compared to the 1,194,000 hectares in the United States (OECD 1995: 149). Nevertheless, this represents only a small share of total wetland area. For example, most recent estimates suggest that wetlands cover 14 percent or 127,000,000 hectares of Canada's land base; this is nearly 25 percent of the world's wetlands (Environment Canada 1991c: [26]7). Since 1986, the OECD survey reports indicate that Canada has suffered no net loss of wetlands. American wetlands have also been stable since 1980 (Figure 33).

Figure 33: Area of Wetlands in the United States and Canada



Source: OECD, 1993; Frayer et. al., 1983; Bailey, 1995; Environment Canada, 1996a.

In 1996, the United States, Canada, and Mexico launched the North America Wetlands Management Program, a billion-dollar wildlife-conservation program. The program is a partnership of federal, provincial, territorial and state governments, non-governmental organizations, and the private sector that grew out of public concern over the loss of North American wetlands in the mid-1980s. As of late 1994, Canada has secured 3,355 km2 of wildlife habitat through the plan's joint ventures (Environment Canada 1996c).

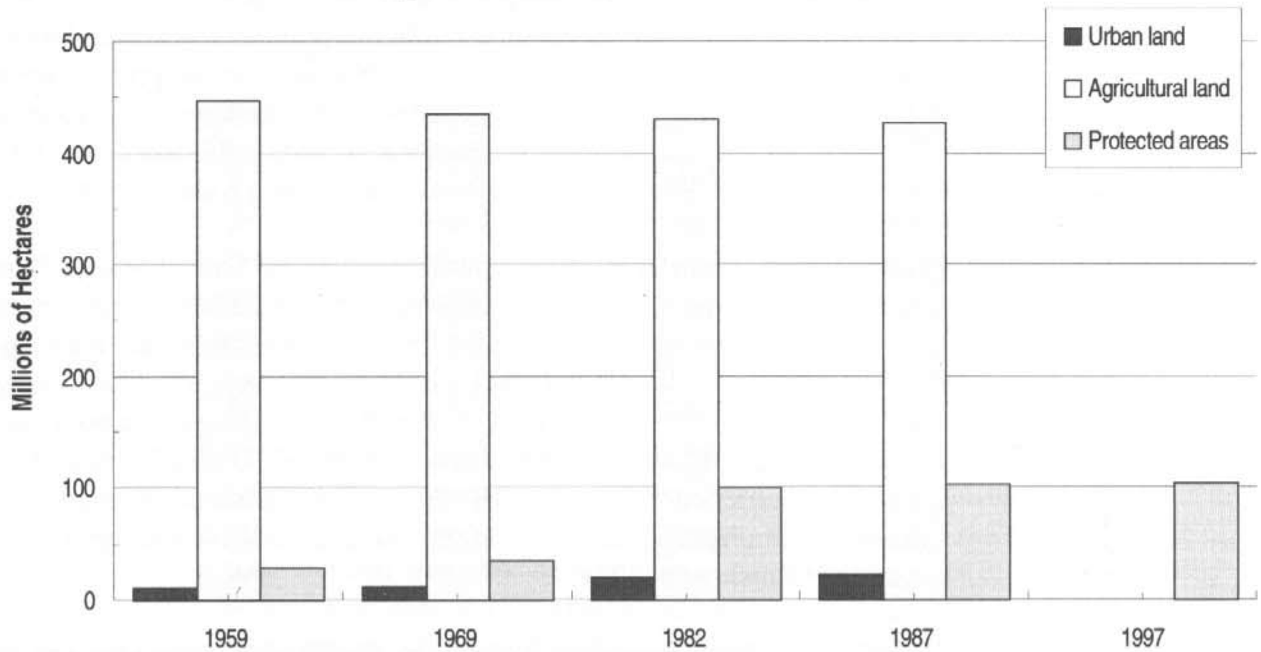
Private sector's role in preserving wetlands. In the United States, 75 percent of wetlands are on privately owned land.[23] Regulations for the protection of wetlands are usually imposed without compensation; this places a heavy burden on the landowners and causes controversy. There is, however, a new approach to the protection of wetland habitat emerging in both the United States and Canada. The private organizations Ducks Unlimited and the Nature Conservancy have become the two largest private stewards of Canada's 1.1 million hectares of non-government conservation lands (Statistics Canada 1994: 214-15).

In addition to private organizations, industry has been an active player in protecting key areas. Canadian examples include Shell Oil's 1992 donation of a large holding in British Columbia to the Nature Conservancy of Canada, MacMillan Bloedel's relinquishment of Cathedral Grove in the 1940s, and New Brunswick's Bowater-Mersey Forest Products Limited, which has periodically donated areas of ecological importance, including wetlands, to government and non-governmental conservation groups (Environment Canada 1996c).

Urban Growth

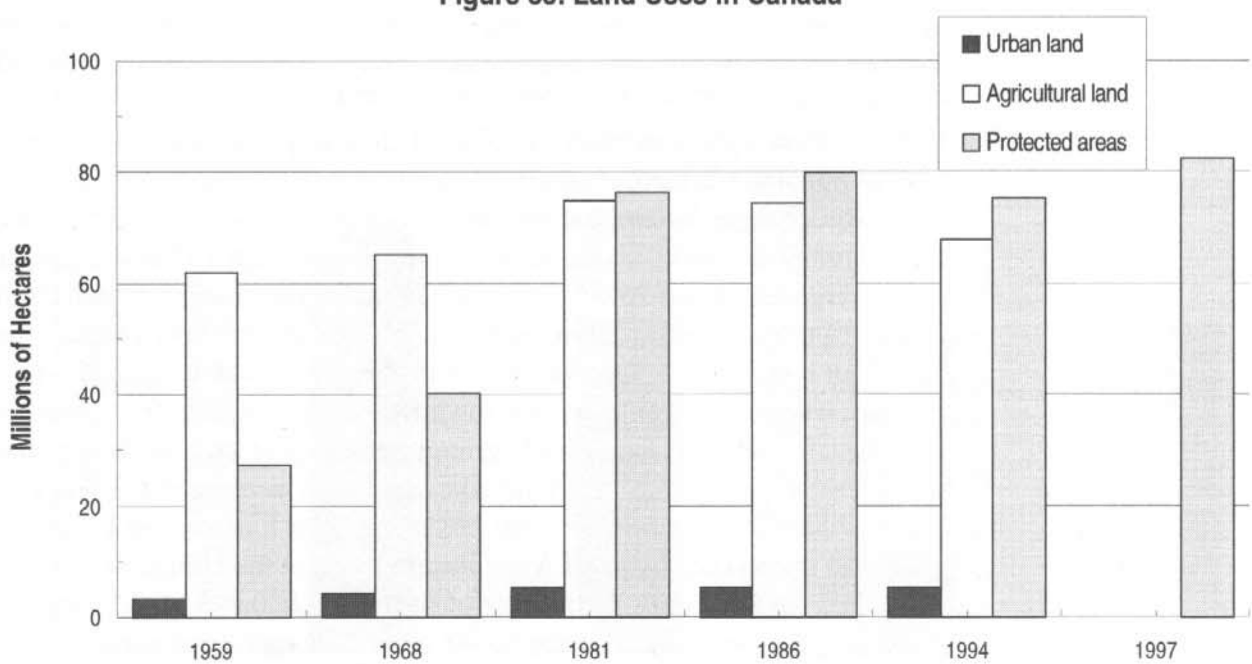
Urban centers were originally established close to prime agricultural land and, as populations increased, urban growth began to encroach onto farm land. But changes in land use for urban, agricultural, and protected areas in the United States and Canada occurred between the late 1950s and the mid-1990s (Figures 34 and 35).[24] Urban areas expanded steadily in both countries during the decades following World War II. In the United States, the agricultural landbase remained fairly stable despite urban expansion. In Canada, where large expanses of Crown land were available for conversion to designated uses, the growth of agricultural and protected lands kept pace with urban expansion. Urban land takes up only 1 percent of Canada's 9,215,430 km2, and crop and range lands represent 8 percent of Canada's total land mass (U.S. Dept. of Agriculture 1994). In the United States, developed land occupies 4.9 percent of the total 7,850,945 km2. Crop, pasture, and range lands account for 48 percent of total land mass in the United States.

Figure 34: Land Uses in the United States



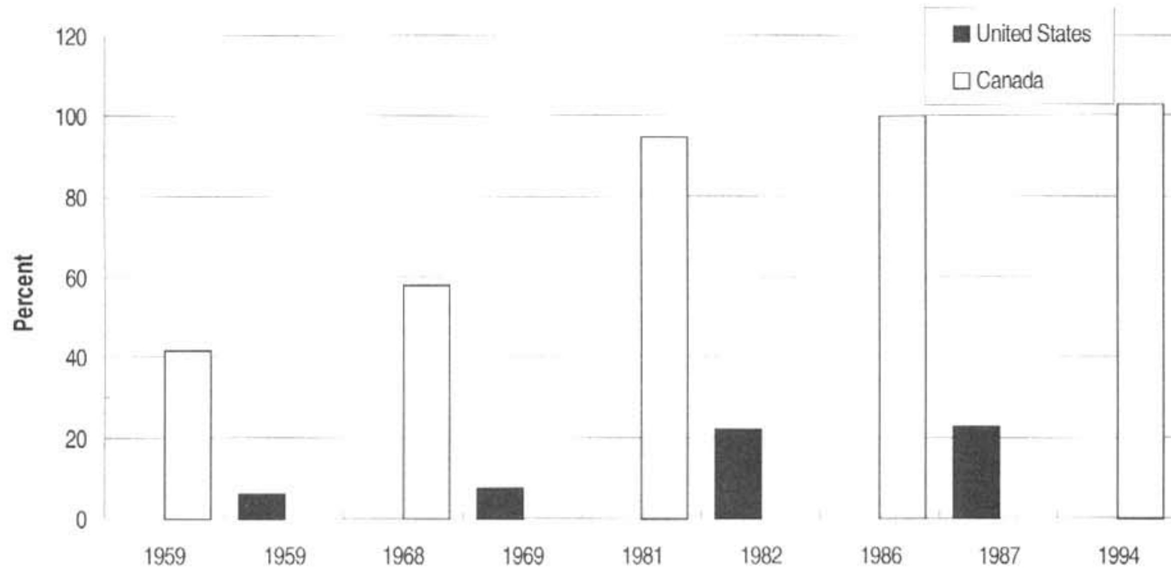
Sources: UN, 1993; USDA, 1994; WCMC, 1997. Note that the graph only considers land with currently competing uses; it does not include the entire land base.

Figure 35: Land Uses in Canada



Sources: UN, 1993; USDA, 1994; WCMC, 1997. Note that the graph only considers land with currently competing uses; it does not include the entire land base.

Figure 36: Protected Areas as a Percentage of Urban and Agricultural Areas

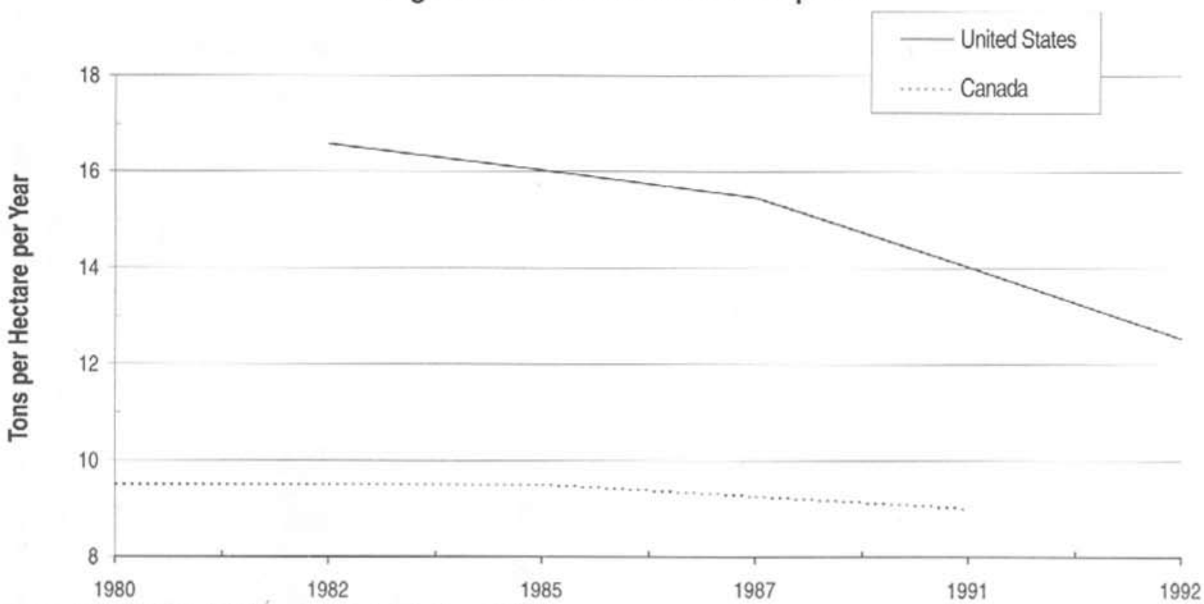


Sources: UN, 1993; U.S. Department of Agriculture, 1994; OECD, 1996b; WCMC, 1997

Urban growth's minimal effect on farming and wilderness areas. Agricultural land bases are many times the size of urban areas. Further, the Figures presented above do not reflect the increasing productivity of agricultural land. According to the indices of the United States Department of Agriculture (USDA), the American agricultural sector was 158 percent more productive at the end of the 1980s than at the beginning of the 1960s; in Canada, productivity grew by 206 percent (U.S. Dept. of Agriculture 1994). This growth in output far outweighs any threat to farmlands posed by incremental urban expansion on farmlands.

Similarly, wilderness areas are not in danger of disappearing. In both countries, protected areas have increased since 1959. The ratio of protected areas to urban and agricultural lands had grown from 6.4 percent to 22.9 percent in the United States by 1987 (Figure 36). In Canada, with its lower population density, this ratio is much higher. By 1986, Canadian protected areas were larger in total area than urban and agricultural lands combined and this trend appears to be continuing. Between 1986/87 and 1991/92, agricultural land bases remained fairly stable, decreasing by less than 1 percent in each country (U.S. Dept. of Agriculture 1996). Protected areas increased in total size by 10.3 percent in Canada and 1.0 percent in the United States (OECD 1995; United Nations 1993). Claims about a "crisis" of urban sprawl are exaggerated.

Figure 37: Soil Erosion from Cropland



Sources: OECD, 1996b; U.S. Department of Agriculture, 1994.

Soil Erosion Erosion is the most common soil-degradation problem. It is a natural process that removes topsoil, reduces the level of organic matter, and breaks down soil structure.

Erosion due to water occurs when precipitation levels exceed the soil's capacity to absorb water. Such erosion varies widely depending on climate, ground slope, vegetation, and soil type and condition, and causes the accumulation of silt, affects fish habitat, and pollutes water.

Wind erosion. Erosion due to wind occurs as a result of high winds and dry surface conditions. Some farming practices contribute to erosion: compacted soil and lost organic matter impede water absorption; cropping practices (like summer fallow) that leave soil unprotected can make wind and water erosion worse. Other farming practices that encourage erosion include monoculture, improper tilling on slopes, fall ploughing, and wide-row cropping. Although wind erosion deposits sediments in water, it has a larger impact on air quality. Airborne soil is abrasive, and can damage buildings, machinery, vegetation, and human health.

Cropland erosion. Figure 37 shows the average rates of erosion from cropland in Canada and the United States since the early 1980s. Erosion from American croplands declined from 16.6 tons per hectare (t/ha) in 1982 to

12.6 t/ha in 1992. In Canada, these rates were lower than in the United States, declining from 9.5 to 9.0 t/ha between 1980 and 1991. This reduction has occurred as farmers continue to adopt sensible farming practices such as crop rotation, interseeding, and the planting of winter crops.

In the United States, the USDA has initiated a Crop Replacement Program whereby it pays participants an annual rent per acre plus half the cost of establishing a permanent land cover, in exchange for retiring cropland at high risk of erosion for a period of 10 years. Between 1986 and 1992, this voluntary program saw the enrollment of 36,422,722 acres, and thus a reduction of soil erosion by an average of 19 tons per acre per year (U.S. Bureau of the Census 1996). As well, the Natural Resources Conservation Service (NRCS), conserved a total of 41,619,019 acres, including 16,211,566 acres of cropland (Environment Canada 1991c: [9]10).

Soil erosion, however, does not mean soil loss. Studies show that only a small percentage of eroded soil is permanently removed from agricultural lands; most is merely moved from one field to another (Easterbrook 1995: 388). Further, soil is continuously being created by natural processes. The average rate of soil creation is about 0.5 to 1.0 tonne per hectare per year. This is equal to the rate of soil lost on lands with permanent cover (Environment Canada 1991c: [9]10). Soil loss of less than 5 t/ha is difficult to see. Losses in excess of 5 to 10 t/ha can represent a potential for long-term damage to productivity (Environment Canada 1991c: [9]10).

Table 5: Summary of Land Use and Conditions as Environmental Indicator

General comments	Performance record: U.S.	Performance record: Canada
Wetlands		
• government farming subsidies have contributed to wetland loss. • Wetlands fluctuate dramatically in size and number with wet and dry years. • Wetlands can help to conserve and purify groundwater sources and protect against drought.	• The U.S. has 1,194,000 ha of wetlands rated as internationally important waterfowl habitat. • American wetlands have been relatively stable since 1980.	• Canada has 13,030,200 ha of wetlands rated as internationally important waterfowl habitat. • Canada has suffered no net wetland loss since 1986.
Urban growth		
• Claims about a "crisis" of urban growth are exaggerated. • Agricultural lands are not in danger of being overrun by towns and cities. • Wilderness areas are not in danger of disappearing.	• In the U.S., developed areas comprise only 4.6% of the landbase. • Urban areas relative to agricultural land increased from 2.5% to 5.4% between 1959 and 1987. • The ratio of protected areas to urban and agricultural lands grew from 6.4% to 22.9% between 1959 and 1987.	• In Canada, urban growth comprises only 0.1% of the landbase. • Urban areas relative to agricultural land increased from 5.5% to 7.9% between 1959 and 1994. • By 1986, Canadian protected areas were larger in total area than urban and agricultural areas combined.
Soil erosion		
• Erosion is the most common soil degradation problem. • Erosion is a natural process that removes topsoil. • Most eroded soil is merely moved from one field to another. • Soil is continuously being created by natural processes. • Farmers have adopted farming practices aimed at reducing erosion.	• Erosion from American croplands declined from 16.6 to 12.6 t/ha between 1982 and 1992.	• Erosion from Canadian croplands declined from 9.5 to 9.0 t/ha between 1980 and 1991.

Solid Waste

Solid waste has become a leading environmental issue in recent years. Occasionally, it is even billed as a "crisis" because of the perceived lack of landfill space. The famous Mobro garbage barge episode in the mid-1980s, in which the wandering barge appeared night after night on the news, became the icon of the trash debate in the United States.[25]

The management of solid waste involves decreasing the amount of solid waste generated ("reduce and reuse") and disposed ("recycle and recover"). The United States and Canada have adopted ambitious targets — as much as 50 percent by the year 2000 — for the reduction and recycling of solid waste.[26]

Reduction and Reuse

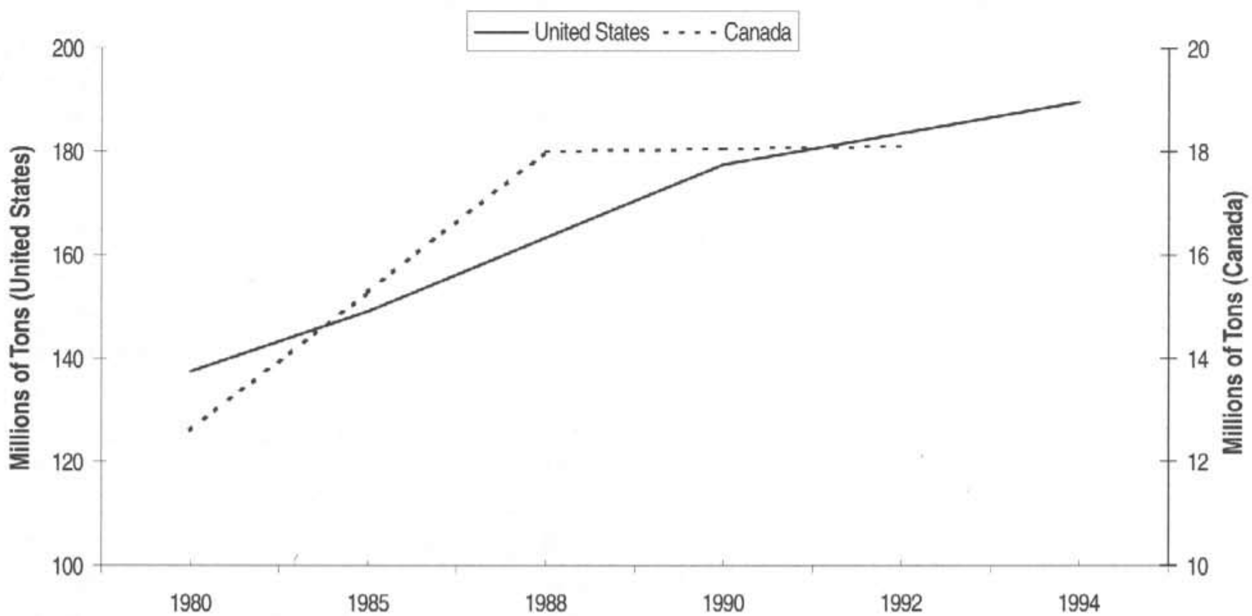
The composition of municipal waste in the United States is (by weight) 39 percent paper and cardboard, 21 percent food and garden refuse, 9 percent plastics, 6 percent glass, 8 percent metals, and 16 percent textiles and other (OECD 1997: 155). In Canada, the percentages are (by weight) 28 percent paper and cardboard, 34 percent food and garden refuse, 11 percent plastics, 7 percent glass, 8 percent metals, and 13 percent textiles and other (OECD 1997: 155). A comprehensive study in the United States and a report by the Ontario Ministry of the Environment both show that discarded packaging accounts for about one third of waste (Franklin Associates 1992; Environment Canada 1991c: [25]7).

There are several reasons to expect that the generation of solid waste will increase as a country's wealth increases. The first and most obvious is that rising incomes lead to rising consumption. The increase in single-person households and in the number of women in the workplace also may increase the amount of solid waste generated because both increase the consumption of small packaged items.

An OECD survey tracks the total solid waste and the amounts generated per capita by municipalities.[27] Overall municipal waste increased 38.1 percent in the United States between 1980 and 1994, and 43.7 percent in Canada between 1980 and 1992 (Figure 38). Solid waste generated per capita increased 21.7 percent in the United States from the 1980 to 1994; in Canada, it increased 23.5 percent from 1980 to 1992 (Figure 39).

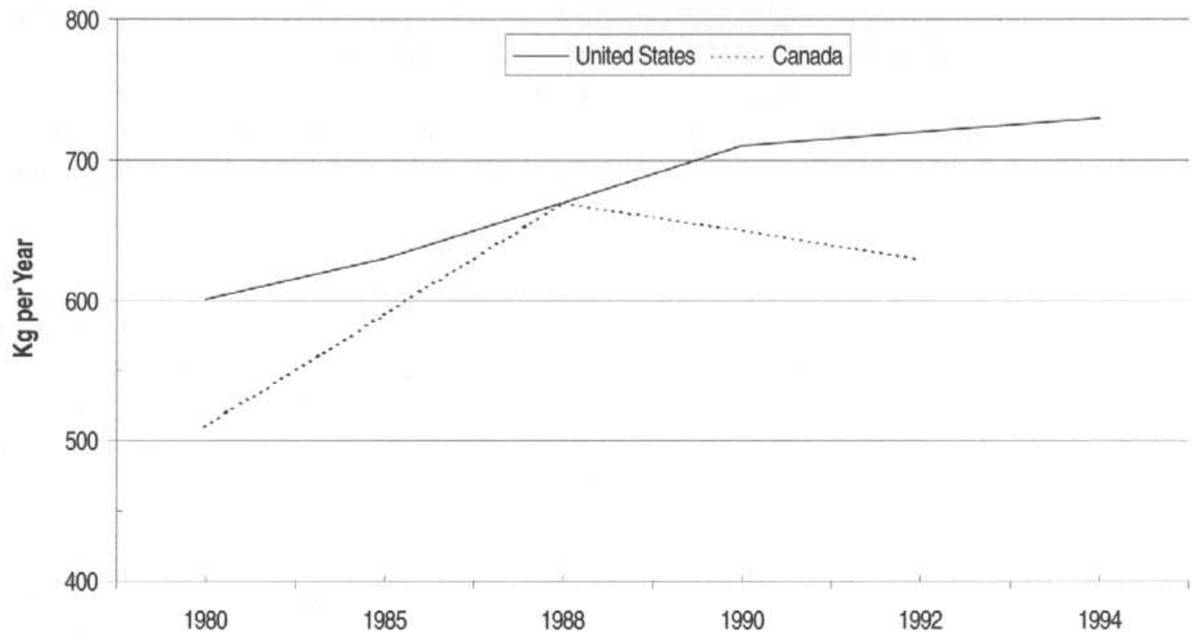
No shortage of landfill space. Most solid waste is buried in landfill sites. The United States disposes of 56.8 percent of its solid waste in landfills and incinerates 15.6 percent (U.S. Bureau of Census 1996: Table 360). Canada disposes of 67.2 percent of its solid waste in landfills but only incinerates 3.0

Figure 38: Total Municipal Solid Waste Generated in the United States and Canada



Source: OECD, 1997.

Figure 39: Municipal Solid Waste Generated Per Capita in the United States and Canada



Source: OECD, 1997.

percent (Christenson 1996). The heavy reliance on landfills has caused the fear that North America is running out of space for landfills, but this popular belief is unfounded: North America is not running out of space for landfills. Although many landfills are close to capacity, this is because they are designed to have a short life span. Thus, they are always scheduled to reach capacity and close within a few years of opening. There is no shortage of room for landfills. A single square of land, 114 km on each side and about 37 meters deep, could accommodate all of the garbage generated in the United States for 1000 years.[28] Canada would require about one-tenth of this area.

It is not a scarcity of land that inhibits the siting of landfills and incinerators but rather the high price of land close to urban areas and political pressure. When a site is chosen for garbage disposal, it becomes unavailable for other uses, and communities worry about odor, dust, litter, and scavenging animals that have been associated with landfills in the past. New sanitary landfill technology now being used greatly reduces these problems.

Recycling and Recovery

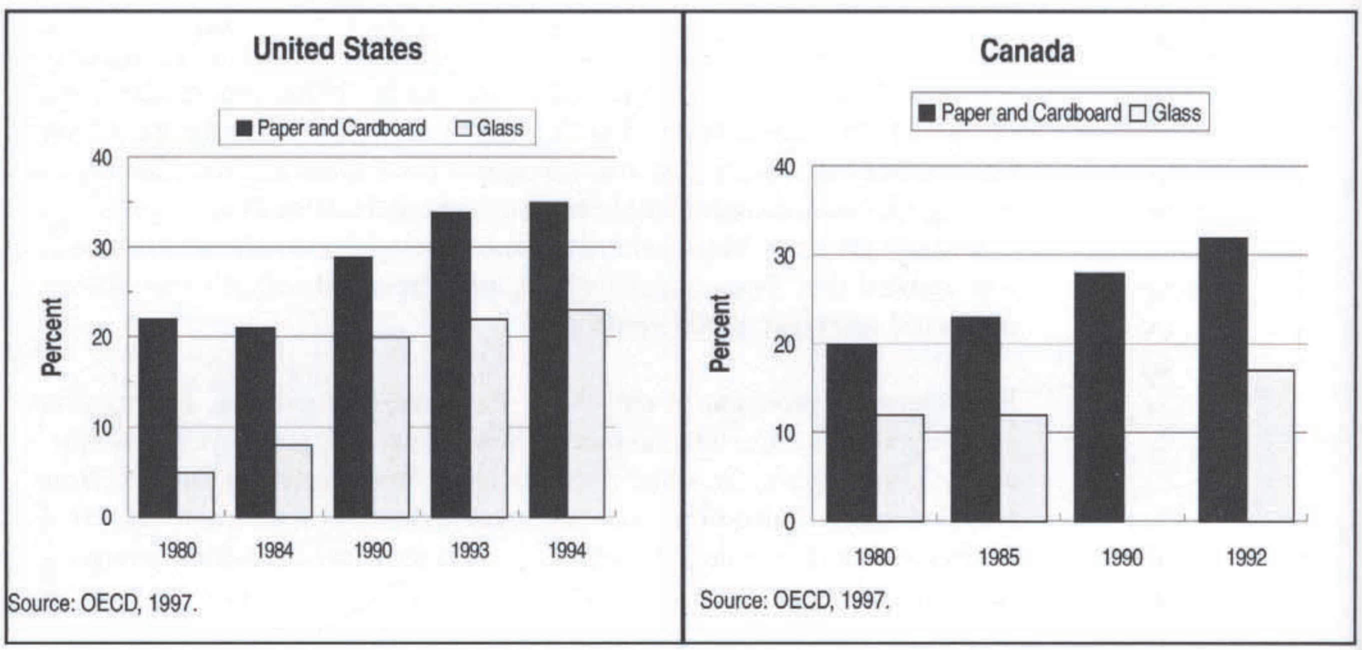
Concerns about running out of space for landfills have made recycling an increasingly popular alternative to disposal. In the 1970s, most municipalities opened community recycling depots. In Canada, municipalities, provincial governments, grocery stores, newspaper publishers, and the plastics, packaging, and soft-drink industries jointly fund the Blue Box program. Under this program, household newspapers, bottles, and cans are collected on a designated day. Some municipalities have expanded collection to include cardboard and rigid plastic containers.

Environmental problems of recycling. Recycling, composting, and resource recovery all affect the total amount of waste disposed, but recycling is not always economically feasible. In many cases, manufacturing products from recycled materials requires more resources and energy and, ironically, produces more pollution than manufacturing the same products from primary raw materials.

In addition, recycling is not always environmentally desirable (Wiseman 1992). For instance, in Canada, McDonald's decision to discontinue the use of polystyrene hamburger packaging has several unfortunate resource trade-offs. It requires 30 percent less energy to produce a polystyrene package than it does to produce the paperboard alternative; this means 46 percent less air pollution and 42 percent less water pollution (Scarlett 1991). Finally, recycling is not possible for all products. For example, it is impossible at current prices and with current technology to recycle burned out light bulbs, since these contain glass, interior coatings, adhesive cement, and two or three different metals (Environment Canada 1991c: [25]7).

According to the OECD, paper and cardboard recycling in the United States was 22 percent of consumption in 1980, but increased to 35 percent by 1994.[29] Glass recycling climbed from 5 percent to 23 percent of consumption over the same period. In Canada, paper and cardboard recycling rose from 20 percent in 1980 to 32 percent in 1992. Glass recycling was 12 percent of consumption in 1980, and rose to 17 percent in 1992 (Figure 40).[30]

Figure 40: Recycling Rates in the United States and Canada



DID YOU KNOW?

Recycling: Finding the Optimal Solution

The debate over recycling is not about whether recycling is good or bad, but about finding the optimal amount of recycling and determining the best way to achieve that amount. While sometimes recycling makes sense both ecologically and economically, it can also be wasteful and counterproductive.

Much of the recycling craze that has swept the United States began in the late 1980s. In 1988, the EPA announced a five-year target for the nation: to recycle 25 percent of municipal trash, up from 10 percent. This target, combined with the misperception that the U.S. was running out of landfill space, spurred numerous states and cities to pass mandatory recycling laws.

New York and California required 50 percent of their trash to be recycled, New Jersey required 60 percent, and Rhode Island required 70 percent. Additionally, both federal and state governments began passing laws mandating that public agencies, newspapers, and other companies buy recycled materials.

Since 1988, experience has shown us that recycling programs are enormously expensive (New York City alone spends over $100 million annually on their recycling program), with economic costs frequently outweighing the economic benefits. According to Lynn Scarlett of the Los Angeles-based Reason Public Policy Institute, while using 30 percent recycled materials for paper packaging can yield benefits of $50/ton under best case scenarios, it can also cost as much as $80/ton.

Many people believe recycling is necessary in order to save trees. This notion is simply false. Large trees are used chiefly for lumber and plywood, not for paper production. In fact, timber companies grow trees specifically for paper production, and currently grow far more trees than they harvest. As a result, there is over three times as much forested land in America than there was in 1920.

The most practical and realistic option is to put much of our waste in landfills. While environmentalists have depicted landfills as scarce and unsafe, this couldn't be further from the truth. There is far more landfill space today than a decade ago. A 30-square mile area could hold all of the United States' trash for the next 1,000 years. Furthermore, modern landfills are mostly filled with harmless materials such as paper, cardboard, and yard debris. As explained by John Tierney in the 1996 *New York Times Magazine* article, "Recycling Is Garbage," the small amounts of hazardous wastes that are discarded in the landfills are quite safe; the landfills are lined with plastic and clay, contain drainage and gas collection systems, and are monitored regularly for leaks.

Table 6: Summary of Solid Waste as Environmental Indicator

General comments	Performance record: U.S.	Performance record: Canada
Reduction and re-use • Solid waste can be managed through decreasing the amount generated and decreasing the amount disposed. • Both the U.S. and Canada have adopted ambitious solid-waste reduction targets and recycling programs. • Most sold waste is buried in landfill sites. • Waste disposal sites are designed to impose minimal burden on communities. • There is no shortage of room for landfills. • Recycling has become an increasingly popular alternative to disposal.	• Overall municipal waste generation increased 38% in the U.S. between 1980 and 1994. • Per-capita waste generation increased 22% between 1980 and 1994.	• Overall municipal waste generation increased 44% in Canada between 1980 and 1992. • Per-capita waste generation increased 24% between 1980 and 1992.
Recycling and recovery • Recycling is sometimes more polluting than producing new materials.	• Paper and cardboard recycling increased from 22% of consumption to 35% between 1980 and 1994. • Glass recycling climbed from 5% of consumption to 23% over the same period.	• Paper and cardboard recycling increased from 20% in 1980 to 32% in 1992. • Glass recycling was 12% in 1980 and rose to 17% in 1992.

Secondary Environmental Indicators

The secondary environmental indicators discussed in this section are carbon dioxide, oil spills, pesticides, toxic releases, and wildlife. These often cited measures of the state of the environment are classed as secondary indicators in this report because, at best, they provide indirect information about environmental quality. In some cases, such as carbon dioxide, it is unclear whether the indicator contributes to an environmental problem, such as global warming. In other cases — wildlife, for example — the questionable data make it difficult to draw reliable conclusions.

Carbon Dioxide Emissions

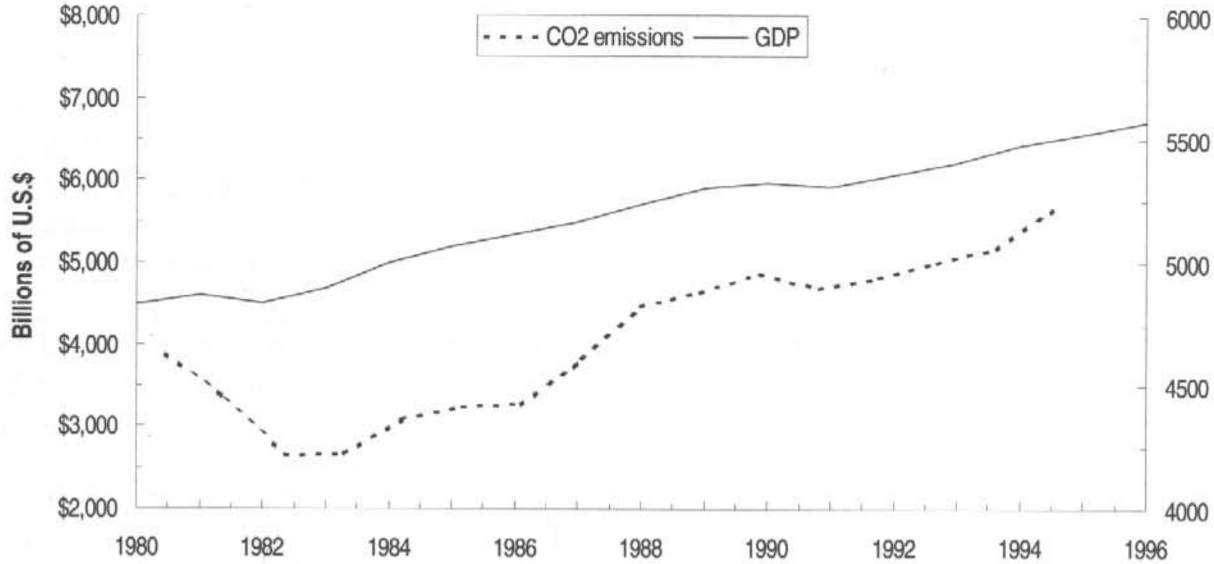
Carbon dioxide (CO_2) is a vital nutrient for plants. Oceans absorb and produce CO_2 in great quantities through a complex cycle and store about 50 times more carbon than does the atmosphere.[1] The combustion of fossil fuels by humans also generates CO_2.

Figures 41 and 42 are a graphic indication of how CO_2 emissions correlate with fluctuations in Gross Domestic Product (GDP). American and Canadian CO_2 emissions rose with economic growth until the 1970s. Emissions then leveled off before declining in the early 1980s. Recently, emissions have increased.

CO_2 emissions have been linked to a possible human-induced global warming. As a result, controlling CO_2 emissions has been the subject of many recent policy debates. But in order fully to understand the popular global warming debate, one must appreciate the distinction between the greenhouse effect and the enhanced greenhouse effect.

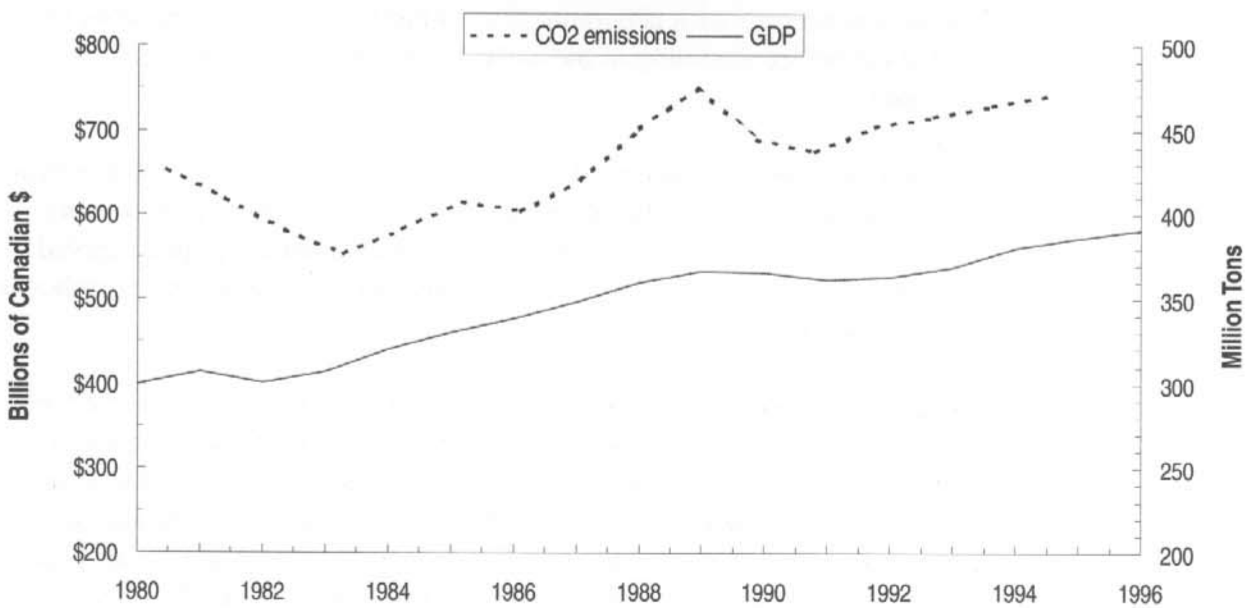
The greenhouse debate. Scientists agree that there is a greenhouse effect that causes the earth to be warm. This effect occurs because greenhouse gases such as carbon dioxide, water vapor, nitrous oxide, and methane are transparent to the short wavelength radiation from the sun but opaque to the longer wavelength radiation emitted from the earth. In simple terms, greenhouse gases trap the heat from the sun and this warms the earth.

Figure 41: GDP Compared to CO_2 Emissions: Trends in the United States



Source: U.S. EPA, 1994; IEA, 1997; Bureau of Economic Analysis, 1998. Note: GOP is in constant (1992) U.S. dollars.

Figure 42: GDP Compared to CO_2 Emissions: Trends in Canada



Source: Environment Canada, 1995a; IEA, 1996; Canadian Economic Observer, 1998. Note GOP is in constant (1992) Canadian dollars.

The popular debate revolves around the question of whether humans, through their contributions of greenhouse gases to the atmosphere,[2] enhance the greenhouse effect that occurs naturally and, thus, contribute to global warming. The theory of enhanced greenhouse effect gained many advocates in the 1950s but lost popularity in the 1960s and 1970s when average temperatures fell. During the 1970s, the idea that pollution was causing global cooling by reflecting sunlight away from the earth's surface was supported by many who now promote the theory of the enhanced greenhouse effect.

Although some now claim that the increase in CO_2 levels in the atmosphere will cause a catastrophic warming, there are many credible challenges to this theory in the scientific community due to the fact there is no proven link between CO_2 and global warming.

Scientists who criticize global warming possess three powerful lines of attack on the apocalyptic theories: 1) the inadequacy of the computer models being used to forecast future temperatures, 2) the evidence from actual temperature records, and 3) the strength of competing hypotheses (currently under-reported and insufficiently considered by policy makers) to explain warming.

Inadequacy of Computer Models. It is important to realize that current projections of global warming and policy recommendations for dealing with the predicted crisis are based on computer models that try to forecast future temperatures based on a number of assumptions. At the present time, these computer models are incapable of modeling the atmospheric system completely. Large gaps in understanding about the way important variables such as oceans and clouds affect climate, and how the effects of these variables change with additions of CO_2 make the predictions of these models unreliable.

In fact, the computer models cannot even replicate what has already happened to temperatures. For example, according to the model used by the Intergovernmental Panel on Climate Change (IPCC), the northern hemisphere should have warmed between 1.3° and 2.3° Celsius since the beginning of the century. It has not. For the northern hemisphere, the warming measured at ground-based stations is about 0.6 degrees Celsius — less than one-third the warming that was predicted to occur.

Evidence from Temperature Records. The second major criticism of the theory that temperatures are likely to rise as a result of increasing CO_2 emissions and cause dramatic damage to the environment is that temperature records do not support a strong link between CO_2 emissions and warming. According to ground-level temperature records, there has indeed been an increase in temperature over the past 100 years. Most of this increase, however, occurred before 1940. This is relevant because most human activity generating CO_2 emissions did not occur until after 1940. In other words, most of the increase in temperature occurred before the main input of human-induced CO_2 emissions.

In addition, records from the satellites that have been measuring temperatures in space since 1979 do not support the hypothesis that the earth is warming. While the climate models produced by computers predict that there should have been some warming over the past 18 years, the satellite data show a slight global cooling. Thus, the evidence does not support the predictions of the models. It is considered a problem in any scientific discipline when the evidence contradicts a theory. Such a discrepancy should lead to a re-evaluation of the models.

Other Explanations for Temperature Change. There are other viable explanations to explain atmospheric temperature change that do not rely upon CO_2 emissions. Unfortunately, these explanations have not received widespread media attention.

Some scientists hypothesize, for example, that much of the temperature fluctuation can be explained by changes in the brightness of the sun — something that is obviously beyond human control. Sallie Baliunas, a scientist at the Harvard Center for Astrophysics, explains:

> Most of the warming early in this century, then, must have been due to natural causes of climactic change, and these natural causes must be understood in order to make an accurate assessment of the effect upon climate of any human activities that may have been added to the natural changes. One possible natural cause of climactic change is variation in the brightness of the sun. (Baliunas and Soon: 81)
>
> The processes of "fingerprinting" various mechanisms of climactic change and projecting climactic change requires knowing all the relevant factors, both those that are natural and those that are the result of human activity. And, these factors must be considered simultaneously in a model. Once such a model is verified, then only can each mechanism be identified. Since the mechanisms of climactic change are not fully known — as we have shown, the question how the sun affects the climate is unresolved — and the models have not been verified, fingerprinting is not yet possible. (Baliunas and Soon: 86-7)

It is clear that a great deal of uncertainty surrounds the issue of climate change and many important questions remain unanswered. Are we experiencing a trend toward global warming? Do humans contribute to the trend through the emission of greenhouse gases? How significant is the human contribution? Would global warming cause widespread problems?

Some argue that we must take drastic regulatory action to control greenhouse gases without delay. However, because of the uncertainty and the unanswered questions, this is a simplistic approach to policy. In fact, we cannot afford to take action until we are reasonably certain that we have a problem. Taking drastic measures to control greenhouse gases will come at the expense of other social objectives.

DID YOU KNOW?

Most Energy Efficient Country in the World: The U.S.

Although carbon dioxide emissions have increased in the United States, this is because emissions correlate with production, particularly Gross Domestic Product (GDP). Because U.S. citizens are more productive than ever before, carbon dioxide emissions are up.

A better way to consider contributions to aggregate levels of carbon dioxide is to measure energy efficiency — that is, CO_2 emissions as a percent of GDP. Because the U.S. has access to the most advanced technology in the world, the U.S. is the most energy efficient nation in the world. It produces fewer greenhouse gases per million dollars of GDP than any other country. By comparison, India uses three times the energy and emits four times the carbon dioxide per unit of GDP than the U.S. Similarly, China uses five times the energy and emits eight times the carbon dioxide.

Recently, carbon dioxide emissions have received much attention due to the International Treaty on Global Climate Change that was signed in Kyoto last December. The treaty requires developing nations to reduce carbon dioxide emission, but makes no requirements for developing nations due to the inevitable economic costs of carbon dioxide emission reductions.

Because the Kyoto Treaty does not include developing countries, global greenhouse gases will continue to increase. By 2025, China will emit more carbon dioxide than the U.S., Japan, and Canada combined. If the goal of the Kyoto Treaty is to prevent global warming by reducing greenhouse gas emissions, it will fail unless the Treaty is globally applied. Yet given the fact that most developing nations cannot even feed their citizens, it is unrealistic to mandate that they divert economic resources to energy efficiency when the threat of global warming is still so uncertain.

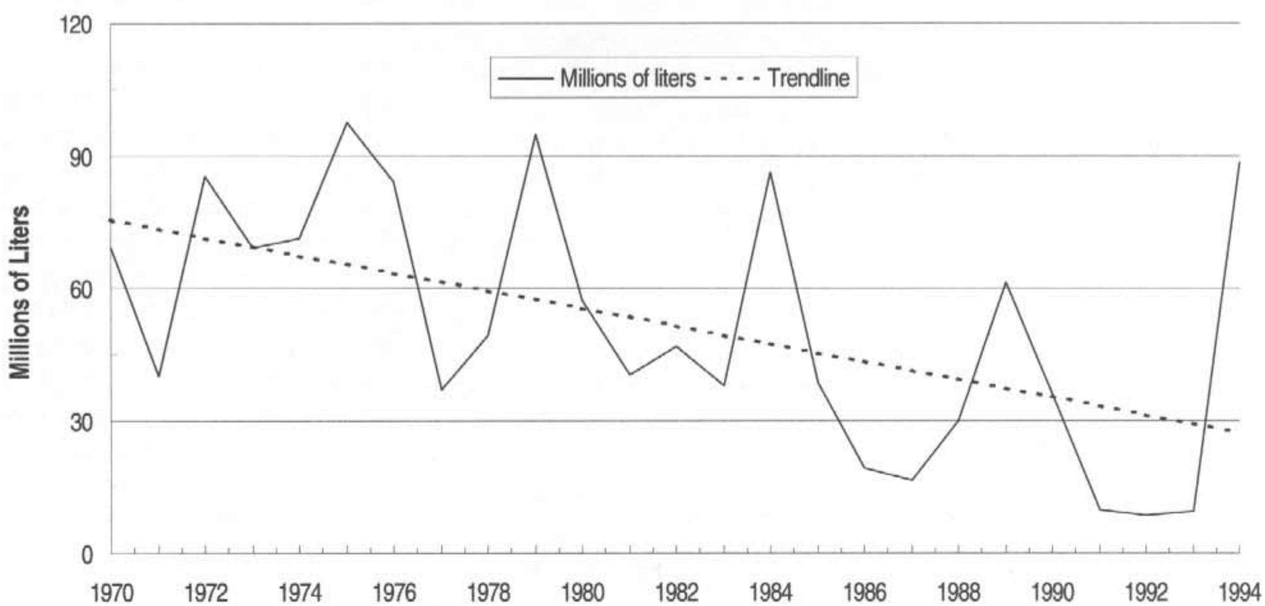
The best course of action at this point is to continue studying the effects of greenhouse gases on the earth's atmosphere to more accurately determine if global warming is a reality or myth. In the meantime, the real problem to address is developing countries, where economic strife hinders energy efficiency. The Kyoto Treaty not only fails to prevent global warming, but hinders the very economic growth that can make all countries, both developing and developed, more energy efficient and environmentally responsible.

Oil Spills

Despite the public perception that the number of oil spills and the severity of those spills has increased, Figure 43 shows that there has been a declining trend in the amount of oil spilled in American waters over the last two decades. As a source of water pollution, oil spills from the petroleum industry are a minor source of pollution when compared to oil waste generated by households. It is estimated that American households pour 1.3 billion liters of oil and oil-based products down the drain every year (Allen 1993). In comparison, the Exxon Valdez spilled just over 41 million liters of crude oil into Prince William Sound.

While oil spills are never desirable, and the immediate damage can be alarming, nature in time will effectively deal with spilled oil. Since oil is a natural substance produced by the decomposition of micro-organisms, it degrades naturally in the environment. Within 48 hours of an accident, 40 percent of

Figure 43: Oil Spills in and around American Waters (by volume)

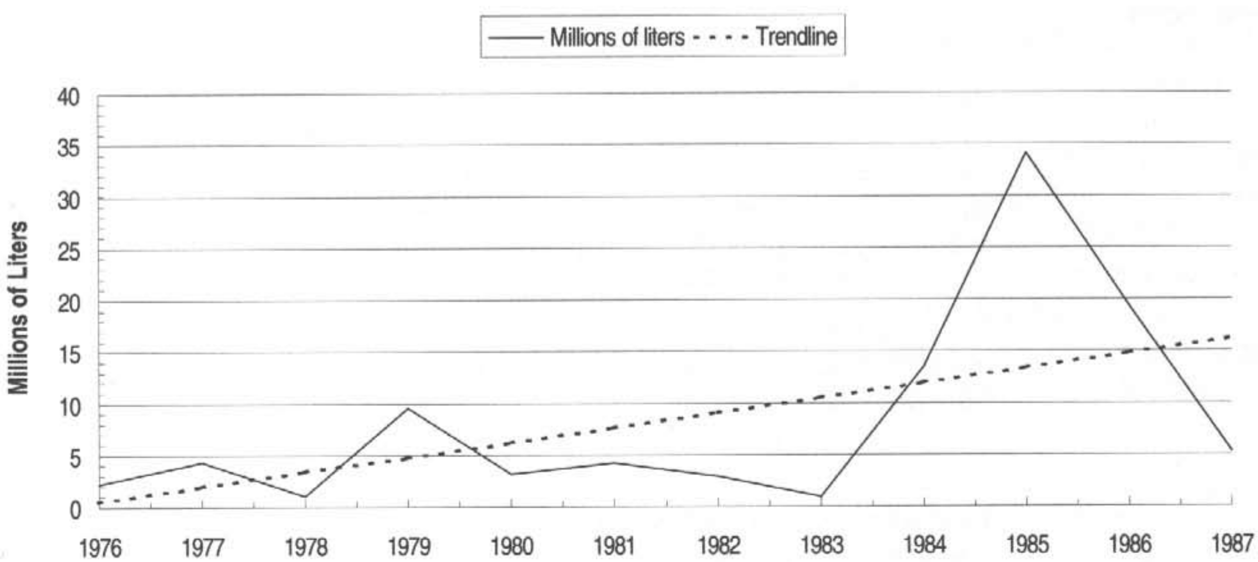


Source: U.S. Coast Gard, cited in U.S. Bureau of the Census, 1996.

spilled oil evaporates. Bacteria and other marine species break down and consume over 90 percent of the remaining oil (Bast, Hill and Rue 1994: 148-53). In some cases, active cleanup can actually cause more harm than good. For example, the steam used to clean rocks kills many tiny organisms, including those that would otherwise ingest and decompose spilled oil.

Canadian data track total marine spills from petroleum, industrial waste, and other chemicals. Data are only available from 1976 to 1987 (Figure 44). Both the number of events and the volumes of oil spilled fluctuate widely during this period. This fluctuation can be attributed primarily to differences in the numbers of vessels involved in collisions, groundings, and sinkings. It is also due to changes in the number of accidents occurring when oil is being transferred from one vessel to another.

Figure 44: Significant Spills in and around Canadian Waters (by volume)



Source: Environment Canada, 1991c. Note that the Canadian data includes all spills in the Pacific and Atlantic oceans. From 1976 to 1987, petroleum = 32.1%; industrial waste = 60.5%; other = 7.4%.

Table 7: Summary of CO_2 Emissions and Oil Spills as Environmental Indicator

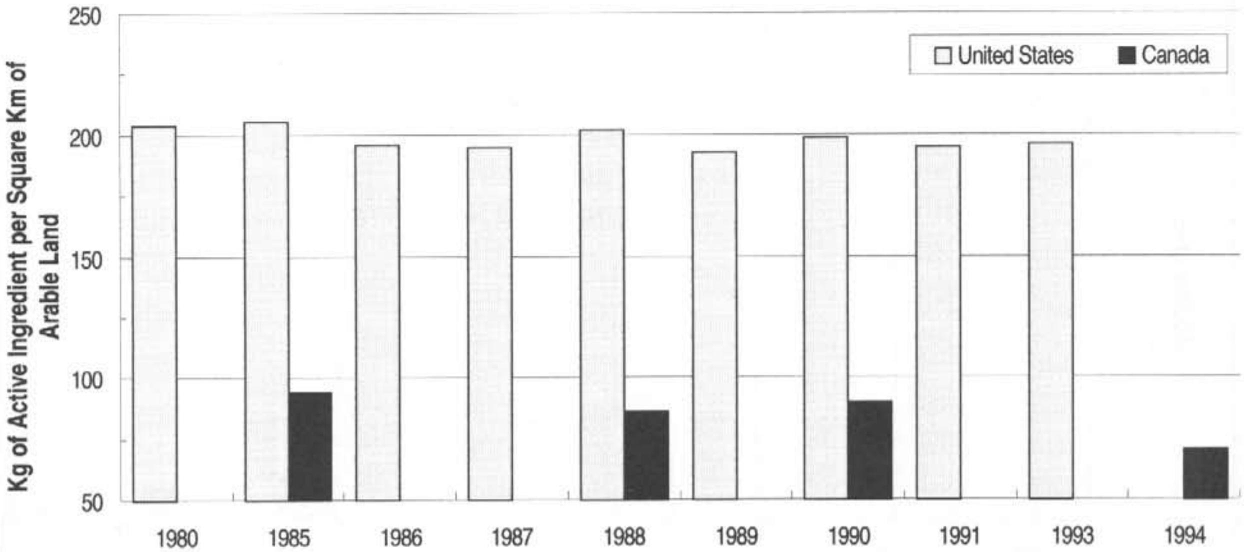
General comments	Performance record: U.S.	Performance record: Canada
Carbon dioxide (CO_2) emissions		
• CO_2 is a vital nutrient for plants and oceans absorb and produce it in massive quantities. • CO_2 is believed to contribute to global warming but the temperature record does not support this theory. • The sophisticated computer climate models, upon which the global warming theory is partly based, have come under heavy criticism. • Industrialized economies produce great amounts of CO_2. • A massive economic downturn would be needed to reduce CO_2 emissions radically.	• CO_2 emissions in the United States have risen and fallen with GDP fluctuations over the last two decades. • In recent years, emissions have begun rising again, although not as steeply as in the decades before the "energy crisis" of the 1970s.	• CO_2 emissions in the United States have risen and fallen with GDP fluctuations over the last two decades. • In recent years, emissions have begun rising again, although not as steeply as in the decades before the "energy crisis" of the 1970s.
Oil Spills		
• Oil spills from the petroleum industry are minor compared to oil waste generated by households. • Since oil is a natural substance, it degrades naturally in the environment. • Within 48 hours of an accident, 40% of spilled oil evaporates, then bacteria and other marine species break down and consume over 90% of the remaining oil. • In some cases, active cleanup can actually cause more harm than good.	• There has been a downward trend in the amount of oil spilled over the last 20 years. • The Exxon Valdez spilled 41 million liters whereas American households pour 1.3 billion liters of oil and oil-based products down the drain every year.	• Petroleum, industrial waste, and other chemical spills vary considerably from year to year. From 1976 to 1987, the volume of spills varied from 34.1 million liters to only 0.9 million liters.

Pesticides

Pesticides are a family of substances including herbicides, insecticides, fungicides, and fumigants. Although DDT and several other notorious pesticides have been discontinued, pesticide use remains controversial. Figure 45 shows the use of pesticides per square kilometer of arable land in the United States and Canada. The limited data available show that, in the United States, the use of pesticides fell from 204 kg/km2 in 1980 to 196 kg/km2 in 1993. In Canada, use of pesticides fell from 94 kg/km2 to 70.5 kg/km2 between 1985 and 1994. While these declines are not dramatic, they illustrate that fears of greatly increased pesticide use have not materialized. (For a summary, see Easterbrook 1995: 79 ff.)

Pesticides today are substantially changed from what they were when first introduced. Research has produced pesticides that have a much shorter half-life and are, therefore, less dangerous to human and animal health. In the 1960s, about one-half of all pesticides were chlorinated hydrocarbons such as Aldrin, Dieldrin, and DDT. These persist in the environment and tend to

Figure 45: Pesticide Use



Source: OECD, 1994, 1997.

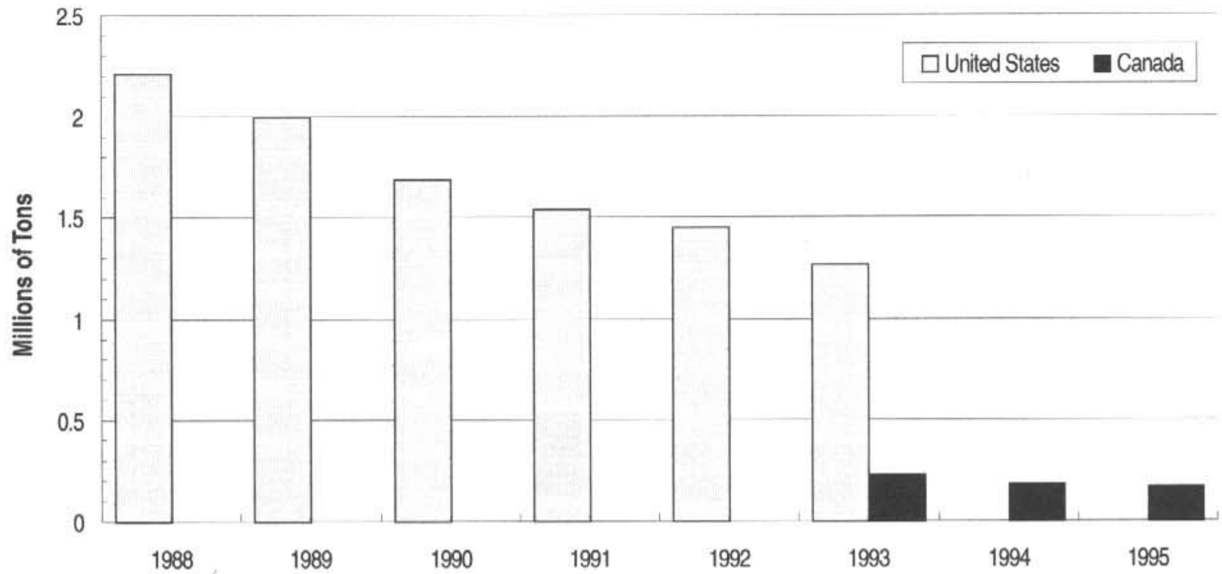
accumulate in animal tissue. Today, chlorinated hydrocarbons account for only about 5 percent of all pesticides (Hayward 1994). They have been replaced by a new class of pesticides that are effective in lower doses, less persistent, and have fewer environmental side-effects.

Although pesticides are hazardous chemicals that should be handled carefully, their use yields enormous benefits, and the risk from residues is minor. Pesticides stimulate crop production so that less land is converted from wilderness to agricultural uses, and food costs are lower. Banning pesticides and other agricultural chemicals could increase the average household's food bill by as much as 12 percent per year (Knutson et al. 1990). The EPA's most conservative risk-assessment models attribute a maximum of about 0.00008 percent of all cancer cases per year to pesticide residues (Utt 1991). In fact, the risk from carcinogenic compounds that occur naturally in food is much greater than the risk from pesticide residues (Ames and Gold 1996).

Toxic Releases

The United States' Congress passed the Emergency Planning and Community Right-to-Know Act in 1986, after the toxic catastrophe in Bhopal, India and a near disaster in West Virginia shortly after. This act put into place the Toxic

Figure 46: Toxic Waste Releases



Sources: U.S. EPA, 1995a; Environment Canada, 1995, 1997.

Release Inventory (TRI), which requires industrial facilities to report a broad range of toxic emissions. In 1993, the latest year for which data are available, the TRI program required the reporting of 316 chemical releases in 20 different categories. In Canada, time-series data do not exist over the same period, although the National Pollutant Release Inventory (NPRI) began a similar program in 1993. Figure 46 shows the data available for the United States and Canada.

In the United States, toxic releases declined sharply over the brief period for which data are available. Though this trend indicates an improvement in environmental quality, toxic releases are a problematic environmental indicator. Broad definitions apply to toxic wastes, and the TRI does not distinguish between releases that pose environmental problems and those that do not. As the EPA points out:

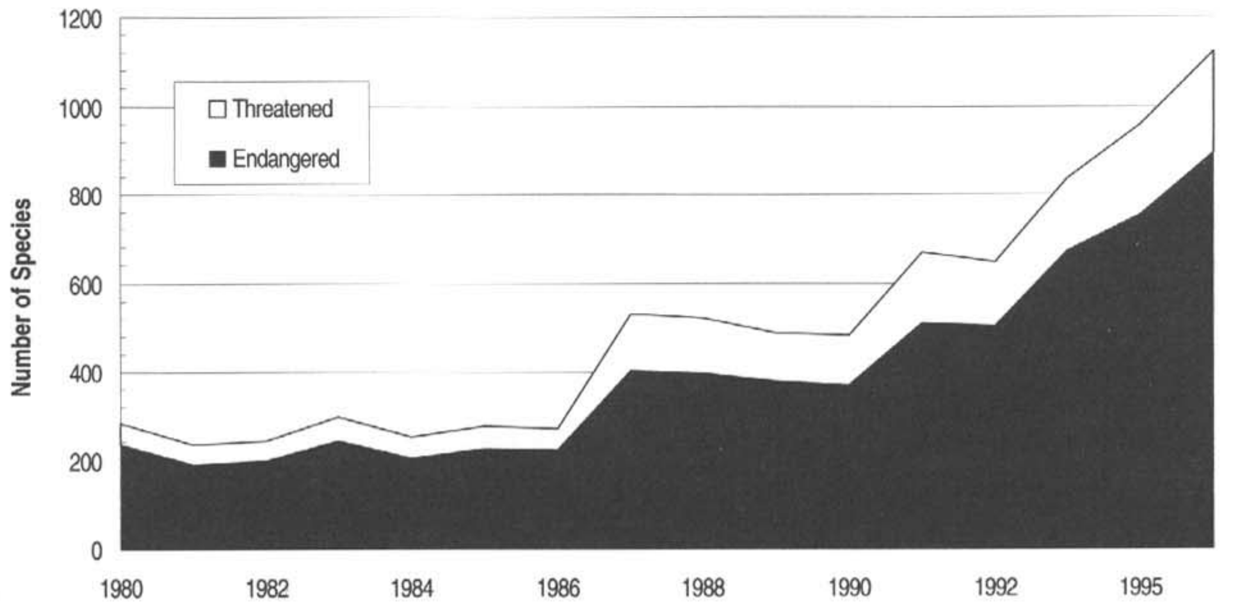
> TRI data alone cannot indicate the risk that chemical releases pose to human health and the environment . . . A determination of risk depends on many factors, including the toxicity of the chemical, the extent of exposure, the type of release, and the conditions of the environment. For example, small releases of highly toxic chemicals may present a greater risk than large releases of less toxic chemicals. (U.S. EPA 1995a)

Further, the TRI definition of "releases" makes no distinction between releases into the environment and instances where toxic wastes are disposed of in well contained enclosures. For example, though some chemical wastes are stored in secure underground facilities, the TRI program counts these underground disposals as toxic releases (Bast, Hill and Rue 1994: 148-53). In light of these problems with the data, the decline in releases may be a positive sign of environmental improvement, but the magnitude of this improvement is difficult to measure.

Table 8: Summary of Pesticide Use and Toxic Release as Environmental Indicator

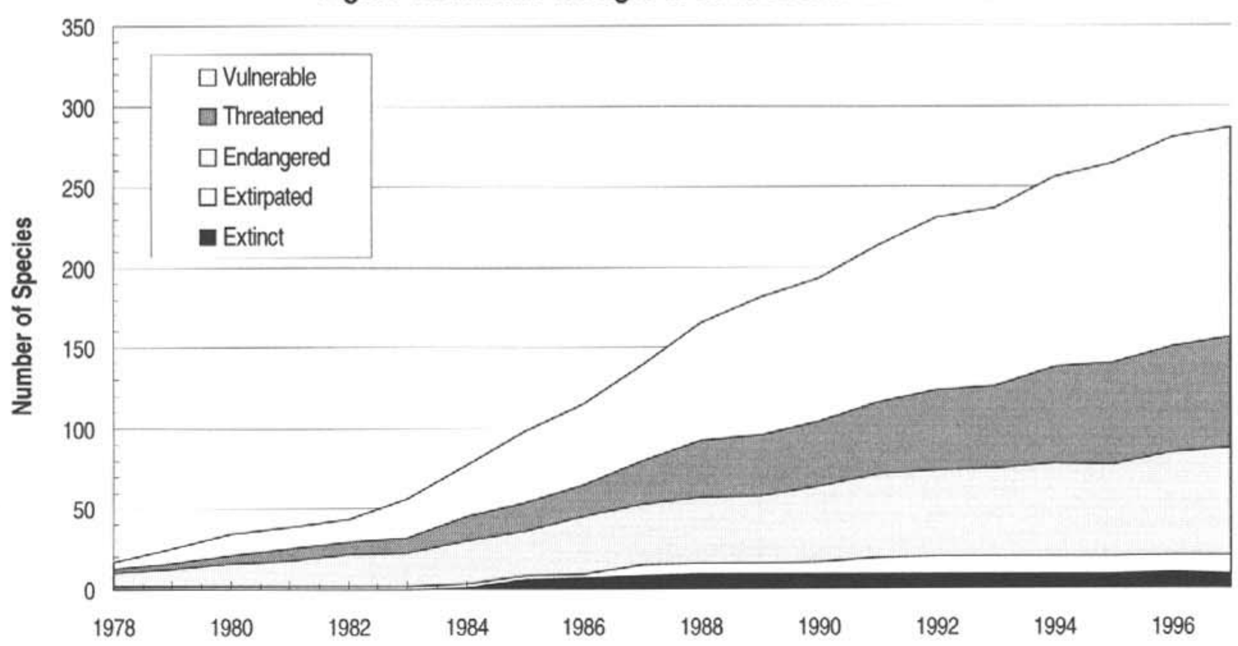
General comments	Performance record: U.S.	Performance record: Canada
Pesticides • Use of DDT and several other harmful pesticides has been discontinued. • Today's new class of pesticides are less persistent and have fewer environmental side-effects. • Pesticide use increases crop production, which means that less land is converted from wilderness to agricultural use. • Naturally occurring carcinogenic compounds pose a much greater risk than pesticide residues.	• In the U.S., pesticide use fell from 204kg/km^2 in 1980 to 196 kg/km^2 in 1993.	• In Canada, pesticide use fell from 94 kg/km^2 in 1985 to 70.5 kg/km^2 in 1994.
Toxic releases • The U.S. TRI requires the reporting of 316 chemical releases in 20 different categories. • The Toxic Release Inventory (TRI does not distinguish between releases that pose an environmental problem and those that do not. • Determining risk depends on the toxicity of the chemical, the extent of exposure, the type of release and environmental conditions. • The TRI makes no distinction between toxic wastes released into the environment and those that are put into special, long-term storage facilities.	• There has been a significant reduction in releases from 1988 to 1993.	• Canada's National Pollutant Release Inventory (NPRI) program, modeled after the TRI program in the U.S., was started in 1993. • There has been a 26 percent decrease in toxic releases between 1993 and 1995.

Figure 47: Wildlife Thought to be at Risk in the United States



Source: U.S. Fish and Wildlife cited in Council on Environmental Quality, 196. Note that data is unavailable for 1993 and 1996. Designated wildlife includes plants; birds; mammals; fish; reptiles and amphibians; crustaceans, snails, and clams; insects and arachnids.

Figure 48: Wildlife Thought to be at Risk in Canada



Source: Committee on the Status of Wildlife in Canada, 1995; COSEWIC in Environment Canada, 1996c; COSEWIC in WWF, 1997. Note that designated wildlife includes plants; birds; mammals; fish; reptiles and amphibians and lichens.

Wildlife

The North American wildlife population consists of at least 1,950 species of vertebrates, 4,200 species of vascular plants, approximately 95,000 species of invertebrates, and 34,000 species of insects (Environment Canada 1991c: (6)4). Many more unrecorded species may exist.

The number of species officially designated as threatened or endangered by the U.S. Fish and Wildlife Service has almost quadrupled from 283 in 1980 to 1,125 in 1997 (Figure 47). In Canada, the number of species designated by the Committee on the Status of Wildlife (COSEWIC) as extinct, extirpated, endangered, threatened, or vulnerable[3] has increased from a total of 17 in 1978 to 280 in 1996 (Figure 48).

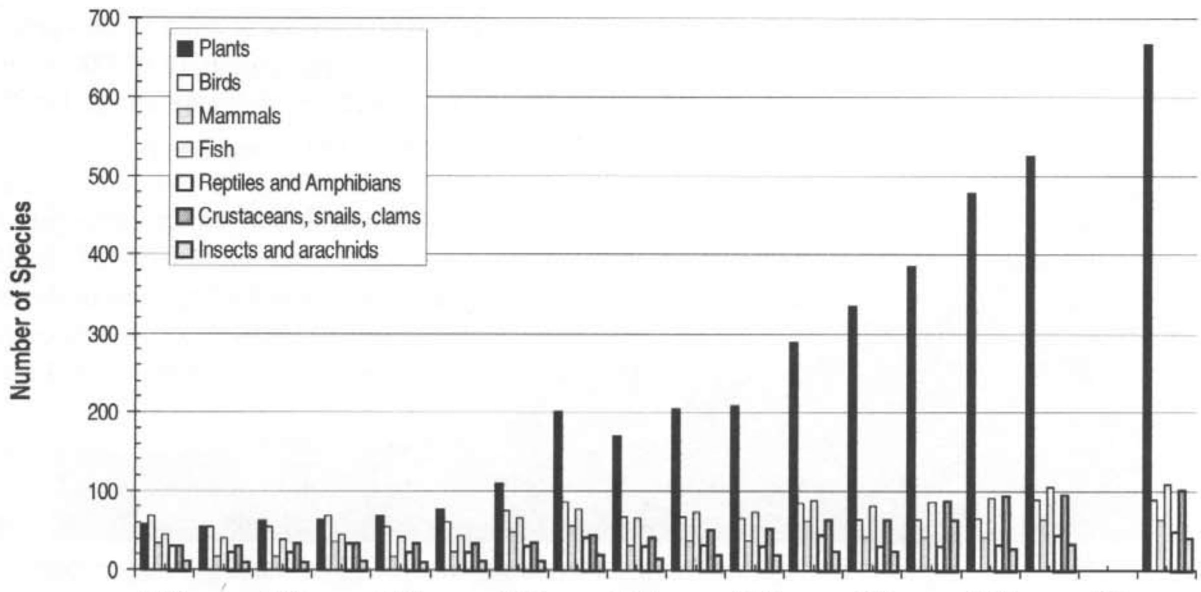
Although the number of endangered species in the United States appears to exceed those in Canada, it is unclear whether this reflects any actual differences in the number of endangered species. The numbers may reflect differences between the countries' definitions of what constitutes an endangered species. In addition, definitions within each country have changed to include more species over time. In the United States, for example, species are listed according to a process established by the Endangered Species Act (1973). The public originally supported the act on the grounds that it would protect animals such as the bald eagle and the grizzly bear. Today, however, more than half of the species listed are plants (Figure 49). The Fish and Wildlife Service has identified an additional 3,500 species as candidates for listing (Mann and Plummer 1992: 52).

In Canada, over 120 government and private programs address wildlife issues (Environment Canada 1991c: (6)20-3). The Committee on the Status of

Table 9: Summary of Wildlife as Environmental Indicator

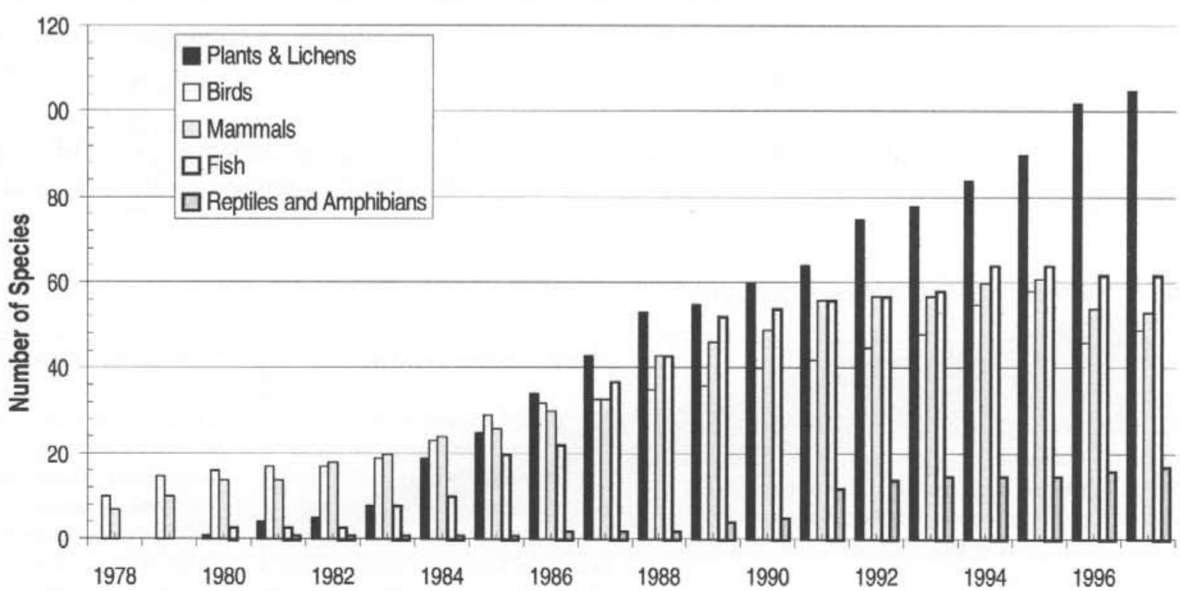
General comments	Performance record: U.S.	Performance record: Canada
• The North American wildlife population is diverse. • There is no standard by which to determine the threats human activity actually poses to ecosystems. • The rate of species extinction, the practice of relating species decline to habitat destruction, and even the total number of species that exist are all hotly disputed issues in the scientific community.	• The number of species officially designated as threatened or endangered by the U.S. Fish and Wildlife Service has tripled from 283 in 1980 to 1125 in 1997. • More than half of the species listed are plants. • The U.S. Fish and Wildlife Service has identified another 3,500 species as candidates for listing.	• In Canada the number of species categorized by the Committee on the Status of Wildlife as extinct, extirpated, endangered, threatened and vulnerable has increased from a total of 17 in 1978 to 286 in 1997. • Plants have been the largest category of listed species since 1986.

Figure 49: Species Thought to be at Risk in the United States



Source: U.S. Fish and Wildlife, 1994; Council on Environmental Quality, 1996. Note that designated wildlife includes only the categories endangered and threatened. Data is unavailable for 1996.

Figure 50: Species Thought to be at Risk in Canada



Source: Committee on the Status of Wildlife in Canada, 1995; COSEWIC cited in Environment Canada, 1996c; COSEWIC in WWF, 1997. Note that designated wildlife includes all categories: extinct, extirpated, endangered, threatened, and vulnerable.

Endangered Wildlife in Canada (COSEWIC) is composed of federal, provincial, and territorial management agencies, the Canadian Nature Federation, the Canadian Wildlife Federation, and the World Wildlife Fund of Canada. Figure 50 shows the trends in species listings. Since 1986, plants have been the largest category of the species listed.

There are many problems in using wildlife as an indicator when assessing environmental quality. For example, the practice of relating the number of species becoming extinct to the amount of habitat destruction is a hotly disputed topic in the scientific community (Edwards 1995: 211-65). In addition, there is uncertainty associated with the classification of species as endangered and the distinction between a species and a subspecies.[4] Regardless of the answers to these scientific questions, private landowners are being forced to bear almost the entire burden of protecting listed species and habitat. In the United States, "critical" habitat is heavily regulated without compensation for the landowners, a practice that has already begun to erode political support for species and habitat protection.

DID YOU KNOW?

ESA Fails to Protect Endangered Wildlife

Few topics gain more public attention than the protection of wildlife in the United States, particularly endangered species. In 1973, the U.S. passed the Endangered Species Act (ESA) in an attempt to address this issue. Twenty-five years of controversy and a failed track record show that the ESA does not work.

Why should we replace the Endangered Species Act? Because it does not save endangered species. Supporters of the ESA frequently refer to the fact that since ESA's inception in 1973, 27 species have been removed, or "recovered," from the endangered species list. This is not, however, because those species are no longer endangered. Seven species went extinct. Nine should not have been listed in the first place, but instead were data errors made by the U.S. Fish and Wildlife Service. Of the remaining 11, eight were taken off the list because biologists later discovered previously unknown populations of the species. For example, biologists once considered the Rydberg milk vetch endangered, but later removed it when they discovered a remote yet flourishing population of over 300,000.

The three remaining species — the eastern brown pelican, the arctic peregrine falcon, and the California grey whale — legitimately owe their recovery to human action. It was not, however, the Endangered Species Act that saved them. Biologists attribute the re-population of both the eastern brown pelican and the arctic peregrine falcon to the 1972 ban on DDT. The 1937 and 1946 international treaties that banned commercial whaling in open access waters undoubtedly saved the California grey whale.

In the words of Michael Bean, chair of the Environmental Defense Fund's Wildlife Program: "What is clear to me after close to 20 years of trying to make Endangered Species Act work, is that...on private lands at least, we don't have very much to show for our efforts other than a lot of political headaches. And so some new approaches, I think, desperately need to be tried because they're not going to do much worse than the existing approaches."

The Endangered Species Act fails to save endangered species because it doesn't provide incentives for people to create or preserve the species' necessary habitat. Like most environmental laws, the Act takes a command-and-control approach: it orders people to take measures to protect endangered species at their own expense.

This command approach inadvertently provides misguided incentives that actually harm endangered species. In effect, the Endangered Species Act punishes good stewardship because any landowner that does provide habitat can essentially have that land taken away by the U.S. Fish and Wildlife Service if they determine that the land hosts endangered species.

Benjamin Cone, Jr. of North Carolina exemplifies such a case. After the Fish and Wildlife Service took control of 1,560 acres of his land because colonies of red-cockaded woodpeckers were found there, Cone began massive clear-cutting on the rest of his land. He did this in order to harvest the timber before woodpeckers were discovered there as well, and the rest of his land was taken away from him.

The Fifth Amendment of the U.S. Constitution states "nor shall private property be taken for public use without just compensation." Yet the ESA allows the government to do just this, making the ESA not only ineffective, but unconstitutional.

Instead, landowners should be reimbursed when the government takes control of their property. Such reimbursement gives landowners an incentive to provide habitat. Without such reimbursements, landowners will rightfully continue to fight not only the Endangered Species Act, but endangered species themselves.

The Index of Environmental Indicators

The indicators in this report show improvements in many areas that are of environmental concern, including the quality of air and water, the use of natural resources, and the management of solid wastes. This section develops an index that measures improvements or reductions in overall environmental quality for the United States and Canada. The index shows that the relative severity of environmental problems is decreasing and that environmental quality in most categories is improving relative to the quality in 1980. It also shows that, both in the United States and in Canada, overall environmental quality has improved relative to 1980 levels.

Methodology

To aggregate individual environmental indicators such as lead, phosphorus, and soil erosion into a single measure of environmental quality, a common unit of measure is required. To create the index of environmental indicators, annual values within each of the four main categories (air quality, water quality, natural resources, and solid waste) are converted to the base year 1980. This makes it possible to compare environmental quality in later years to the base year. It is important to note that this approach allows a comparison of relative values only. The base-80 values do not provide any information about the absolute level of environmental quality. This is unavoidable as assessments of absolute environmental quality are value judgments — beliefs about the "state of nature" that are social constructs varying among societies and over time.[1]

Base-80 values are comparable across categories because they are measured in the same units. For the same reason, these values can be averaged. A second technical issue arises when determining the weight assigned to each indicator. For example, it is difficult to quantify the respective weights to be given to air pollution and water pollution. For this reason, no attempt is made to give relative weights to each indicator. For each year, base-80 values are averaged within each of the four environmental categories (air quality, water quality, natural resources, and solid waste). The category averages are then weighted equally to arrive at an overall average for each year.[2] The resulting time series represents the general trend in environmental quality for the United States and Canada.

It was necessary to account for missing data in many categories because the available time-series environmental data are often incomplete. Straight forward linear regression techniques are used to estimate missing values. In cases where trends are improving, however, the law of diminishing marginal returns may begin to have a significant effect. This means that future improvements may be more difficult to achieve than past ones. In such cases, linear projections would overestimate the rate of environmental improvement. For this reason, linear projections are used only to interpolate, that is, to fill gaps between known data points and years without data.

Forward projections are conservatively estimated: they use the last known data point as an estimator for later years with missing data. This technique ensures that no additional environmental improvement is assumed where data are missing. In cases where backward projections are necessary, missing data are also conservatively estimated. As a result, the index of environmental indicators likely underestimates the actual improvement in environmental quality relative to 1980.

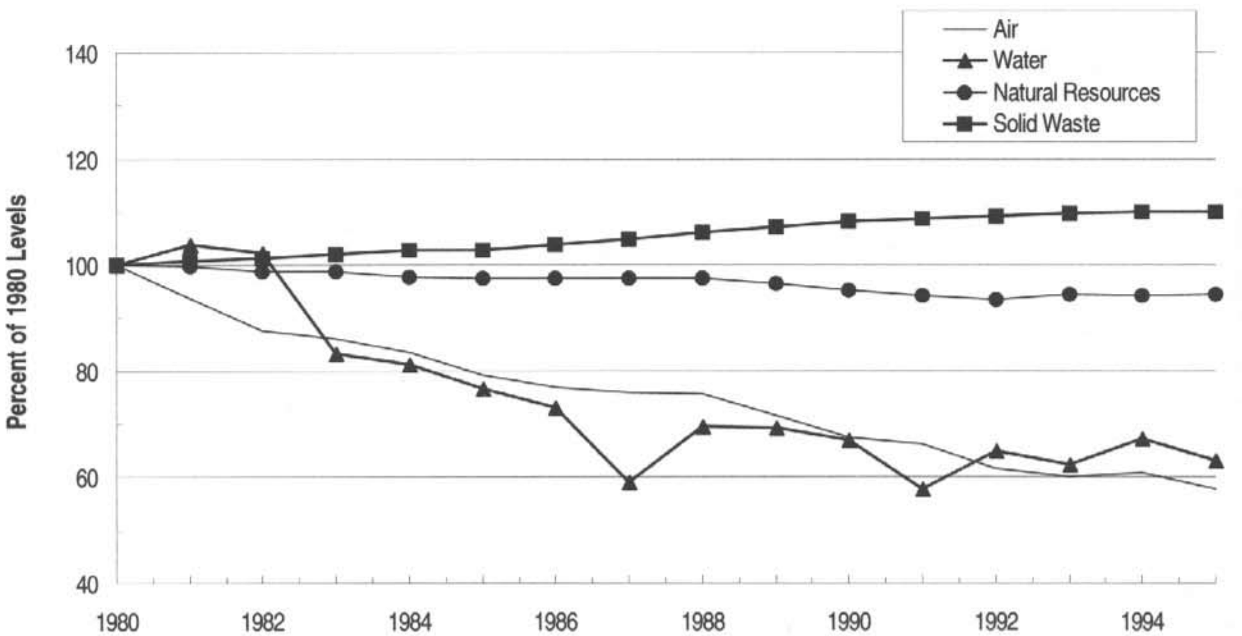
Results

Tables 10 and 11 show the base-80 values for each environmental indicator, as well as category and overall averages for the United States and Canada from 1980 to 1995.[3] The category averages are presented graphically in Figures 51 and 52. The trend in each country is clear: relative to the situation in 1980, environmental pollution is declining in severity in the categories of air quality, water quality, and natural resources.[4] On average, overall environmental problems in the United States in these categories were 19.2 percent less severe in 1995 than in 1980, and 13 percent less severe in Canada (Figure 53).

The greatest improvements in the environment in both countries were in air quality and water quality. American ambient air quality showed an 44.4 percent improvement between 1980 and 1995, while water quality improved by 36.8 percent. During the same period, the overall ambient air quality in Canada improved by 39.3 percent, while water quality improved by 27.1 percent. The improvement in water quality, however, should be taken with a note of caution as the available data represent only a small fraction of the number of rivers, lakes and streams in each country.

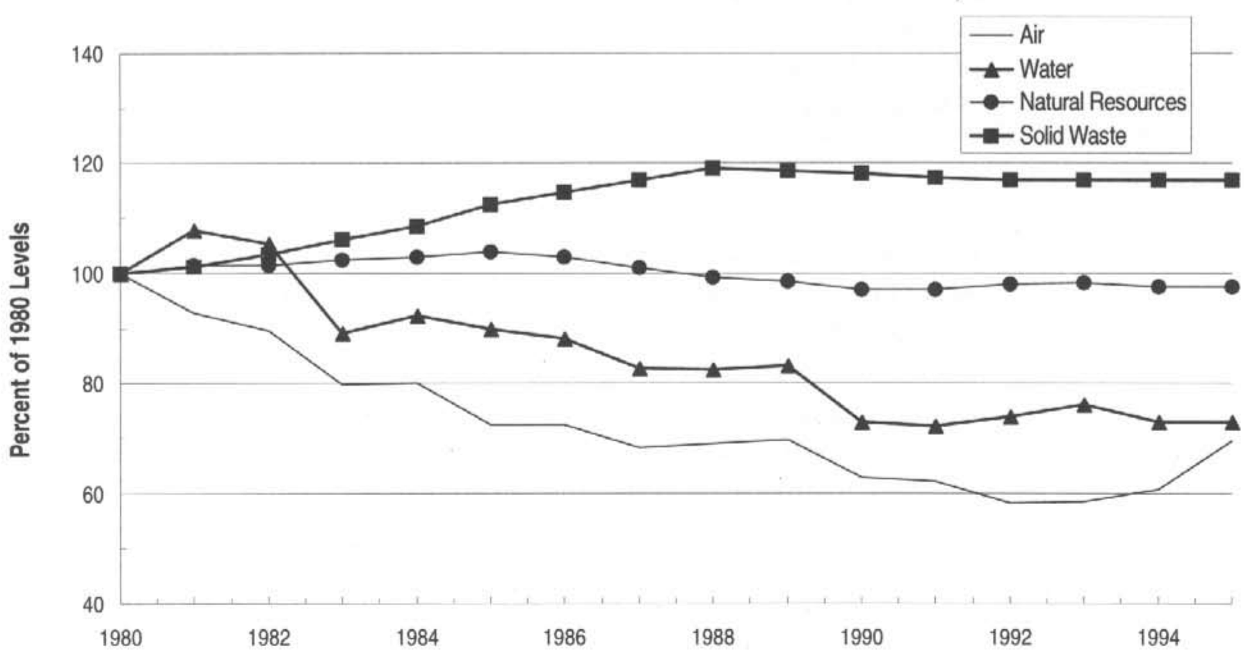
While these trends are encouraging, a few indicators showed a decrease in environmental quality. For example, ground-level ozone levels deteriorated in Canada in the 1980s. Because ground-level ozone is the result of many

Figure 51: Relative Severity of Environmental Problems in the United States



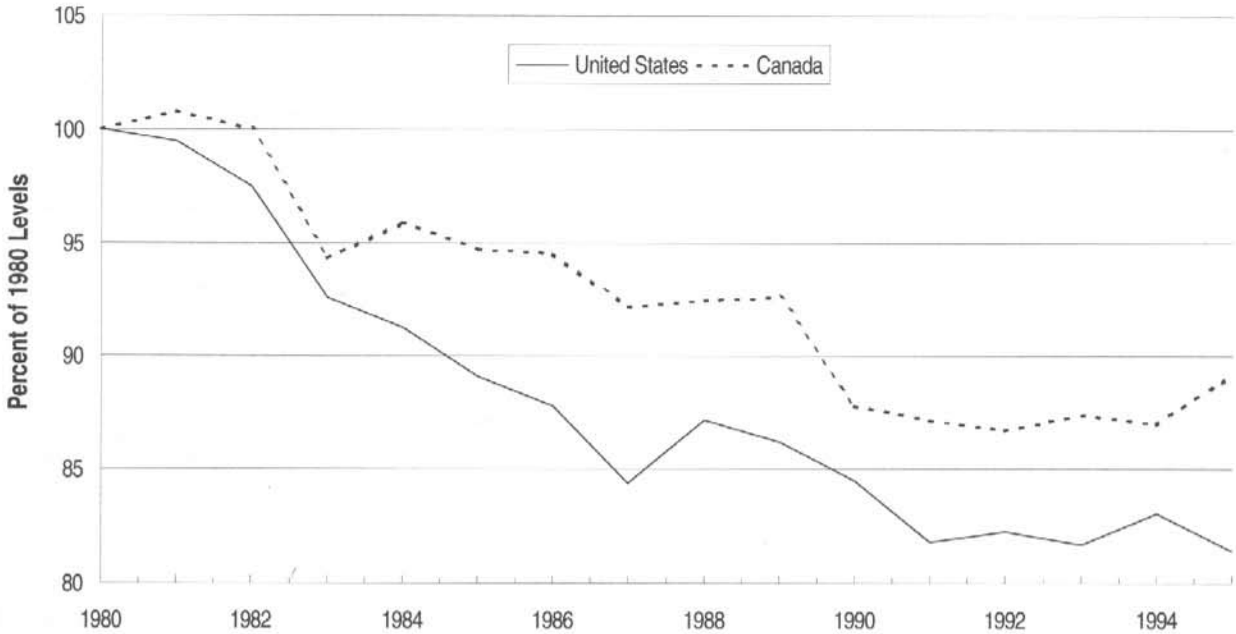
Note: Annual values are calculated by averaging "base-80" values of the four primary indicator categories.

Figure 52: Relative Severity of Environmental Problems in Canada



Note: Annual values are calculated by averaging "base-80" values of the four primary indicator categories.

Figure 53: Relative Severity of Environmental Problems in the United States and Canada



Note: Slopes are calculated by averaging "base-80" values of the four primary indicator categories.

factors, its reduction remains a particularly difficult regulatory problem. In addition, freshwater consumption in Canada increased relative to renewable freshwater resources. However, since Canada has abundant water resources and since freshwater consumption could be drastically reduced by allowing it to be sold at market value, this trend may not be of great concern.

Conclusion

The "index of environmental indicators" for the United States and Canada shows that fears about increasing environmental degradation in these countries are unfounded. In both countries, environmental quality is getting better, not worse. While it is impossible to determine the exact magnitude of the improvement in the environment due to the difficulty in determining how overall environmental quality should be measured, as well as the lack of data for some important categories, the direction of the change in quality is clear. While there are still some serious environmental problems that need to be addressed, the overall trend in environmental quality continues to improve.

Table 10: Relative Severity of Environmental Problems in the United States (base year 1980)

Values >1 represent an increase in environmental degradation; values <1 represent a decrease.

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Net change
Air quality																	
SO_2	1.00	0.94	0.86	0.84	0.84	0.84	0.83	0.81	0.82	0.79	0.73	0.72	0.67	0.65	0.62	0.52	-0.477
NO_2	1.00	0.98	0.96	0.94	0.95	0.94	0.95	0.94	0.95	0.92	0.88	0.88	0.83	0.81	0.86	0.83	-0.168
Ozone	1.00	0.92	0.89	1.00	0.89	0.88	0.85	0.89	0.96	0.82	0.80	0.81	0.76	0.77	0.77	0.80	-0.199
CO	1.00	0.97	0.88	0.88	0.87	0.79	0.76	0.72	0.69	0.68	0.63	0.60	0.56	0.53	0.54	0.48	-0.516
PM-10s	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.91	0.90	0.82	0.79	0.80	0.78	-0.220
Pb	1.00	0.83	0.65	0.51	0.45	0.32	0.22	0.20	0.13	0.10	0.10	0.07	0.06	0.06	0.05	0.05	-0.949
Average	1.00	0.94	0.88	0.86	0.84	0.80	0.77	0.76	0.76	0.72	0.68	0.66	0.62	0.60	0.61	0.58	-0.421
Water quality																	
"Exceedances"	1.00	0.92	0.94	0.88	0.77	0.75	0.71	0.55	0.70	0.69	0.66	0.46	0.60	0.57	0.68	0.68	-0.322
Phosphorus (Gr. Lakes)	1.00	0.96	0.91	0.87	0.83	0.78	0.78	0.87	0.80	0.74	0.78	0.74	0.74	0.78	0.61	0.61	-0.391
Nitrogen (Gr. Lakes)	1.00	1.03	1.06	1.08	1.11	1.14	1.15	1.18	1.13	1.12	1.13	1.18	1.19	1.19	1.19	1.19	0.194
DDE (Gr. Lakes)	1.00	1.32	1.36	0.67	0.78	0.75	0.68	0.42	0.54	0.58	0.62	0.75	0.67	0.77	0.69	0.48	-0.523
PCB (Gr. Lakes)	1.00	1.24	1.23	0.73	0.80	0.67	0.55	0.37	0.45	0.57	0.50	0.48	0.44	0.34	0.48	0.39	-0.610
HCB (Gr. Lakes)	1.00	1.22	0.98	0.56	0.72	0.58	0.60	0.34	0.50	0.48	0.34	0.34	0.46	0.33	0.36	0.26	-0.740
Average (Great Lakes)	1.00	1.15	1.11	0.78	0.85	0.78	0.75	0.64	0.69	0.70	0.67	0.70	0.70	0.68	0.67	0.59	-0.414
Average	1.00	1.04	1.02	0.83	0.81	0.77	0.73	0.59	0.69	0.69	0.70	0.58	0.65	0.63	0.67	0.63	-0.368
Natural resources																	
Forests	1.00	1.01	1.02	1.02	1.03	1.04	1.05	1.05	1.06	1.06	1.07	1.07	1.07	1.07	1.07	1.07	0.071
Water	1.00	0.98	0.96	0.94	0.92	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	-0.100
Energy	1.00	1.00	0.96	0.99	0.97	0.97	0.98	0.99	1.02	1.00	0.96	0.94	0.95	1.00	0.98	1.00	0.000
Development sprawl	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.004
Soil erosion	1.00	1.00	1.00	0.99	0.97	0.96	0.95	0.93	0.90	0.86	0.83	0.79	0.76	0.76	0.76	0.76	-0.243
Average	1.00	1.00	0.99	0.99	0.98	0.97	0.97	0.98	0.97	0.97	0.95	0.94	0.93	0.94	0.94	0.94	-0.056
Solid waste																	
Waste generation	1.00	1.02	1.03	1.05	1.07	1.09	1.13	1.17	1.21	1.25	1.29	1.32	1.34	1.36	1.38	1.38	0.381
Recycling rate	1.00	1.00	0.99	0.99	0.99	0.97	0.95	0.93	0.91	0.89	0.87	0.86	0.85	0.83	0.82	0.82	-0.179
Average	1.00	1.01	1.01	1.02	1.03	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.09	1.10	1.10	1.10	0.101
Overall average	**1.00**	**1.00**	**0.98**	**0.93**	**0.91**	**0.89**	**0.88**	**0.84**	**0.87**	**0.86**	**0.85**	**0.82**	**0.82**	**0.82**	**0.83**	**0.81**	**-0.186**

Table 11: Relative Severity of Environmental Problems in Canada (base year 1980)

Values >1 represent an increase in environmental degradation; values <1 represent a decrease.

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Net change
Air quality																	
SO_2	1.00	0.89	0.89	0.67	0.78	0.67	0.67	0.56	0.67	0.67	0.67	0.56	0.56	0.56	0.56	0.56	-0.444
NO_2	1.00	0.92	0.92	0.88	0.96	0.87	0.87	0.83	0.85	0.91	0.85	0.78	0.72	0.74	0.74	0.74	-0.261
Ozone	1.00	0.94	1.00	1.00	1.00	1.00	1.06	1.06	1.19	1.19	1.06	1.25	1.13	1.13	1.31	1.31	0.313
CO	1.00	1.01	0.86	0.79	0.70	0.65	0.62	0.63	0.60	0.63	0.54	0.50	0.48	0.49	0.43	0.43	-0.572
TSP	1.00	0.87	0.77	0.71	0.69	0.64	0.64	0.72	0.65	0.65	0.58	0.58	0.54	0.54	0.54	0.54	-0.462
Pb	1.00	0.94	0.94	0.74	0.68	0.52	0.48	0.30	0.18	0.14	0.07	0.06	0.06	0.06	0.06	0.06	-0.940
Average	1.00	0.93	0.90	0.80	0.80	0.73	0.72	0.68	0.69	0.70	0.63	0.62	0.58	0.58	0.61	0.61	-0.393
Water quality																	
"Exceedances"	1.00	1.00	1.00	1.00	1.00	1.02	1.01	1.02	0.97	0.97	0.79	0.74	0.78	0.84	0.79	0.87	-0.129
Phosphorus (Gr. Lakes)	1.00	0.96	0.91	0.87	0.83	0.78	0.78	0.87	0.80	0.74	0.78	0.74	0.74	0.78	0.61	0.61	-0.391
Nitrogen (Gr. Lakes)	1.00	1.03	1.06	1.08	1.11	1.14	1.15	1.18	1.13	1.12	1.13	1.18	1.19	1.19	1.19	1.19	0.194
DDE (Gr. Lakes)	1.00	1.32	1.36	0.67	0.78	0.75	0.68	0.42	0.54	0.58	0.62	0.75	0.67	0.77	0.69	0.48	-0.523
PCB (Gr. Lakes)	1.00	1.24	1.23	0.73	0.80	0.67	0.55	0.37	0.45	0.57	0.50	0.48	0.44	0.34	0.48	0.39	-0.610
HCB (Gr. Lakes)	1.00	1.22	0.98	0.56	0.72	0.58	0.60	0.34	0.50	0.48	0.34	0.34	0.46	0.33	0.36	0.26	-0.740
Average (Great Lakes)	1.00	1.15	1.11	0.78	0.85	0.78	0.75	0.64	0.69	0.70	0.67	0.70	0.70	0.68	0.67	0.59	-0.414
Average	1.00	1.08	1.05	0.89	0.92	0.90	0.88	0.83	0.83	0.83	0.73	0.72	0.74	0.76	0.73	0.73	-0.271
Natural resources																	
Forests	1.00	1.04	1.08	1.12	1.16	1.21	1.14	1.08	1.03	0.98	0.94	0.99	1.05	1.11	1.11	1.11	0.110
Water	1.00	1.03	1.06	1.09	1.12	1.15	1.17	1.19	1.20	1.22	1.23	1.23	1.23	1.23	1.23	1.23	0.231
Energy	1.00	1.00	0.94	0.91	0.86	0.84	0.84	0.81	0.79	0.80	0.78	0.74	0.74	0.70	0.68	0.67	-0.331
Development sprawl	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.91	0.91	-0.087
Soil erosion	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.98	0.97	0.97	0.96	0.95	0.95	0.95	0.95	0.95	-0.053
Average	1.00	1.01	1.02	1.02	1.03	1.04	1.03	1.01	0.99	0.99	0.97	0.97	0.98	0.98	0.98	0.97	-0.026
Solid waste																	
Waste generation	1.00	1.05	1.11	1.16	1.21	1.27	1.32	1.38	1.43	1.43	1.43	1.44	1.44	1.44	1.44	1.44	0.437
Recycling rate	1.00	0.97	0.96	0.96	0.96	0.98	0.97	0.96	0.95	0.94	0.93	0.92	0.90	0.90	0.90	0.90	-0.101
Average	1.00	1.01	1.04	1.06	1.09	1.13	1.15	1.17	1.19	1.19	1.18	1.18	1.17	1.17	1.17	1.17	0.168
Overall average	**1.00**	**1.01**	**1.00**	**0.94**	**0.96**	**0.95**	**0.95**	**0.92**	**0.93**	**0.93**	**0.88**	**0.87**	**0.87**	**0.87**	**0.87**	**0.89**	**-0.108**

End Notes

Introduction

1 This is especially true for developing nations, whose environmental quality can be expected to begin improving significantly once a certain threshold of per capita income is reached. This finding is compellingly argued in Gene M. Grossman and Alan B. Krueger's 1991 paper, "Environmental Impacts of a North American Free Trade Agreement" (Cambridge: National Bureau of Economic Research, working paper no. 3914).

Primary Indicators

1 U.S. EPA 1996a:1. Cities with a population of 50,000 to 100,000 have a class-two station and cities with populations over 250,000 are required to have a class-one monitoring station according to the NAPS.

2 SO_2 converts to sulphuric acid when it combines with oxygen and water in intense sunlight.

3 The World Health Organization (WHO) guidelines define "good" objectives as 0 to .011 parts per million, and producing no effects on human health or the environment. Environmental Canada, 1991 c(2)11. WHO guidelines as reported in U.S. EPA, 1995c, p. 7-4.

4 For a more complete analysis, see Ackerman and Hassler, *Clean Coal, Dirty Air,* 1981. This regulation carries with it an enormous cost, as well. Scrubbers on coal-fired plants can cost as much as $200 million to install. See Portney, "Air Quality Policy," 1990, p. 76. Also, see Terry L. Anderson and Donald R. Leal, *Free Market Environmentalism* (San Francisco: Pacific Research Institute, 1991), pp. 155-158.

5 Working Assets Long Distance, a San Francisco-based long distance phone company, bought and retired $74,000 worth of permits in 1992; this represents 336 metric tons of emissions.

6 WHO guidelines define "good" annual objectives as 0 to .032 parts per million, and producing no effects on human health or the environment. Environment Canada, 1991c: (2)11.

7 Although there are no annual objectives, in the 1990 study of Canadian stations, 98 percent of stations met the 8-hour and 1-hour "fair" objectives. "Fair" objectives are defined for the 8-hour as 5 to 13 parts per million, and for the 1-hour objective as 13 to 31 parts per million. For effects on human health and the environment, fair produces "no detectable impairment but blood chemistry is changing." Environment Canada 1994: 23-27.

8 Dr. Donald Stedman, a chemistry professor at the University of Denver, has developed a device that can measure and test the exhaust of moving vehicles, thus isolating the heaviest polluters. For more on this see Bast, Hill, and Rue 1994: 115Ð6. Also, if power plants were to add chemical or isometric "labels" to their emissions, lasimetric technology could map chemical concentrations from orbit. See Smith 1995: 390.

9 Levels of PM_{10} have actually been falling in the U.S. since the 1940s, decades before federal government regulations were enacted. See Indur M. Goklany, "Richer Is Cleaner: Long term Trends in Global Air Quality," *The True State of the Planet,* ed. Ronald Bailey (New York: The Free Press), 1995, p. 358.

10 It should be noted that the Canadian ozone standard (.082 ppm) is stricter than that of the United States (.120 ppm).

11 Even measures at Canada's worst sites are relatively low. A recent study shows that the lake-shore sites around the Great Lakes record an average of 150 hours (20 days) annually that exceed the .082 ozone standard. Recorded levels greater than .120 ppm are rare in

most regions and very infrequent in southern Ontario with only 0.14 percent of measures exceeding this level. See Dann 1996: 1-27.

12 Point versus non-point sources of water pollution could be compared to stationary versus mobile sources of air pollution.

13 Eutrophication, or nutrient enrichment, is the oversupply of inorganic nutrients that cause algae and plants to multiply rapidly; when they die and decompose, the water's dissolved oxygen content is depleted. Dissolved oxygen, which is derived from photosynthesis by aquatic plants and atmospheric exchange, is essential to ensure the maintenance of aquatic life and self-purification processes in natural water systems.

14 Bioaccumulation in aquatic organisms occurs when a persistent, fat-soluble, contaminant enters the organism's body through the skin or by ingestion. If consumption exceeds the organism's ability to metabolize or eliminate the contaminant, over time it accumulates in tissues.

15 Phosphorus targets: Lake Michigan, 5,600 tons; Lake Superior, 3,400 tons; Lake Huron, 4,360 tons; Lake Erie, 11,000 tons; Lake Ontario, 7,000 tons.

16 DDT (dichloro-diphenyl-trichloro-ethane) is a persistent, bioaccumulative, synthetic insecticide. Its use was heavily restricted in the 1970s and prohibited after 1990. The breakdown product, DDE (dichloro-diphenyl-dichloro-ethylene), is most easily measured in the fat of animals or in the eggs of birds. Most other pesticides in use today are not as persistent and hence are not transported to the same degree as DDT.

17 PCBs were once used extensively in many parts of the electrical and transmission industry, in flame retardants, water-proofing agents, printing inks, adhesives; they were also spread on roads to prevent airborne dust. In the 1980s, tight restrictions allowed PCBs to be used only in closed electrical equipment, and safe incineration technologies now are used to destroy those currently in storage. They have been associated with declining fish populations in some locations.

18 HCBs are used in fungicides, dye manufacturing, and wood preservatives; they are also produced as a waste by-product of chemical manufacturing. The Great Lakes region is at risk from HCB contamination since numerous chlorine plants are located near the Lakes on both sides of the border.

19 Organization for Economic Cooperation and Development (OECD), Environmental Data Compendium, 1997, p. 120. Production for each nation as a percentage of global production: wood pulp - U.S., 19.8%; Can., 34.7%; sawnwood and sleepers - U.S., 10.2%; Can., 33.0%; industrial roundwood - U.S., 26.3%; Can., 2.0%; paper and cardboard - U.S., 10.2%; Can., 15.6%; wood-based panels - U.S., 5.96%; Can., 9.2%.

20 Environment Canada 1991b: 74. Conversion based on 1989 exchange rate of CDN$1.184 per US$1, from Statistics Canada 1995: 89. Prices are quoted in US dollars.

21 Calculations of U.S. and Canadian figures are based on data from OECD 1997: 67-70.

22 One measure of energy efficiency is the ratio of energy use to the size of the national economy. See OECD 1995: 205.

23 Brookes 1991: 104-112. This estimate excludes Alaska, which is 90 percent wetland area and 90 percent government owned.

24 Comparable data do not exist after this period because the Canada Land Use Monitoring Program ended in 1986. Statistics Canada is attempting to derive comparable data for 1991 (Trant 1996).

25 Whatever happened to the Mobro garbage barge? After wandering up and down the Atlantic seaboard for several weeks, the trash it carried was placed in a landfill in New York, just a few miles from where it had started its journey.

26 The Canadian Council of Ministers of the Environment (CCME) has set a nation-wide goal of 50 percent reduction per capita from 1988 level, by the year 2000. A second initiative, the National Packaging Protocol (NAPP), targets the 35 to 40 percent of solid

waste that is composed of discarded packaging, and aims to reduce the level of discarded packaging to 50 percent of the 1988 level by the year 2000. See Environment Canada 1991c: (25)4.

27 In the United States, municipal waste is waste collected by, or on the order of, municipalities. It includes waste originating in households, commercial activities, office buildings, institutions like schools and government buildings, and small businesses that dispose of waste at the same facilities used for municipally collected wastes. In Canada, municipal waste is all waste that is not construction and demolition debris. See OECD 1997: 153.

28 Imperial measures are 44 square miles and 120 feet deep. See Wiseman 1990.

29 Canadian data are based on apparent consumption (a proxy for waste generated derived from consumption) using figures from domestic consumption of the respective product + imports - exports. American data are based on amounts of waste generated. OECD 1995: 153.

30 Canada's glass recycling figure includes the reuse of refillable money-back bottles. OECD 1997: 164.

Secondary Indicators

1 The atmosphere contains 750 billion tons of carbon dioxide; living plants contain 560 billion tons, soils 1,400 billion tons, ocean sediments 11,000 billion tons and the oceans themselves 38,000 billion tons. See Environment Canada 1991c: (22) 7.

2 Scientists do not dispute that the increase in equivalent CO_2 has occurred. Since the Industrial Revolution, equivalent CO_2 levels have risen from approximately 290 ppm to nearly 440 ppm in 1994 (Bailey 1995: 87). Humans do not, however, contribute to the main absorbers of infrared light in the atmosphere. Water vapor and clouds are responsible for over 98 percent of the current greenhouse effect (Lindzen 1992: 2).

3 Extinct: a species no longer existing; extirpated: a species no longer existing in the wild in Canada but existing elsewhere; endangered: a species facing imminent extirpation or extinction; threatened: a species likely to become endangered if limiting factors are not reversed; vulnerable: a species of special concern because it has characteristics that make it particularly sensitive to human activities or natural events. From COSEWIC 1995: 1.

4 Easterbrook 1994. Easterbrook argues that the number of spotted owls has been badly underestimated, that it does not differ genetically from the spotted owl populations in California, that it thrives in more kinds of habitat than is claimed, and, therefore, that it is not endangered.

Index

1 For a comprehensive discussion of the wide variety of beliefs about nature in this century alone, see Bramwell 1989.

2 This two-stage averaging process is necessary to avoid giving exaggerated weight to categories that include a larger number of sub-categories.

3 This is the time period for which the data are most complete across all categories.

4 In the U.S. and Canada, municipal waste generation has increased substantially since 1980; recycling rates, however, have increased as well. While the U.S. and Canada produced increasing amounts of refuse, fewer economically valuable resources were being sent to landfills and incinerators. In addition, using the total amount of waste generated as an indicator of environmental quality may overstate the waste problem, as there is no shortage of landfill space in either the U.S. or Canada.

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