# Secondary Environmental Indicators

The indicators discussed in this section are carbon dioxide, oil spills, pesticides, toxic releases, and wildlife. Often cited as reliable measures of the state of the environment, they are classed as secondary indicators in this report because they provide information about environmental quality that is, at best, indirect. 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 makes 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 74 through 77 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 levelled off before declining in the early 1980s. Recently, emissions have increased. Mexico's emissions have also grown along with economic growth over the past 14 years. In the United Kingdom, $CO_2$ emissions dropped slightly between 1980 and 1996 while GDP has increased substantially over the same period.

### Global Warming

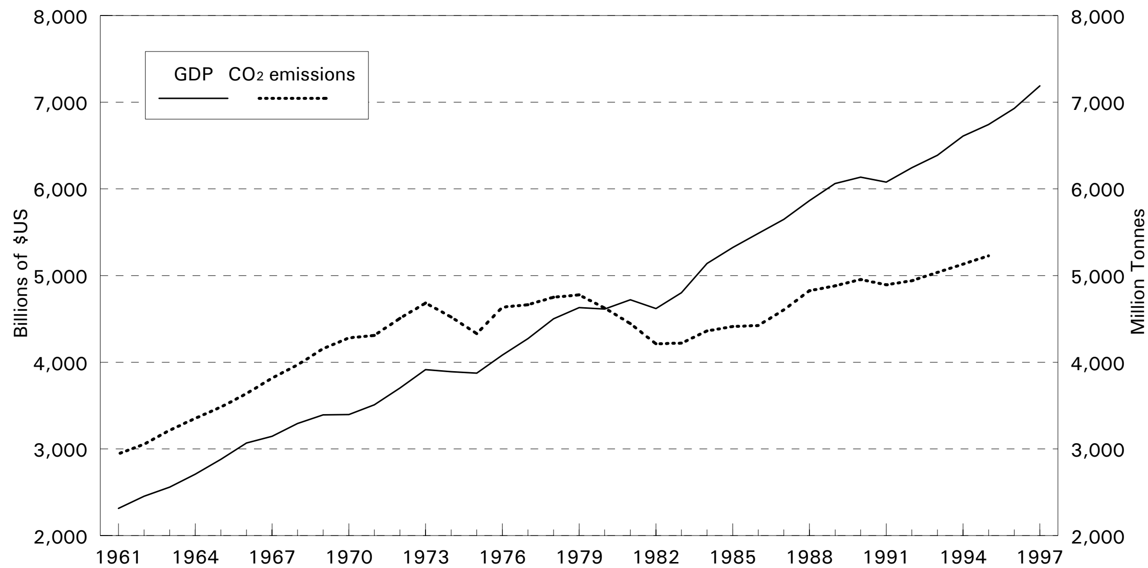
Emissions of $CO_2$ have been linked to a possible human-induced global warming. As a result, controlling $CO_2$ emissions has been the subject of many recent policy debates. In order to understand fully the popular global warming debate, one must appreciate the distinction between the greenhouse effect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

The popular debate revolves around the question whether humans, through their additions 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 face of the uncertainty within the scientific community about the link between $CO_2$ and global warming and in the absence of a proven link to global warming, $CO_2$ cannot be considered a pollutant but, at most, a secondary indicator of environmental quality.

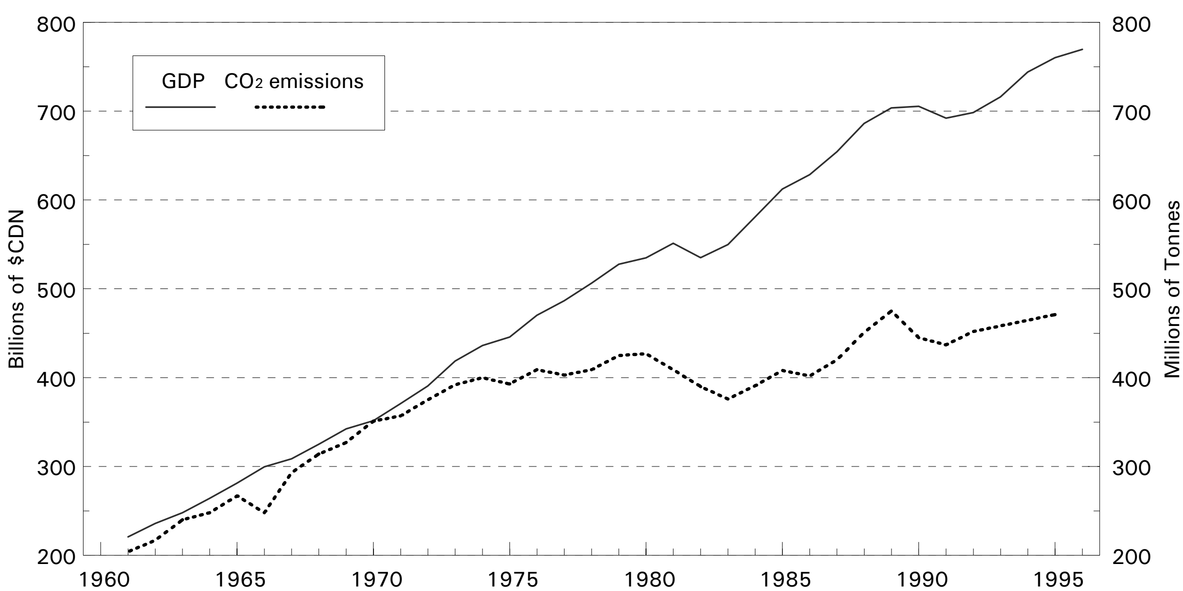
The scientists who criticize global warming possess three powerful lines of attack on the apocalyptic theories: the inadequacy of the computer models being used to forecast future temperatures, the evidence from actual

**Figure 74: GDP Compared to $CO_2$ Emissions: Trends in the United States**



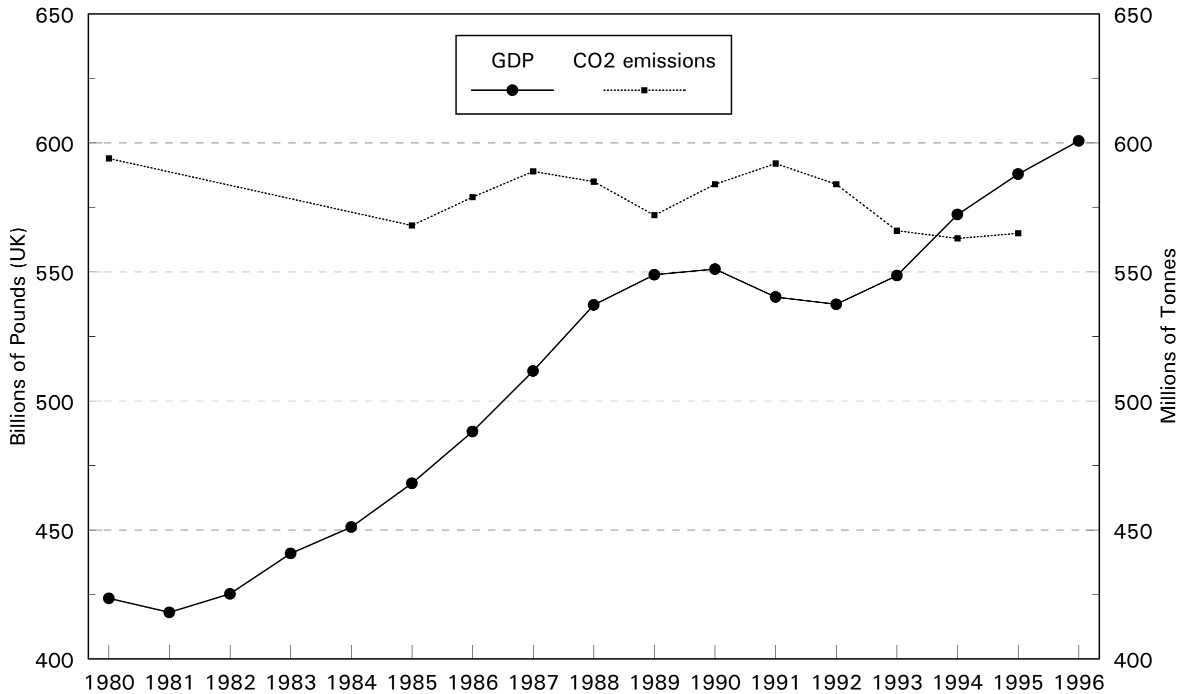

Sources: US EPA 1994; IEA 1997; Bureau of Economic Analysis 1998.
Note: GDP is in constant (1992) US dollars.

**Figure 75: GDP Compared to $CO_2$ Emissions: Trends in Canada**



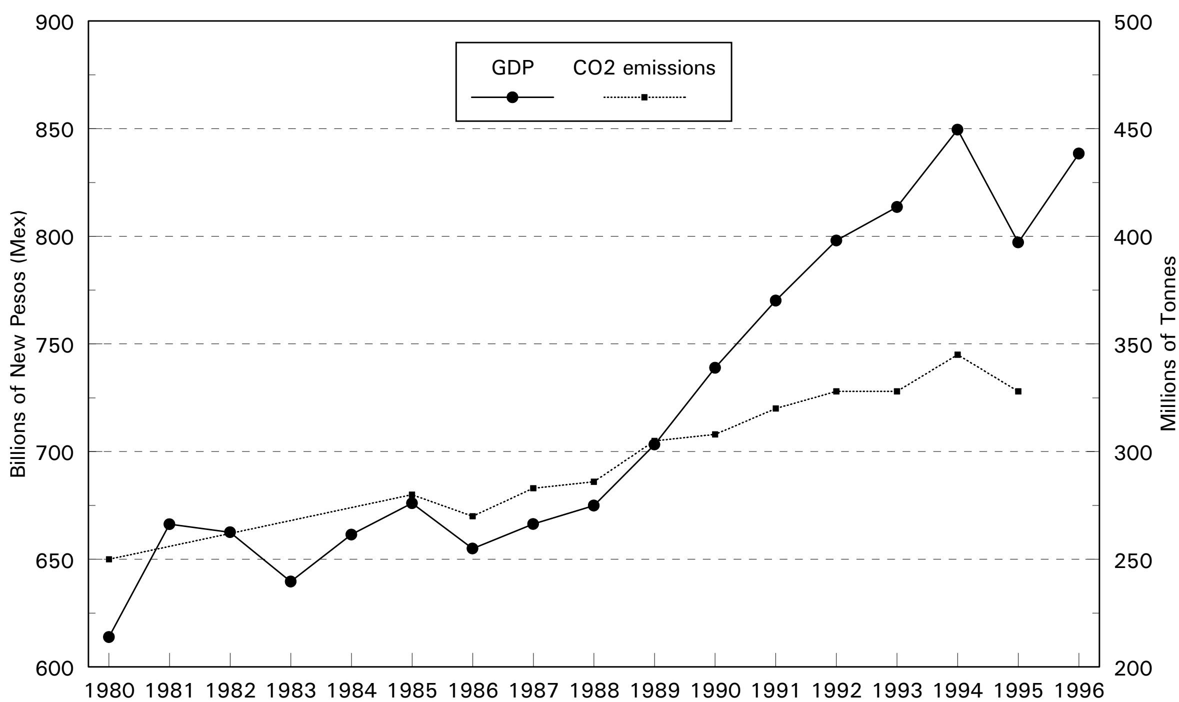

Sources: Environment Canada 1996a; IEA 1996; Canadian Economic Observer 1998.
Note: GDP is in constant (1992) Canadian dollars.

**Figure 76: GDP Compared to $CO_2$ Emissions: Trends in the United Kingdom**




Sources: OECD 1997; *International Financial Statistics Yearbook* 1998.
Note: GDP is in constant (1990) UK Pounds.

**Figure 77: GDP Compared to $CO_2$ Emissions: Trends in Mexico**




Sources: OECD 1997; *International Financial Statistics Yearbook* 1998.
Note: GDP is in constant (1990) Mexican New Pesos.

temperature records, and the strength of competing hypotheses (currently under-reported and insufficiently considered by policy makers) to explain warming.

### The inadequacy of the 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 our understanding of 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.

Aside from their inability to make accurate predictions, 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 1.3º and 2.3º 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.

### 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; 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. 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, and 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 climatic 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 climatic change is variation in the brightness of the sun. (Baliunas and Soon: 81)

The processes of “fingerprinting” various mechanisms of climatic change and projecting climatic 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 climatic 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 towards 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 because taking drastic measures to control greenhouse gases will come at the expense of other social objectives.

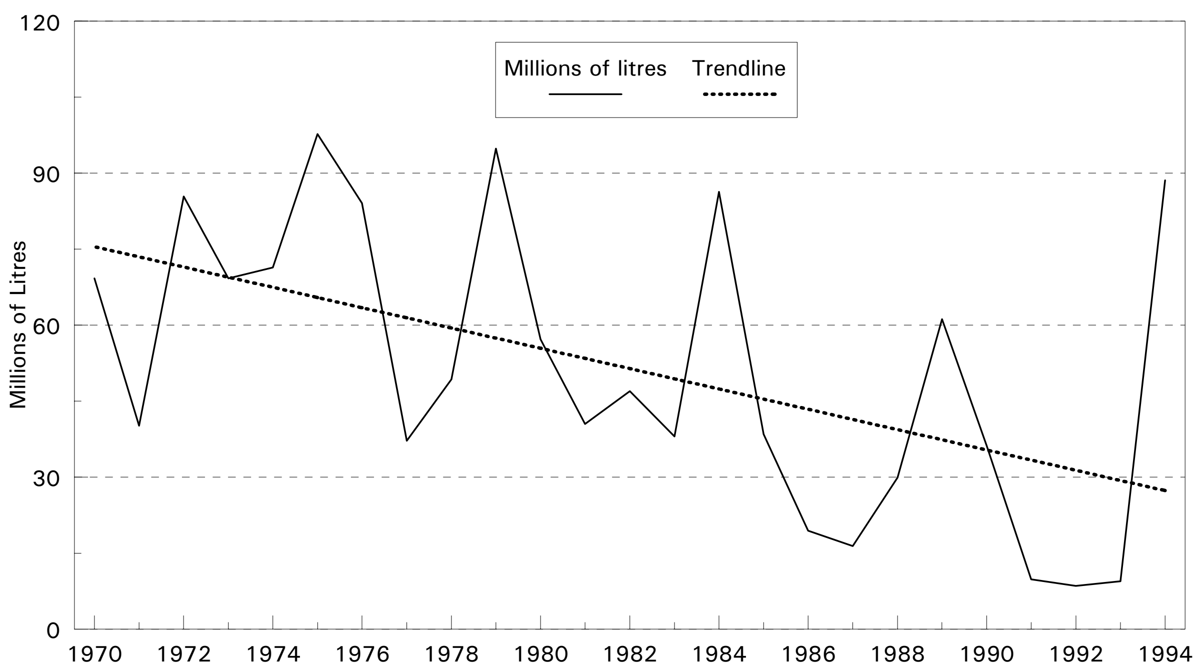
# Oil spills

Oil spills are high profile events. Incidents such as the Santa Barbara oil spill of 1969, the *Exxon Valdez* spill in 1989, and the Braer spill off the British coast in 1993 receive intense media coverage. Despite the public perception that the number of oil spills and the severity of those spills has increased, figure 78 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 litres of oil and oil-based products down the drain every year (Allen 1993). In comparison, the *Exxon Valdez* spilled just over 41 million litres of crude oil into Prince William Sound.

While oil spills are never desirable, and the immediate damage can be alarming, in time nature 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 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 for the 10-year period from 1976 to 1987 (figure 79). 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 num-

**Figure 78: Oil Spills in and around American Waters (by volume)**



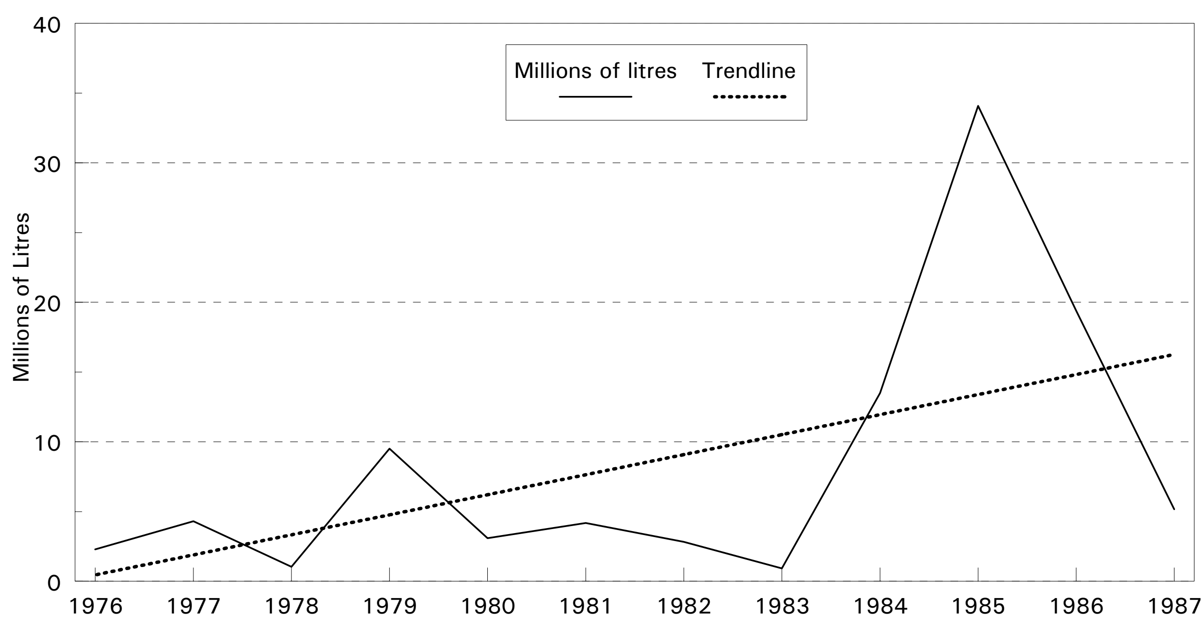

Source: US Coast Guard, cited in US Bureau of the Census 1996.

bers 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.

A variety of data on oil spills are available for the United Kingdom including number of incidents reported, number of spills over 100 gallons, oil spilled offshore on drill cuttings, and total number of spills requiring clean-up. It is, however, difficult to estimate the total tonnage of oil spilled because of the large number of small spills. Larger spills are obviously easier to track and in recent years there have been two major oil spills in British waters, both related to shipping accidents. In 1993, the *Braer* spilled 84,000 tonnes of oil and, in 1996, the *Sea Empress* spilled roughly 70,000 tonnes of oil (UKDETR 1998: 116).

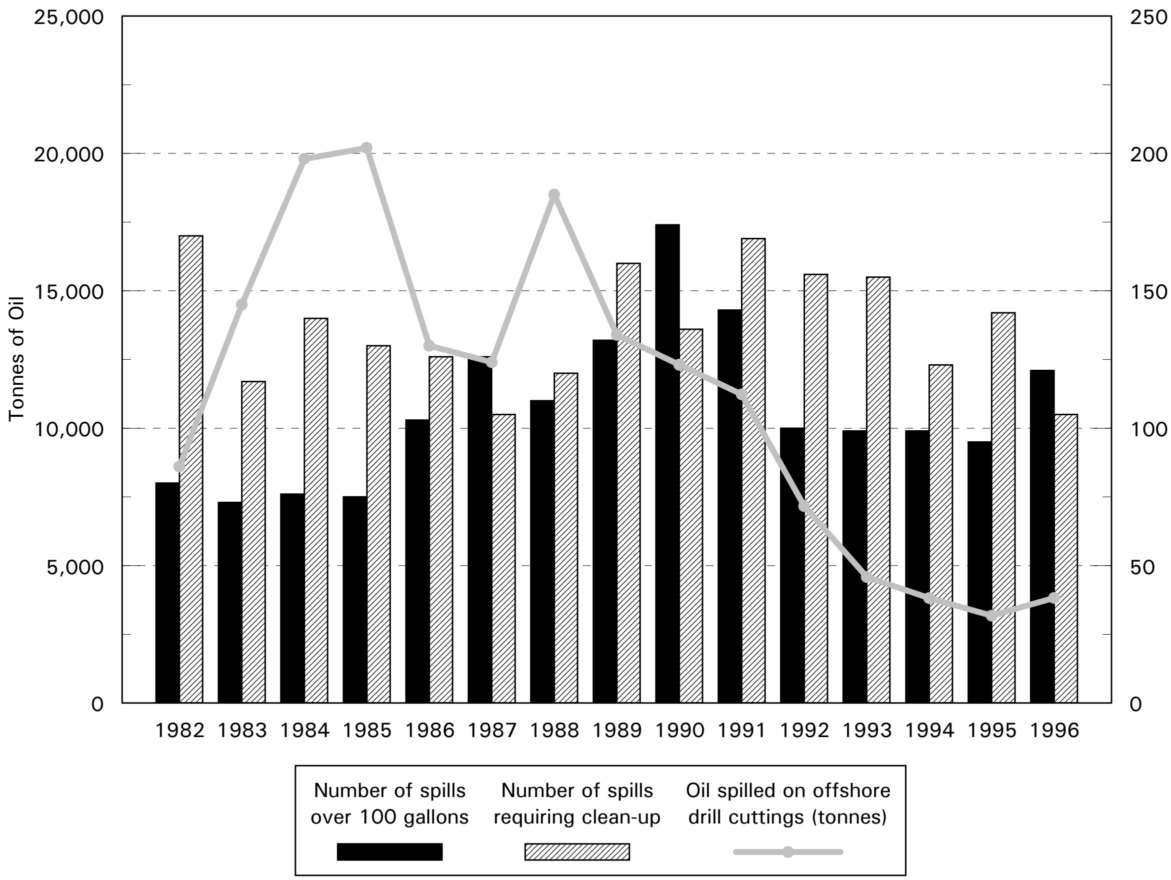
Figure 80 shows that the number of spills over 100 gallons has been variable over the period from 1982 to 1996 with a low of 73 spills in 1983 to a high of 174 spills in 1990. The number of spills requiring clean-up has also been variable but reached its lowest level, 105 spills, in 1996. In addition to accidental spills, oil is also discharged into the North Sea from offshore installations. Some of the discharges are the result of water contaminated with oil, which is extracted with the oil and then discharged following treatment. Other discharges are a result of drill cuttings made using oil-based drilling muds (UKDETR 1998: 116). Figure 80 shows that the discharges of oil from drill cuttings have fallen substantially since 1988. This is largely due to the greater use of alternatives to oil-based muds (UKDETR 1998: 117).

**Figure 79: Significant Spills in and around Canadian Waters (by volume)**




Source: Environment Canada 1991c.
Note: 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%.

**Figure 80: Oil Spills in and around the United Kingdom**




Sources: UKDETR1998a: 130–31; Advisory Committee on Protection of the Sea, *Surveys of Oil Pollution around the Coasts of the United Kingdom*, 1982–1996.

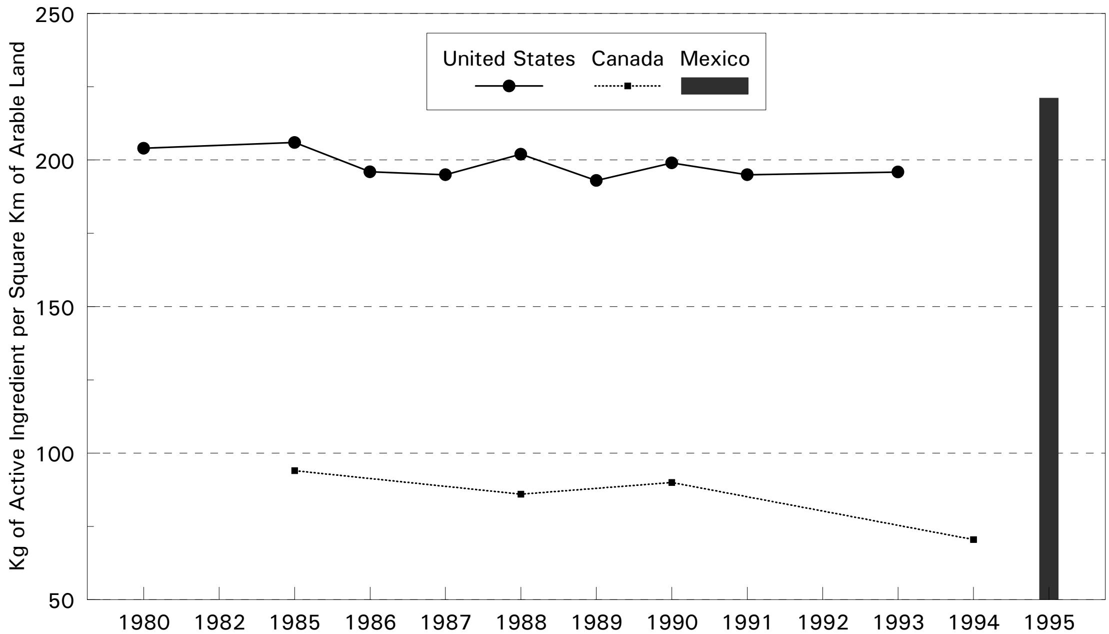
# Pesticides

Pesticides are a family of substances including herbicides, insecticides, fungicides, and fumigants. Although DDT (dichlorodiphenyltrichloroethane) and several other notorious pesticides have been discontinued, pesticide use remains controversial. Figure 81 shows the use of pesticides per square kilometre of arable land in the United States and Canada. Figure 82 shows the amount used per hectare grown in the United Kingdom. The limited data available show that, in the United States, the use of pesticides fell 3.9 percent, from 204 $kg/km^2$ in 1980 to 196 $kg/km^2$ in 1993. In Canada, use of pesticides fell 25 percent, from 94 $kg/km^2$ to 70.5 $kg/km^2$ between 1985 and 1994. In the United Kingdom, pesticide use increased 35.6 percent from 1974 to 1994, but has decreased 17.1 percent since 1982. While these declines are not dramatic, they illustrate that fears of greatly increased pesticide use have been unfounded. (For a summary, see Easterbrook 1995: 79 ff.) There are no historical data available for pesticide use in Mexico.

The pesticides used today are substantially different from those in use when pecticides were 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, which persist in the environment and tend to accumulate in animal tissues. Today, chlorinated hydrocarbons account for only about 5 percent of all pesticides (Hayward 1994). They have been replaced by a new class of pesticide that is effective in lower doses, less persistent, and has fewer environmental side-effects.

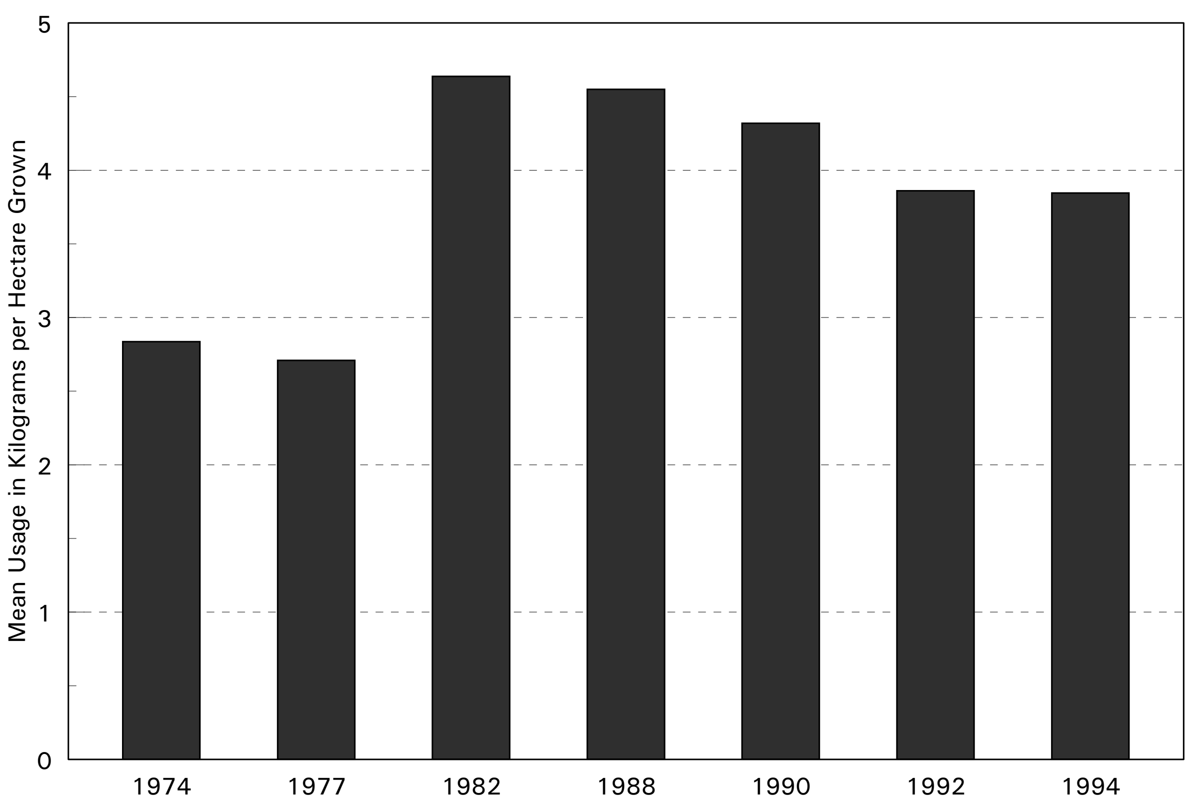
Although pesticides are hazardous chemicals that should be handled carefully, their use yields enormous benefits and the risk from residues is minor. Pesticides stimulate crop production so that less land is converted from wilderness to agricultural uses, and food costs are lower. Banning pesticides 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).

**Figure 81: Pesticide Use in the United States, Canada and Mexico**




Sources: OECD 1994, 1997; Estadisticas del Medio Ambiente 1997.

**Figure 82: Pesticide Use in the United Kingdom**




Source: UKDETR 1996.

# Toxic releases

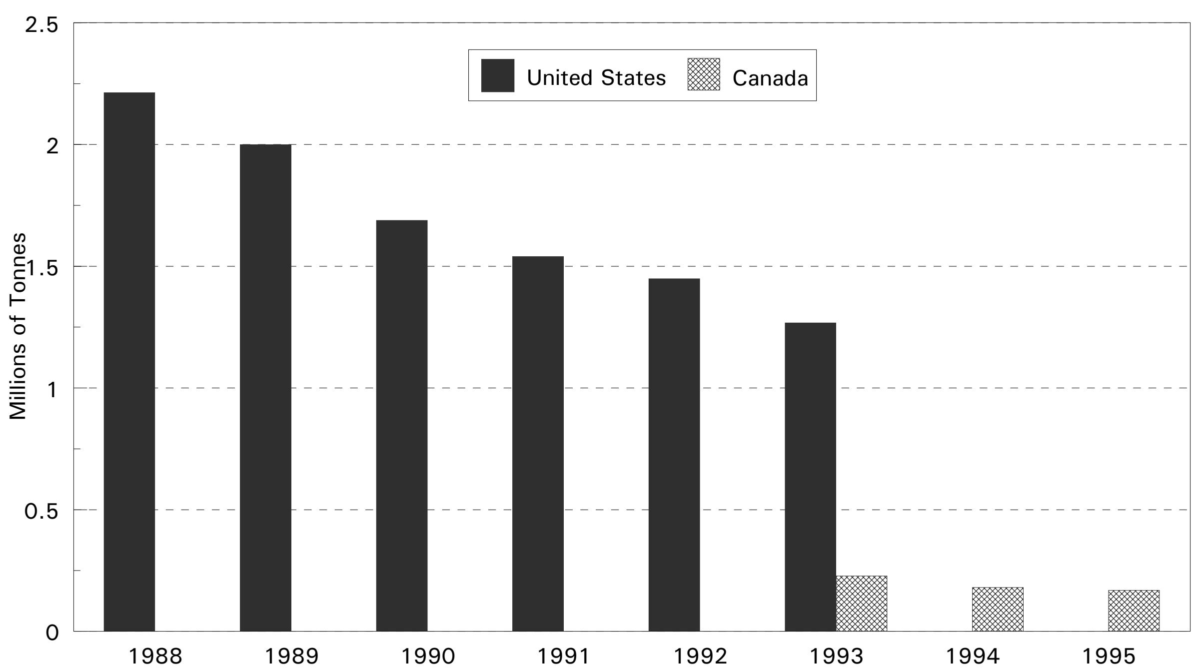
The Congress of the United States passed the Emergency Planning and Community Right-to-Know Act in 1986 after the toxic catastrophe in Bhopal, India and a near disaster in West Virginia shortly after. This act stipulated that the EPA compile the Toxic Release Inventory (TRI), which requires industrial facilities to report a broad range of toxic emissions. In 1993, 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 83 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 suggests 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. (USEPA 1995a)

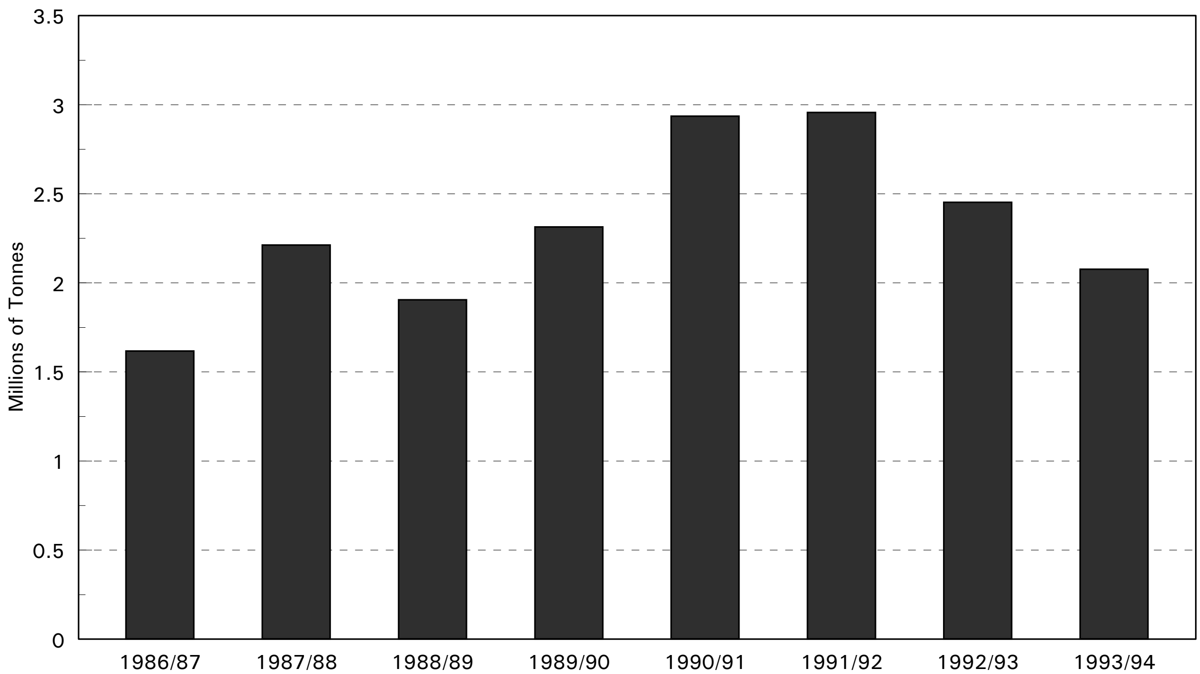
Further, the definition of "releases" used in compiling the Toxic Release Inventory makes no distinction between releases into the environment and instances where

**Figure 83: Toxic Waste Releases in United States and Canada**




Sources: US EPA 1995a; Environment Canada 1995, 1997.
Note: Canadian data unavailable before 1993.

**Figure 84: Hazardous Waste in the United Kingdom**



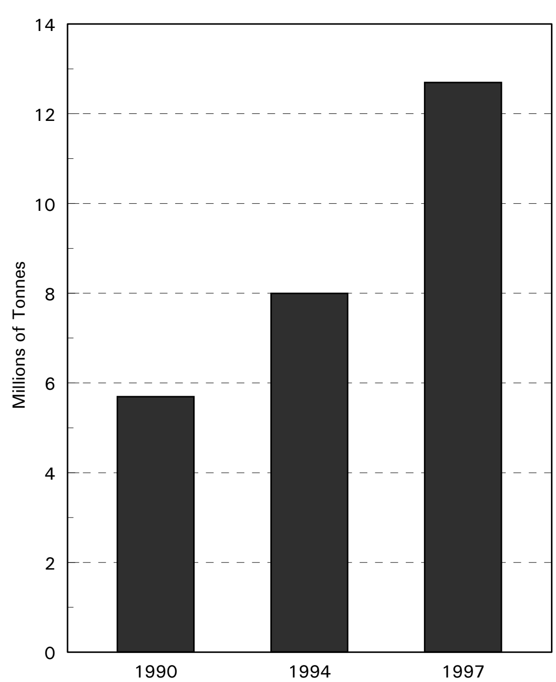

Sources: Indicators of Sustainable Development 1996; DES No. 20: 180.

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.

The United Kingdom measures "special waste," that is, waste that contains hazardous material. The amount of special waste produced has been variable, ranging from a low of 1.6 million tonnes in 1986/1987 to a high of 2.9 million tonnes in 1991/1992. The amounts represent less than 1 percent of total waste (UKDETR 1997b: 156; see figure 84).

In Mexico, the amount of hazardous waste generated has increased 123 percent between 1990 and 1997 (see figure 85). A major concern in Mexico is the handling of this waste as only 12 percent of hazardous wastes are thought to be properly managed. One of the government's goals is "assure the adequate management of half of Mexico's industrial hazardous waste by the year 2000" (www.ine.gob.mx/indicadores/ingles/I_rp3.htm).

**Figure 85: Hazardous Waste Generated in Mexico**




Source: Indicators for Environmental Performance 1997.

# 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). In the United Kingdom, it is estimated that there are 30, 000 species of terrestrial and freshwater animals (UKDETR 1998: 217). About 24,000 species of flora and fauna have been identified in Mexico. Many more unrecorded species may exist.

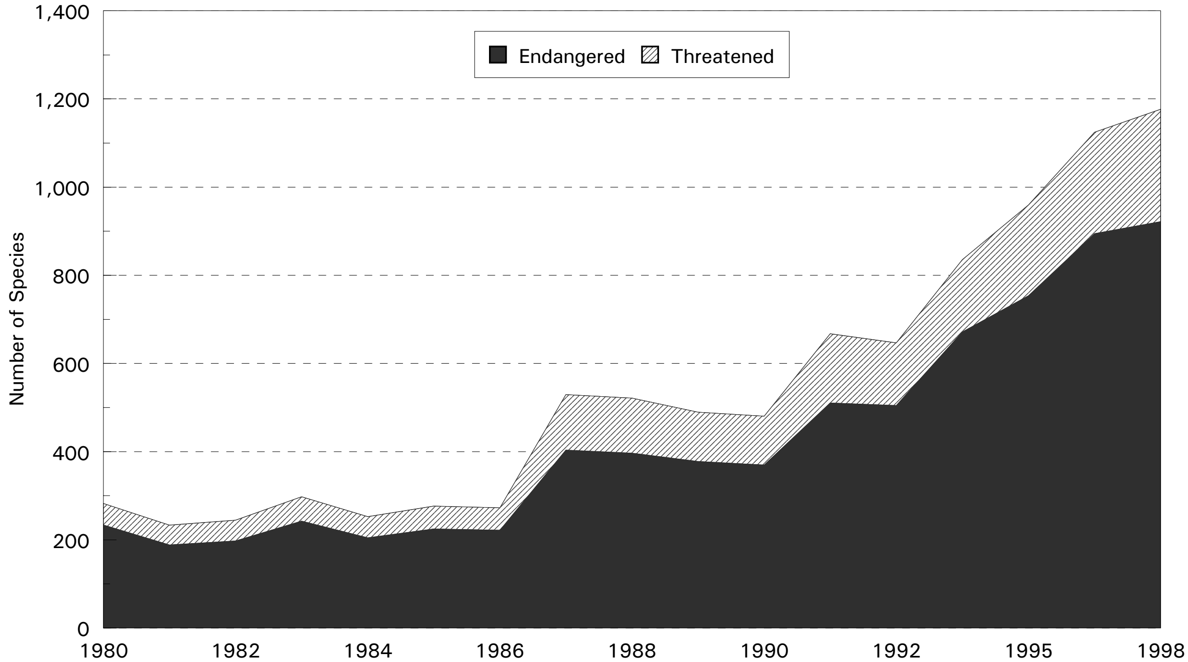
The number of species officially designated by the United States Fish and Wildlife Service as threatened or endangered has almost quadrupled from 283 species in 1980 to 1,125 in 1997 (figure 86). In Canada, the number of species designated by the Committee on the Status of Wildlife (COSEWIC) as extinct, extirpated, endangered, threatened, or vulnerable[3] has increased from a total of 17 species in 1978 to 307 in 1998 (figure 87). In Mexico, species are classified as endangered, threatened, rare, or needing special protection.[4] The total number of species thought to be at risk (and placed in one or another of these categories) is 1, 399, mostly birds and reptiles (see figure 88). In the United Kingdom, species are classified as extinct, endangered, vulnerable, and rare. The total number of species thought to be at risk (and placed in one or another of these categories) has increased from just over 1,500 in 1983 to almost 3,000 species in 1997. Most of these species are plants and insects (see figure 89).

Although the number of species identified as endangered in the United States, the United Kingdom, and Mexico exceeds greatly the number identified in Canada, it is unclear whether this reflects any actual differences in the number of endangered species. These numbers may only reflect differences between the definitions in one country or the other of what constitutes an endangered species. In addition, definitions within each country have changed over time and now include more species. 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 one-half of the species listed are plants (figure 90), and the Fish and Wildlife Service has identified an additional 3,500 species as candidates for listing (Mann and Plummer 1992: 52).

In Canada, there are over 120 government and private programs that address wildlife issues (Environment Canada 1991c: (6)20–3). The Committee on the Status of 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 91 shows the trends in species listings. Since 1986, plants have been the largest category of the species listed. Figure 92 shows the trends in species listings in the United Kingdom.

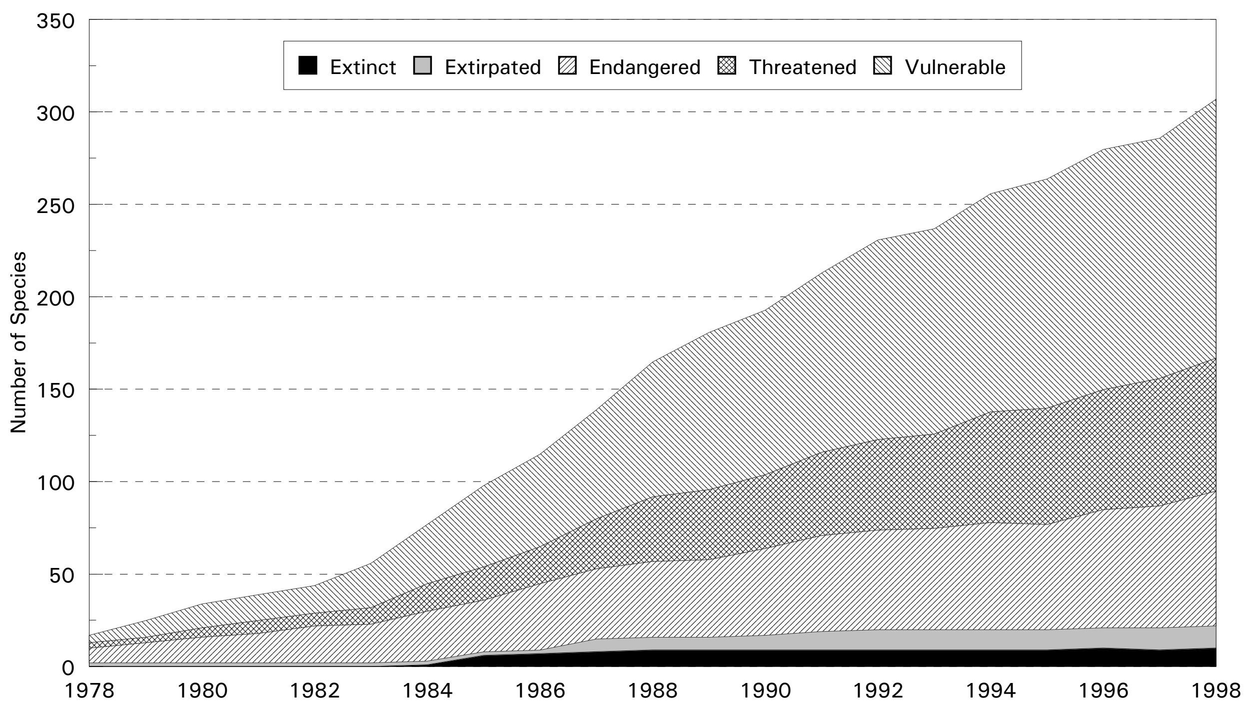
There are many problems in using wildlife as an indicator when assessing environmental quality. For example, the practice of relating the number of species that are becoming extinct to the amount of habitat destruction is a topic that is hotly disputed in the scientific community (Edwards 1995: 211–65). In addition, there is uncertainty associated with the classification of species as endangered and with the distinction between a species and a subspecies.[5] 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 the protection of species and habitat.

**Figure 86: Wildlife Thought to be at Risk in the United States**



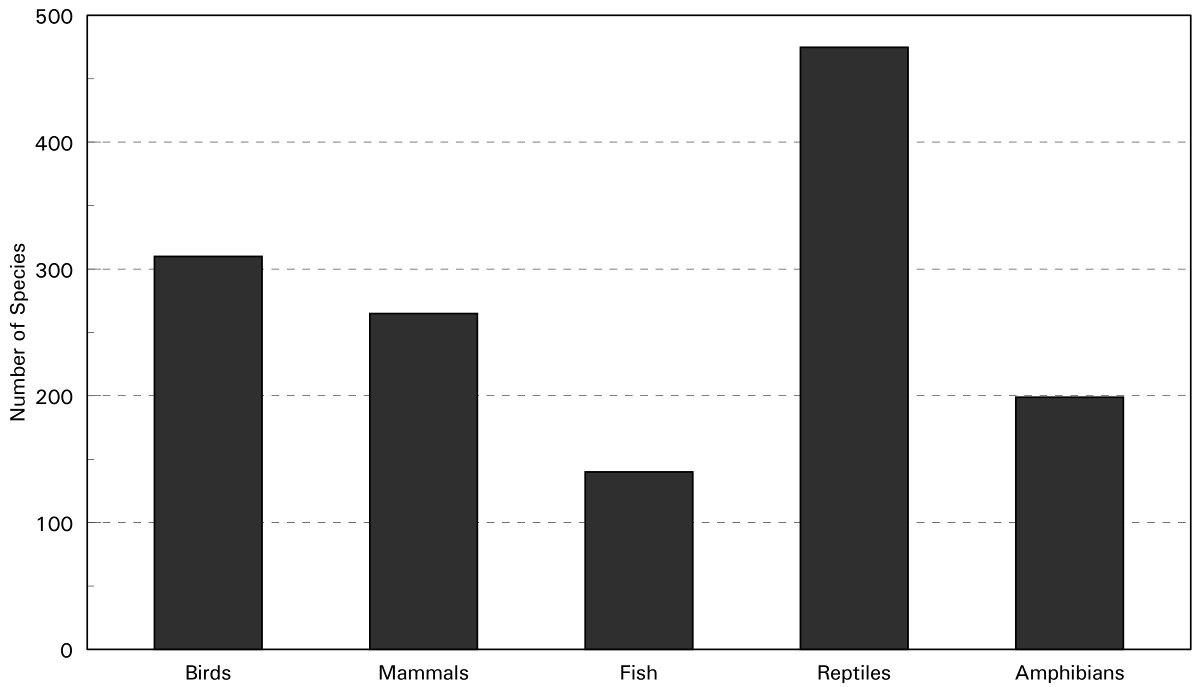

Source: US Fish and Wildlife cited in Council on Environmental Quality 1996.

**Figure 87: Wildlife Thought to Be at Risk in Canada**



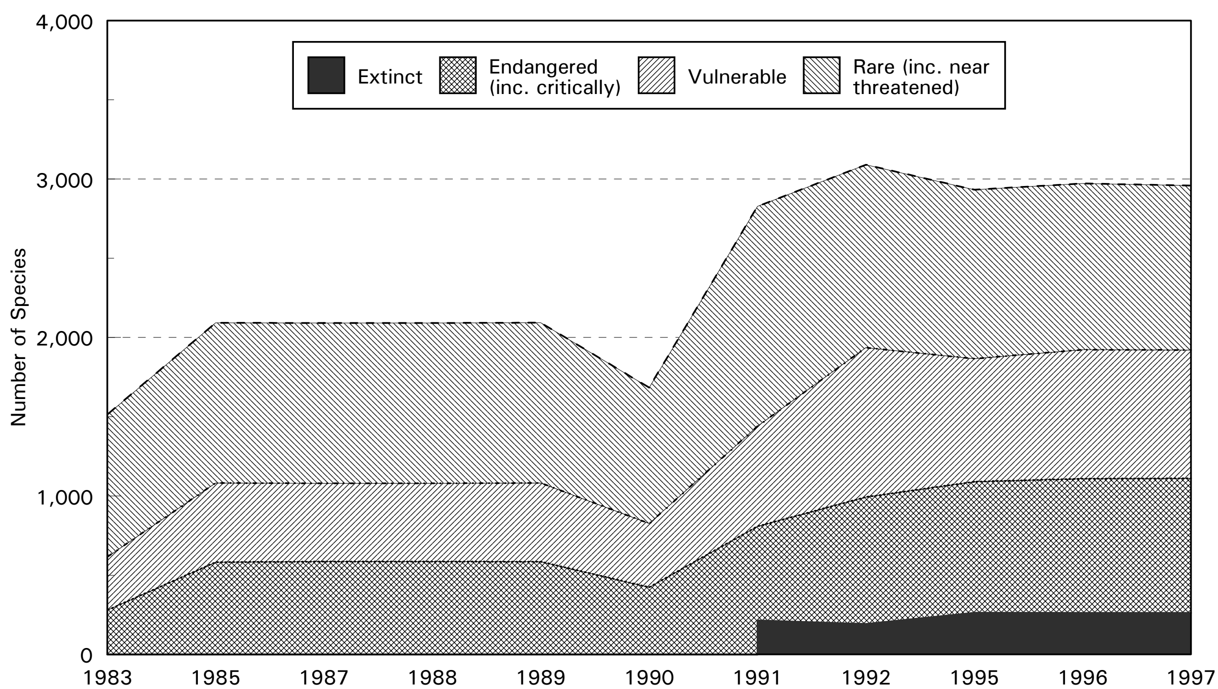

Sources: COSEWIC 1995; COSEWIC in Environment Canada 1996c; COSEWIC in WWF 1997.

**Figure 88: Species Thought to Be at Risk in Mexico in 1997**



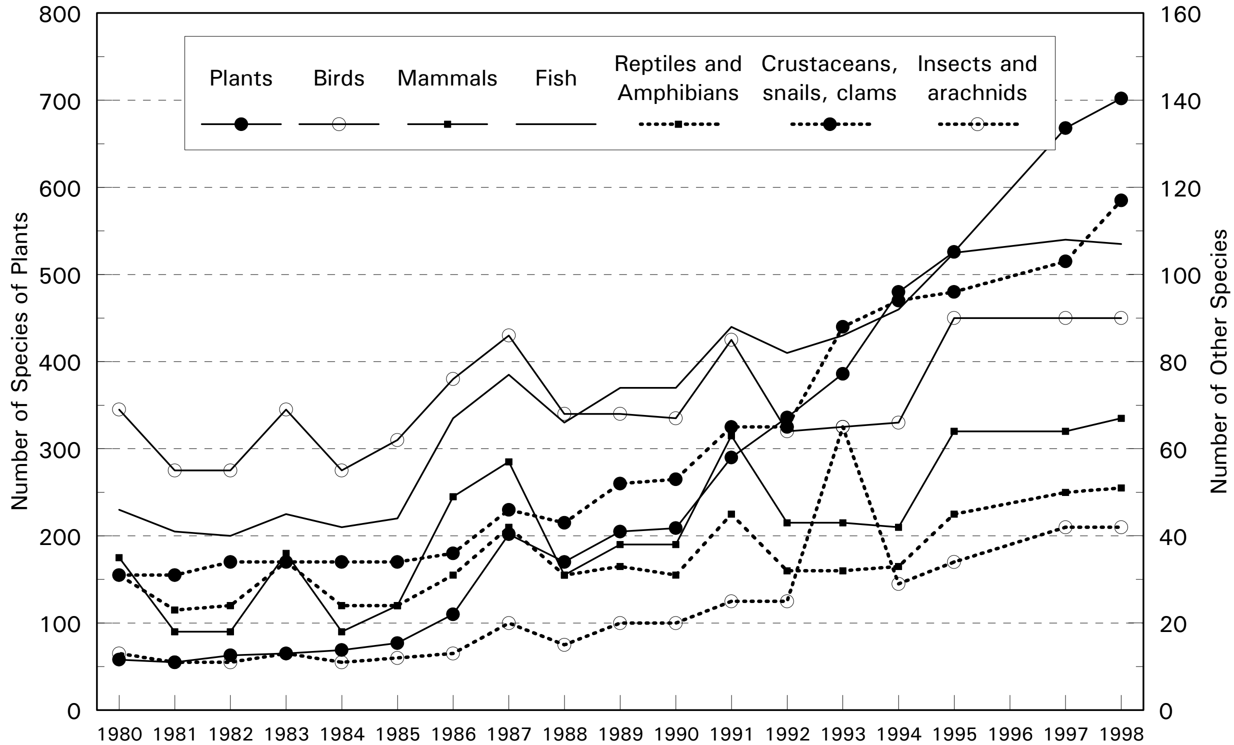

Source: INE Website
Note: Mammals include marine mammals; fish are freshwater.

**Figure 89: Wildlife Thought to Be at Risk in the United Kingdom**



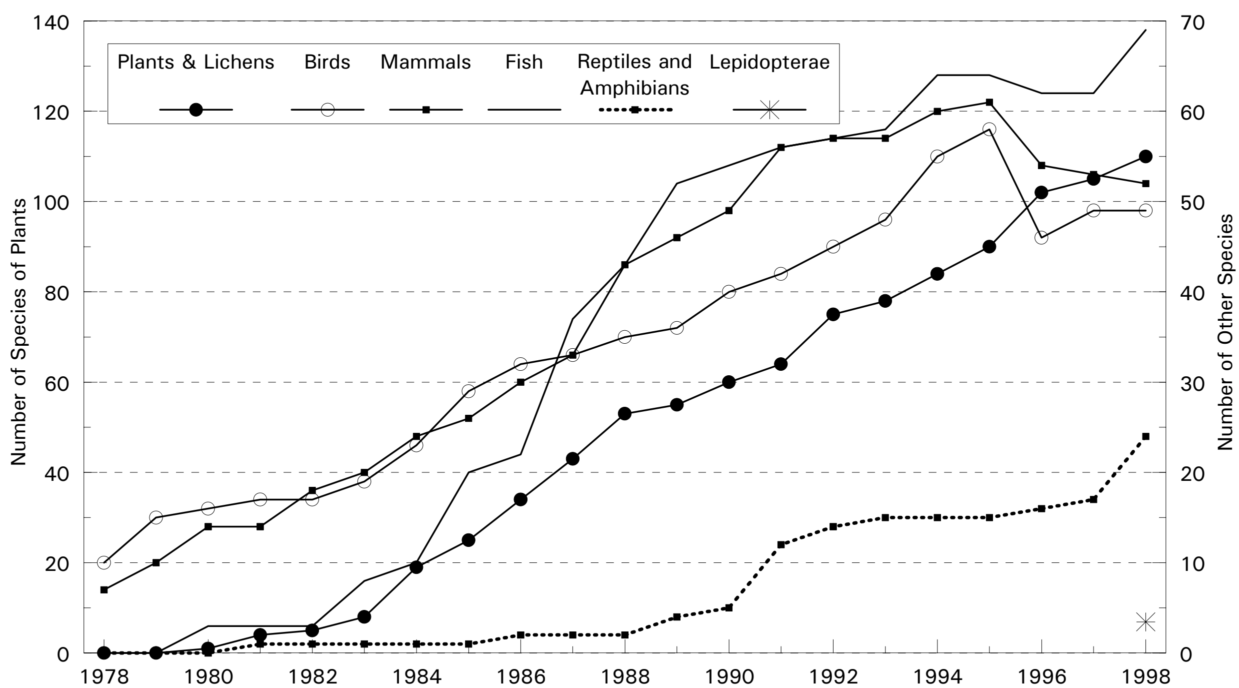

Source: DES
Note: data available for the shown dates only; data from 1991–1997 are incomplete.

**Figure 90: Species Thought to be at Risk in the United States**



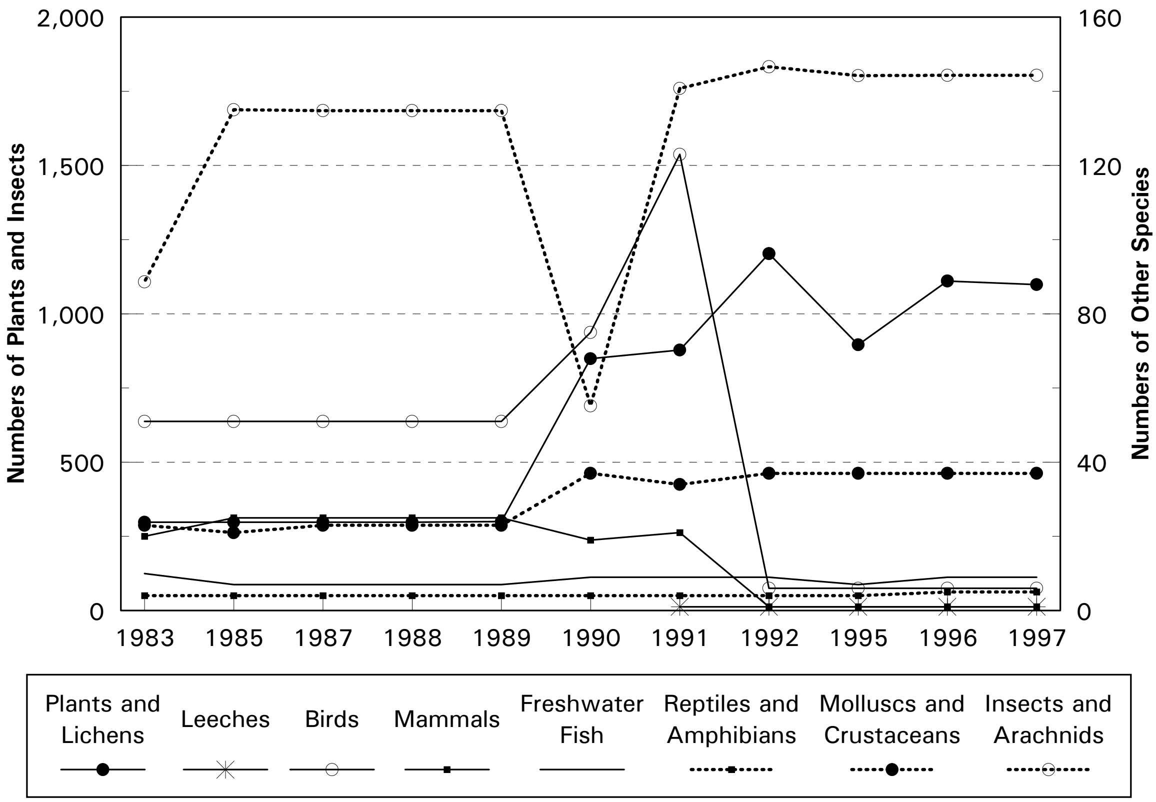

Sources: US Fish and Wildlife 1994; Council on Environmental Quality 1996.
Note: designated wildlife includes endangered and threatened categories; data are unavailable for 1996.

**Figure 91: Species Thought to Be at Risk in Canada**




Sources: COSEWIC 1995, cited in Environment Canada 1996c, cited in WWF 1997, 1998.
Note: wildlife includes extinct, extirpated, endangered, threatened, and vulnerable; lepidopterae were added in 1998.

**Figure 92: Species Thought to be at Risk in the United Kingdom**




Source: UKDETR 1998a.
Note: Data for Mammals and Birds 1991–1997 are incomplete.