S&E SCIENCE AND THE ENVIRONMENT Bulletin
JANUARY 1998

THE SCIENCE OF SMOG:

Human health will benefit from even slight improvements in air quality

The first comprehensive review of the state of Canadian science on ground-level ozone has been published as the *Canadian 1996 NO_x/VOC Science Assessment*. The newly published review shows that human health will benefit from even the slightest improvements in concentrations of ground-level ozone, a major component of smog.

Ground-level ozone is formed from the nitrogen oxides (NO_x) and volatile organic compounds (VOC) found in emissions from vehicle exhaust and industrial processes. As well as posing health risks to humans, ground-level ozone also reduces the productivity of agricultural crops and has significant effects on the health of Canada's forests.

One of the Science Assessment's key findings is that there is no discernible level at which human health is not affected by ground-level ozone. This means the current Canadian objective of 82 parts per billion (ppb) averaged over one hour – one of the most stringent guidelines in the world – does not fully protect human health and vegetation. In areas of Canada with the most severe ozone problem – parts of the Lower Fraser Valley, Ontario, Quebec, and the Atlantic provinces – levels during hot spring and summer months have been more than twice 82 ppb.

The Assessment also found that NO_x/VOC emissions reduction strategies will likely have to be different for each of the ozone problem areas in Canada. Because of geographic and meteorological factors, and the way emissions are distributed through the atmosphere, reducing both NO_x and VOC emissions will benefit large urban areas, while reduction of NO_x

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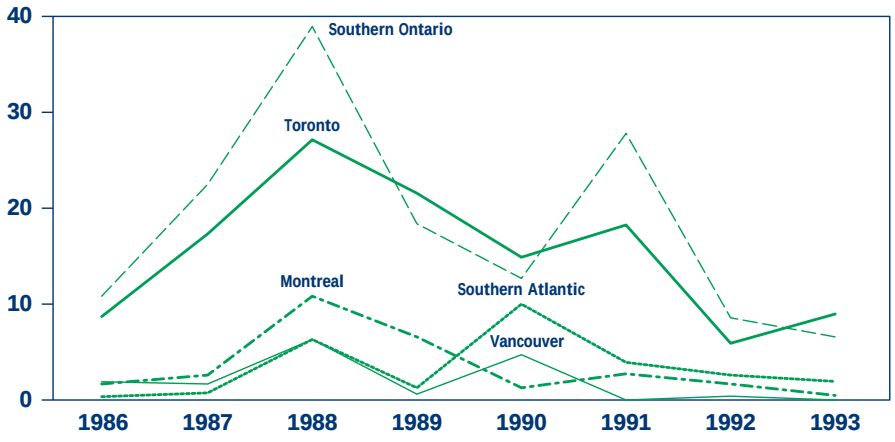
Yearly Average Days with Ozone > Canada's current objective: 82 ppb, by region (1986-93)



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For information: email Roger.White@ec.gc.ca or contact: Environment Canada Inquiry Centre 1-800-667-6868

S&E is at www.ec.gc.ca/science

continued

will benefit the non-urban areas. Overall, it is clear that in all areas, large emissions reductions are needed just to meet the current 82-ppb one-hour ozone objective.

In addition to reducing domestic emissions, the Canadian smog problem requires international action. The Assessment shows transboundary smog from the United States affects Canadian centres, and improvements in U.S. air quality are needed at the same time as Canadian actions. The responsible agencies should maintain support for the monitoring network that keeps track of air quality, and continued support is needed for research on the unanswered policy questions. The review supports smog policy through the Federal Smog Management Plan.

SMOG & HEALTH

Did You Know?

A variety of studies and reports have examined the impacts of smog on health. Some indicate that by reducing Canadian smog-related emissions by 10-15%, and U.S. smog reductions of 15%:

- 243 premature deaths a year would be avoided;
- 130,000 asthma-symptom days and 8,000 emergency room visits a year would be avoided; and
- annual health benefits valued at over $1.5 billion would be realized.

Reducing smog emissions would also decrease the costs from crop damage. Estimates from the ornamental plant industry alone total up to $70 million annually in southern Ontario and $9 million in the Lower Fraser Valley of British Columbia.

CLIMATE CHANGE: IMPACTS ON CANADA

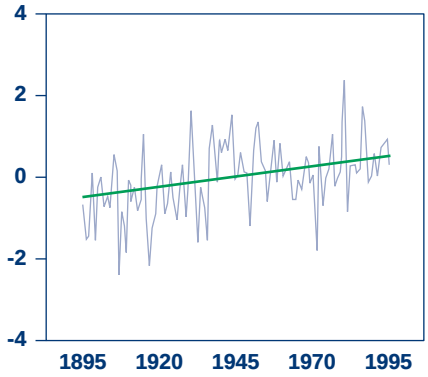
The impact of climate change on water resources will be key to defining what the overall impacts of climate change could be.

Canada is bordered by three oceans and contains nine per cent of the world's renewable freshwater. No wonder, then, that water plays a central role in many economic and social functions.

Environment Canada scientists have examined how climate change could affect Canada's water resources, as part of the **Canada Country Study** series. They found that climate change is expected to directly affect both the quantity of water available and its quality, creating competing demands for this resource from multiple sectors.

With climate change, precipitation is expected to increase with more intense local precipitation events. At the same time, in some regions of southern Canada, including the southern Prairies and Great Lakes, higher temperatures will increase evaporation. Overall these conditions would result in lower lake levels and changes in runoff and streamflow, along with decreases in groundwater levels and soil moisture in southern Canada. Climate change scenarios for the Great Lakes-St. Lawrence Basin suggest potential water level decreases of 20 centimetres to 2 metres. Annual runoff in the Basin could decrease 2 to 54 per cent. Warmer temperatures will also melt permafrost in northern Canada and reduce the length of time that ice covers Canadian lakes and rivers.

Annual National Long-Term Temperature Trend 1895-1995



Decreasing water supplies would have repercussions throughout Canada. For example:

- In agricultural areas, such as the Prairies, there may not be enough water to meet the growing needs for irrigation.
- Lower lake levels and streamflows could reduce habitats for freshwater fish, while higher water temperatures may affect many fish species.
- Lower lake levels could affect hydroelectric power generation capabilities in some areas.
- Lower water levels in the Great Lakes and St. Lawrence River could affect the cargo-carrying capacity of commercial vessels, although warmer winter temperatures could extend the shipping season.

Today, close to $1 billion is spent each year in the water resources sector adapting to climate variability. Climate change will likely increase these expenditures considerably.

Climate Change on Environment Canada's Green Lane: www.ec.gc.ca/climate/index.html

Global Climate Change

PERSISTENT ORGANOCHLORINES:

Certain persistent toxic contaminants continue to decline in the range of 68-91 per cent since 1970, in the eggs of Double-crested Cormorants.

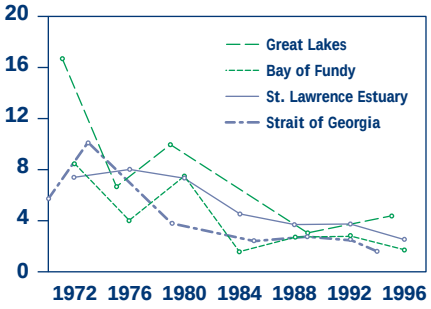
The updated *Environmental Indicator Bulletin: Toxic Contaminants in the Environment, Persistent Organochlorines* has been released. The Double-crested Cormorant is used as a national indicator of persistent organochlorine levels because of its broad distribution across southern Canada, especially in areas of concentrated human activity, and because it is a top predator that eats fish. Environment Canada's Canadian Wildlife Service monitors four main breeding areas: the Strait of Georgia (B.C.), the Great Lakes, the St. Lawrence Estuary and the Bay of Fundy (Atlantic Canada). Similar contaminants in the Arctic will be the subject of a separate Environmental Indicator Bulletin.

Persistent chemical compounds, such as many organochlorines, do not break down easily in ecosystems – it can take decades or even centuries for them to disappear naturally. Because of persistence and high solubility in fat, organochlorines tend to accumulate in the tissues of some animals. The contaminants are then passed through food webs and can reach very high concentrations in the tissues of top predators.

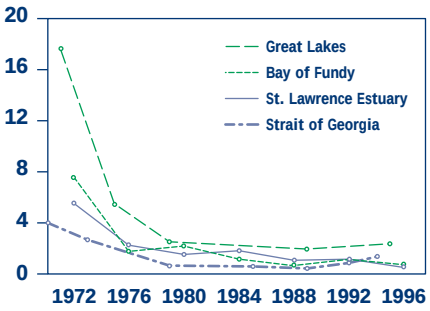
Organochlorines are a family of chemicals that were typically used either as insecticides (such as DDT, most uses of which were banned in Canada in the mid-1970s), or in various industrial applications (such as PCBs, which were formerly used in hydraulic fluids, electrical transformers, and a wide variety of other products). Polychlorinated dioxins and furans are not intentionally manufactured but are formed in various combustion processes (in sources such as incinerators and power boilers) and as by-products of certain industrial processes (such as the chemical processes that occurred in kraft pulp mills that used chlorine bleaching processes).

According to the Indicator Bulletin, concentrations of DDE (the main breakdown product of DDT) in Cormorant eggs have declined substantially since the 1970s. The decline has leveled off somewhat in recent years. Experts suggest that this is because of the slow release of contaminant residues from bottom sediments, and long-range atmospheric transport from countries still using DDT. In contrast, the trend decline of PCB levels in Double-crested Cormorant eggs has been inconsistent, with some increases during the 1990s at a couple of the monitoring locations. This is likely because of the release of PCBs still in use, the escape of PCBs from storage and dump sites, and the long-range transport of PCBs from other countries.

Concentration of PCBs in Double-crested Cormorant Eggs



Concentration of DDE in Double-crested Cormorant Eggs

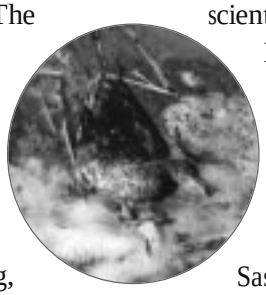


Levels of dioxins and furans declined significantly in the Strait of Georgia breeding area from 1973 to 1994, reflecting changes in the chlorine bleaching process used by local pulp and paper mills. Regulations under the Canadian Environmental Protection Act required the elimination of dioxins and furans from the effluent of all mills using chlorine bleaching. Scientists are already seeing beneficial results from the regulations – discharges from Canadian pulp mills declined dramatically, from 450 grams (per year) in toxic equivalents in 1988 when the problem was first identified, to 5 grams (per year) in 1995.

AVIAN BOTULISM

As many as half a million ducks and other birds died at Old Wives Lake, Saskatchewan, this summer and fall because of avian botulism, one of the most serious diseases affecting migratory waterfowl.

In some years, avian botulism kills millions of waterfowl. Research shows outbreaks tend to occur in water bodies with little or no flow, often when water levels are higher than normal. The birds probably ingested a toxin produced by a bacterium found in the soil of lakebeds that causes flaccid paralysis, or "limber neck." The birds died from drowning, because they could not lift their heads out of the water, or from respiratory failure caused by the poison, or because their inability to lift their heads made them vulnerable to predators.



The bacterium that causes avian botulism grows and produces toxin in decaying organic matter, particularly in the carcasses of vertebrates. The toxin is ingested by maggots and other carrion-feeding invertebrates, which in turn are eaten by birds, resulting in paralysis.

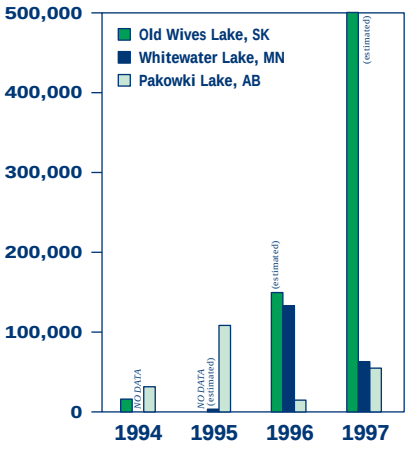
The largest outbreaks in Canada have been at Old Wives Lake in Saskatchewan, Whitewater Lake in Manitoba and Pakowki Lake in Alberta. Many of the birds killed were Northern Pintails and some other shorebirds that are the object of considerable ongoing conservation concern and effort.

Current efforts to control the problem focus on collecting and disposing of carcasses, so that they do not cause more toxin to be produced. Environment Canada scientists in the Prairie and Northern Region are working with counterparts at the National Water Research Institute in Burlington, as well as the University of Saskatchewan, the Canadian Cooperative Wildlife Health Centre, the Institute for Wetland and Waterfowl Research, Ducks Unlimited Canada, Saskatchewan Environment and Resource Management and the California Waterfowl Association to try to better understand the dynamics of the disease. Their research is directed at identifying environmental factors which might trigger the disease, estimating impact on population, determining the effectiveness of carcass collection in reducing mortality and assessing the feasibility of treatment for selected species during outbreaks.

As well, an avian botulism working group, composed of international experts, is evaluating current knowledge about the disease and management alternatives and is to recommend future actions.

http://www.mb.ec.gc.ca/ENGLISH/LIFE/MIGBIRDS/AVIANB/ab_home.html

Bird Carcasses Collected (or Estimated) during outbreaks of Avian Botulism on Canadian Prairie Lakes (1994-97)



Facts & Figures

The detection by the Canadian Wildlife Service of chlorinated dioxins and furans in birds, part of broader monitoring efforts of fish and other biota, has resulted in efforts to clean up these toxic chemicals in fish and water downstream from Canada's pulp and paper operations.

Research by the Canadian Wildlife Service in the 1960s and 1970s on the impact of pesticides on wildlife was instrumental in efforts to ban DDT.

In its 50-year history, the Canadian Wildlife Service has been involved in establishing a network of more than 11 million hectares of protected areas for wildlife.

The number of Whooping Cranes in Canada has increased from 21 in the 1940s to about 350 today, due to the research efforts and recovery plans developed as an integral part of the work of the Canadian Wildlife Service.