Guidelines at a Glance

Canadian Tissue Residue Guidelines

Dioxins and Furans

This fact sheet describes the Canadian Tissue Residue Guidelines for dioxins and furans to protect wildlife consumers of aquatic biota. It is part of the series *Guidelines at a Glance*, which summarizes information on toxic substances and other parameters for which there are Canadian Environmental Quality Guidelines.

The National Guidelines and Standards Office of Environment Canada coordinates the development of Canadian Environmental Quality Guidelines in cooperation with the Canadian Council of Ministers of the Environment (CCME).

Where do dioxins and furans come from?

Dioxins and furans are chemical compounds that contain chlorine and can occur in 210 different configurations, called congeners. Dioxins and furans do not have a known use. They are produced unintentionally by human activities, including waste incineration, chemical manufacturing, petroleum refining, fuel combustion in vehicles, wood burning, and electric power generation. In the past, pulp and paper mill effluents were a major source of dioxins and furans, but regulations that came into effect in 1992 significantly reduced this source. Dioxins and furans are also produced by natural events such as forest fires and volcanic eruptions. In 1997, nearly half of the dioxin and furan load to Canada's environment was through releases to the atmosphere from combustion sources. Atmospheric transport can occur over long distances, taking dioxins and furans far from their original source.

Dioxins and furans are considered toxic under the Canadian Environmental Protection Act, and federal toxic management policies aim to virtually eliminate them from the Canadian environment.

What happens to dioxins and furans released into the environment?

Dioxins and furans are hydrophobic, meaning that they repel water. Because of this characteristic, dioxins and furans released into aquatic environments become attached to organic particles and get into the lipids (fats) of aquatic organisms, including fish, insect larvae, shrimp-like crustaceans, and snails, among others. Aquatic organisms can take up dioxins and furans directly from water or sediment, or they can ingest dioxins and furans by eating contaminated prey. Similarly, wildlife that eat aquatic organisms may accumulate dioxins and furans in their fatty tissues. While levels of dioxins and furans don't seem to magnify in aquatic food webs, there is some evidence that they can magnify in terrestrial food webs.

What effects can dioxins and furans have on fish and other forms of aquatic life?

In mammals, birds, and fish, dioxins and furans bind to a specific protein in their cells and this results in many different effects on the animal. Sensitivity to dioxin and furan exposure varies widely among species: some experience minimal effects when exposed to very high levels while others die when exposed to low levels.

Effects on mammals include decreased food consumption, less weight gain, changes in the size and shape of the liver and other organs, and changes in heart rate and blood pressure. Other problems are hair loss, a suppressed immune system, and changes to the number of blood cells. The fetus and nursing offspring can also have growth and developmental problems. Long-term exposure to dioxins and furans in the diet has been linked to a high incidence of tumors in mammals.

In birds, lower food consumption and lower body weight have been reported as effects of dioxins and furans. Other effects include producing fewer eggs and higher death rates of embryos within eggs. Some bird species, notably bald eagles, seem to be quite tolerant of dioxin toxicity.

In fish, reduced survival and growth rates, reproductive failure, and death have all been found as a result of dioxin and furan exposure.

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Dioxins and Furans

What levels of dioxins and furans are safe for wildlife consumers of aquatic biota in Canadian waters?

A variety of different dioxins and furans typically occur together in the environment, so their combined effects should be considered. Some dioxins and furans are more toxic than others. The Canadian Tissue Residue Guidelines (CTRG) for dioxins and furans are based on the 17 congeners that are thought to be the most toxic. The toxicity of a mixture of dioxins and furans can be expressed by converting the concentrations of each dioxin and furan to an equivalent toxicity of the most toxic one known (the dioxin 2,3,7,8-TCDD). Each converted toxicity is called a dioxin and furan toxic equivalent (TEQ). The TEQs are based on data from measuring the responses of mammals and birds to many different dioxins and furans. The TEQ gives a standardized toxicity for dioxins and furans, and is called TEQ_{mam} when it refers to mammal consumers and TEQ_{bird} when it refers to bird consumers.

The CTRG to protect mammals that consume aquatic biota is 0.71 nanograms of dioxin and furan TEQ_{mam} per kilogram of their prey (wet weight).

The interim CTRG to protect birds that consume aquatic biota is 4.75 nanograms of dioxin and furan TEQ_{bird} per kilogram of their prey (wet weight). In general, birds are less sensitive to the toxic effects of dioxins and furans than mammals.

If the level of dioxin and furan toxic equivalents measured in wildlife prey is less than the corresponding guideline, one would not expect to see adverse health effects in even the most sensitive species. In places where the CTRGs for dioxins and furans are exceeded, adverse effects will not necessarily occur. Whether effects will occur depends on the amount by which the guideline levels are exceeded and the sensitivity of individual species. Further investigation at a particular site and of a particular wildlife consumer is needed to determine whether or not there is a negative impact. Also, some dioxins and furans have toxic effects similar to the effects of some polychlorinated biphenyls (PCBs), which are also synthetic compounds. PCBs often occur together with dioxins and furans at a site, so guidelines for PCBs should also be considered.

How do levels of dioxins and furans in Canadian wildlife consumers of aquatic biota compare to the guidelines?

Most measurements of dioxins and furans in the prey of wildlife consumers have been done at sites with a history of contamination or with a known source of dioxins and furans. These sites are expected to have elevated levels of dioxins and furans. Measurements taken at background sites usually do not detect dioxins and furans in wildlife prey, or the levels measured are below the guidelines.

At freshwater sites, fish and invertebrates had dioxin and furan levels ranging from undetectable to 112 nanograms of dioxin and furan TEQ_{mam} per kilogram of wet weight. When expressed in terms of bird TEQs, freshwater fish and invertebrates had dioxin and furan levels ranging from undetectable to 657 nanograms of dioxin and furan TEQ_{bird} per kilogram of wet weight. For both mammals and birds, one-third of their prey had dioxin and furan TEQ levels within the guideline, with the other two-thirds exceeding the guidelines. Similar results were found when measuring marine species.

How can CTRGs be used to make a difference?

In general, Canadian Tissue Residue Guidelines can be used by Canadian federal, provincial, and territorial governments on a voluntary basis to set local guidelines, for example, for a particular species. CTRGs may also be used to estimate levels in water and/or sediment that would be protective and would not result in accumulation through the food chain. CTRGs are most commonly used in environmental assessments as benchmarks or yardsticks to which measured levels are compared. Anyone can use the guidelines to determine if the level of dioxins and furans measured in wildlife tissues has the potential to cause adverse environmental effects.

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