



Environment
Canada

Environnement
Canada

www.ec.gc.ca



Environment Canada's National Environmental Specimen Banks

Following a Chemical Trail from the Past

The Problem

PCBs and DDT are well-known examples of chemicals once used widely and released to the environment, then later discovered to pose serious risks to human and wildlife health. Although efforts to screen new compounds for potential risks have improved significantly, all possible effects of new substances cannot be predicted with complete certainty.

Pesticides, preservatives and fire retardants are all compounds that Canadians depend upon daily. New chemicals are introduced each year, and while most are beneficial and harmless, some may not be. Environmental scientists, regulators and other decision makers need tools to reduce uncertainty and support better risk assessment to protect the health of Canadians and their environment.



Photo: Clive Hodder

Herring gull eggs in a nest being collected for the National Wildlife Specimen Bank

Canada

Seeking Solutions through S&T

National Wildlife Specimen Bank

Established in the 1960s, maintained in Ottawa, Ontario, at the National Wildlife Research Centre.

Tissues of over 90 000 specimens from over 800 species, including 77% birds, 9% mammals, 14% other (i.e., fish and amphibians).

Primarily preserved in an environmentally controlled facility at -40°C and -80°C in a series of freezers and liquid nitrogen vapour phase. A full database inventory is maintained for efficient access.



Photo: Mandi Clark

Labelled specimen jars used in long-term storage of tissues collected

National Aquatic Biological Specimen Bank

Established in 1977, maintained in Burlington, Ontario, at the Canada Centre for Inland Waters.

Over 52 000 samples from more than 50 species of fish and various aquatic invertebrates.

Cryo-preserved in an environmentally controlled facility at -80°C in a series of freezers. A full database inventory is maintained for efficient access.



Photo: Mike Keir
 -80°C freezers

Environment Canada's tissue specimen banks, the National Wildlife Specimen Bank and the National Aquatic Biological Specimen Bank, are such tools. In the 1960s and 1970s, the Government of Canada established a range of monitoring programs in response to concerns about chemicals in the environment. Samples of fish, bird and mammalian tissues collected as part of these programs became the first specimens stored in what are now Environment Canada's tissue specimen banks. Today, over 100 000 samples are stored, with more added every year.

Over time, advances in scientific methods have made it possible to detect diverse compounds at lower concentrations. Canadian scientists can now apply new methods to archived tissues from the past three decades and determine when a particular compound first became a problem in the environment and to what degree it is persistent and bioaccumulative—essential information for determining the level of risk to human and ecosystem health. Retrospective analysis also allows scientists to identify changes in food web contaminant pathways caused by changes in land use, invasive species or climate change—also essential for assessing risk to our environment.

Transforming Knowledge into Action

Who can use these results?

Policy and decision makers need science to support government initiatives such as the Chemicals Management Plan, a strategy designed to reduce the impact of chemicals on environmental and human health. Retrospective analysis of archived tissues can produce a 10-year timeline for a compound in a matter of months, capitalizing on historical sampling to produce current-day information.

The tissue archives have also proved a valuable resource for scientists working collaboratively on diverse kinds of environmental issues. For example, many projects in the Great Lakes supporting the Canada–U.S. Great Lakes Water Quality Agreement use samples from the National Aquatic Biological Specimen Bank to assess potential impacts of emerging chemicals of concern. Similarly, agencies such as the U.S. Geological Survey have used samples from the National Wildlife Specimen Bank for research on migratory patterns and population structure of breeding and wintering mergansers and other species.

Benefits to Canadians

Environment Canada's National Wildlife Specimen Bank and National Aquatic Biological Specimen Bank bring environmental benefits to Canadians by providing an important resource to hasten new regulations and legislation to reduce and eliminate harmful compounds.

Beyond this, the tissue archives also bring considerable economic benefit to Canadians. Scientists can study decade-long trends in a very short period, providing timely results while reducing the need for costly sample collection. By examining a chemical as it moves through a food web, implications to human and ecosystem health can be quickly ascertained. This means policy makers can take action promptly to deal with a newly identified threat, rather than having to wait several years for further monitoring and analysis. In this way, specimen banks act as an "early warning" system for harmful substances in the ecosystem.



Photo: Daryl McGoldrick

Environment Canada scientists lifting gill nets to collect lake trout aboard the CCGS Kelso



More generally, these specimen collections benefit Canadians in bringing new and important opportunities to Canadian science. The multi-decade, multi-species nature of the samples will support new uses for the specimen banks such as studies of genetic changes within a species over time and impacts of invasive species in water bodies. Applications such as these will ensure the specimen banks will continue to contribute to major advances in scientific knowledge and remain vitally important to assessing risks to environmental and human health.

Photo: Bruce Szczechowski
Herring gull (*Larus argentatus*), adult and chick, from the Laurentian Great Lakes

The Case of Polybrominated Diphenyl Ethers

Brominated flame retardants such as polybrominated diphenyl ethers (PBDEs) have been in industrial use in North America for decades. Global demand for PBDEs in 2001 rose to over 67 000 tonnes, the Americas constituting 59% of that total.

Certain PBDEs have been found to affect the nervous system and disrupt hormones, particularly in estrogen and thyroid pathways. They are found throughout the environment and have been detected in human tissues including fat and breast milk, as well as in the food supply of humans and wildlife.

PBDE concentrations were examined in polar bear tissues and herring gull egg samples collected and stored in the National Wildlife Specimen Bank. This analysis provided evidence of bioaccumulation and biomagnification of these compounds within marine food webs.

Fish tissues from the National Aquatic Biological Specimen Bank were first used to investigate levels and multi-year trends of PBDEs in lake trout from the Great Lakes. Concentrations of PBDEs were found to have peaked in the mid-1990s, and to have been in gradual decline since industries began to phase out their use in anticipation of regulations.

With the specimen banks, scientists were able to develop a 30-year trend for the presence of PBDEs in the Canadian environment. Without them, it would have taken significantly longer to amass the information needed for assessment and regulation.

This information, published by Environment Canada scientists, was used in an ecological screening assessment report published in March 2009 that led to a revised Risk Management Strategy for PBDEs. The revised strategy broadens controls restricting PBDEs in manufactured and imported products to include nona- and deca-BDE.

Chemical Studies Using the Archives

National Wildlife Specimen Bank

- Lead in water birds—studies contributed to lead shot and sinker regulations for recreational hunting and fishing
- PCB concentrations in Great Lakes herring gull eggs
- Dioxins in cormorants and great blue herons in British Columbia and Quebec—studies led to voluntary changes to bleaching technologies, in-mill processes and effluent treatment at pulp mills which were enforced with Canada-wide legislation in 1993
- Organochlorine and metal contaminants in seabirds from Atlantic, Pacific and Arctic coasts
- Organochlorines and metabolites in polar bears—three collections in the 1960s, 1970s and 1989–1994
- Mercury in loon carcasses and unhatched eggs demonstrated a west-to-east gradient of increasing mercury exposure in this species

National Aquatic Biological Specimen Bank

- Brominated flame retardants in aquatic food webs of the Great Lakes
- Investigation of bioaccumulation and magnification of legacy persistent organic pollutants including organochlorine pesticides (DDT, chlordane, hexachlorobenzene, etc.), PCBs, and several metals including mercury
- Bioaccumulation of perfluorooctane sulfonate (PFOS)—study led to regulation of PFOS in Canada and the listing of PFOS in 2009 for virtual elimination from the Canadian environment
- Study of polychlorinated naphthalenes (PCNs) trend in Lake Ontario trout found PCNs have declined significantly since the early 1980s but can still contribute to toxicity in lake trout

For more information:

Canada's National Aquatic Biological Specimen Bank and Database (NABSB)—details on the NABSB specimen collection online on the National Water Research Institute website

www.ec.gc.ca/inre-nwri/default.asp?lang=En&n=D488F7DE-1

Government of Canada Chemicals Management Plan

www.chemicalsubstanceschimiques.gc.ca/plan/index-eng.php

Government of Canada Chemical Substances website

www.chemicalsubstanceschimiques.gc.ca/index-eng.php

Canadian Environmental Protection Act, 1999—Ecological Screening Assessment Report on Polybrominated Diphenyl Ethers (PBDEs), June 2006
[www.ec.gc.ca/CEPARRegistry/documents/subs_list/PBDE_SAR/PBDEs_SAR_EC_June_2006_\(en\).pdf](http://www.ec.gc.ca/CEPARRegistry/documents/subs_list/PBDE_SAR/PBDEs_SAR_EC_June_2006_(en).pdf)

Canada Gazette—Polybrominated Diphenyl Ethers Regulations

www.gazette.gc.ca/rp-pr/p2/2008/2008-07-09/html/sor-dors218-eng.html

Braune, B.M. and M. Simon. 2003. Dioxins, furans and non-ortho PCBs in Canadian Arctic seabirds. *Environ. Sci. Technol.* 37(14): 3071–3077.

Gauthier, L.T., D. Potter, C.E. Hebert and R.J. Letcher. 2009. Temporal trends and spatial distribution of non-polybrominated diphenyl ether flame retardants in the eggs of colonial populations of Great Lakes herring gulls. *Environ. Sci. Tech.* 43: 312–317.

Gebbink, W.A., C.E. Hebert and R.J. Letcher. 2009. Perfluorinated carboxylates and sulfonates and precursor compounds in herring gull eggs from colonies spanning the Laurentian Great Lakes of North America. *Environ. Sci. Tech.* 43: 7443–7449.

Gewurtz, S.B., R. Lega, P.W. Crozier, D.M. Whittle, L. Favez, E.J. Reiner, P.A. Helm, C.H. Marvin and G.T. Tomy. 2009. Factors influencing trends of polychlorinated naphthalenes and other dioxin-like compounds in lake trout (*Salvelinus namaycush*) from Lake Ontario, North America (1979–2004). *Environ. Toxicol. Chem.* 28: 921–930.

Ismail, N., S.B. Gewurtz, K. Pleskach, M. Whittle, P.A. Helm, C.H. Marvin and G.T. Tomy. 2009. Brominated and chlorinated flame retardants in Lake Ontario, Canada, lake trout (*Salvelinus namaycush*) between 1979 and 2004 and possible influences of food-web changes. *Environ. Toxicol. Chem.* 28: 910–920.

Luross, J.M., M. Alae, D.B. Sergeant, C.M. Cannon, D.M. Whittle, K.R. Solomon and D.C.G. Muir. 2002. Spatial distribution of polybrominated diphenyl ethers and polybrominated biphenyls in lake trout from the Laurentian Great Lakes. *Chemosphere* 46: 665–672.

Martin, J.W., D.M. Whittle, D.C.G. Muir and S.A. Mabury. 2004. Perfluoroalkyl contaminants in a food web from Lake Ontario. *Environ. Sci. Technol.* 38: 5379–5385.

Muir, D.C.G., S. Backus, A.E. Derocher, R. Dietz, T.J. Evans, G.W. Gabrielsen, J. Nagy, R.J. Norstrom, C. Sonne, I. Stirling, M.K. Taylor and R.J. Letcher. 2006. Brominated flame retardants in polar bears (*Ursus maritimus*) from Alaska, the Canadian Arctic, East Greenland, and Svalbard. *Environ. Sci. Technol.* 40: 449–455.

Weech, S.A., A.M. Scheuhammer and J.E. Elliott. 2006. Mercury exposure and reproduction in fish-eating birds breeding in the Pinchi Lake region, British Columbia, Canada. *Environ. Toxicol. Chem.* 25: 1433–1440.

Science and Technology into Action to Benefit Canadians

***S&T into Action to Benefit Canadians* tells the story of Environment Canada's success in generating tangible environmental, social and economic benefits. This series of research impact studies demonstrates how S&T influences the environmental decision-making process by supporting regulations, guidelines, strategies, policies, programs and management decisions.**

The *S&T into Action Series* is available online: www.ec.gc.ca/scitech

Tel. 905-315-5228

Fax 905-336-4420

Banner photo credits: Environment Canada, Erik Enderson, Brian Trapp

Aussi disponible en français

© Her Majesty the Queen in Right of Canada, represented by the Minister of the Environment, 2010.

Catalogue No.: En4-135/1-2010E; ISBN 978-1-100-16269-0