

Canadian National Dioxin Sampling Program: Dioxins and Furans in Biota near 46 Pulp and Paper Mills using the Chlorine Bleaching Process

D. M. Whittle^a, C. Mageau^b, R. K. Duncan^b, D. B. Sergeant^a, M.D. Nassichuk^c, J. Morrison^b, J. Piuze^a.

- A Department of Fisheries and Oceans, Burlington, Ontario
- B Department of Fisheries and Oceans, Ottawa, Ontario
- C Department of Fisheries and Oceans, Vancouver, British Columbia
- D Department of Fisheries and Oceans, Nanaimo, British Columbia
- E Department of Fisheries and Oceans, Mont-Joli, Québec

The Canadian National Dioxin Sampling Program was initiated in 1988 to determine the extent of dioxin and furan contamination at marine and freshwater sites in the vicinity of pulp and paper mills using the chlorine bleaching process. This national program, coordinated by the federal departments of Fisheries and Oceans, Health and Welfare Canada and Environment Canada, encompassed fish and shellfish, waterfowl and sediment sampling components. Additional site specific investigative programs were undertaken by provincial governments and the pulp and paper industry.

This paper outlines that component of the national program managed by the Department of Fisheries and Oceans which was designed to evaluate the quality and wholesomeness of fish and shellfish caught near pulp and paper mills using the chlorine bleaching process as well as other selected sites. It presents an overview of the methodology and findings of the program from 1988 to the present time, and summarizes the data and fishery resource use information that was collected and provided to Health and Welfare Canada for human health risk assessment purposes. It also describes the fisheries management actions taken in response to the recommendations by Health and Welfare Canada. Fisheries were closed or advisories to limit consumption were issued in instances where consumption risks were identified due to elevated levels of dioxins and furans found in the finfish and shellfish samples. These actions affected commercial, recreational and Native food fisheries in British Columbia, Alberta, Ontario and Quebec.

The potential for detecting areas and species most likely to be contaminated was maximized by the selection of sampling sites and season. Sampling and analytical efforts were primarily directed towards finfish, as well as bivalve and crustacean shellfish of importance to the fisheries. A variety of tissues was analyzed; whole fish, fillets and liver, crustacean shellfish muscle tissue and digestive organs, muscle and whole organism samples of prawn and shrimp as well as whole organism samples of bivalve shellfish.

Analysis was completed with a high resolution gas chromatograph/low resolution mass spectrometer system. Data were quantified using multiple ion descriptors containing 3 ions for each set of isomers. Spike recoveries were calculated using C¹³-labelled internal standards and all data were corrected for spike recoveries. Lipid concentrations were determined for each sample with a chloroform-methanol solvent extraction (6-8 hour) technique on the homogenate subsample. All samples were subjected to rigorous quality assurance assessment to ensure data confidence and reliability. Quality control and quality assurance samples, which included blind duplicates, laboratory duplicates and reference materials, represented 20-25 percent of the analyses. For each congener group, the 2,3,7,8 substituted isomers were quantified. The results have been stored on a database at the Department of Fisheries and Oceans, Great Lakes Laboratory for Fisheries and Aquatic Sciences in Burlington, Ontario.

All species of fish and shellfish collected in the vicinity of bleached kraft pulp and paper mill discharges accumulated a range of dioxin and furan isomers in muscle tissue samples despite relatively low lipid concentrations of usually less than 5 percent. 2,3,7,8-TCDF, was the most prominent isomer detected. The most contaminated samples were hepatopancreas (digestive organs) tissues of crustacean shellfish. Elevated levels were also found in some whole body tissue homogenates of prawn, shrimp and bivalves, and muscle tissue samples of some finfish. Concentrations in digestive organ samples were consistently greater than those measured in muscle tissue samples analyzed from the same individual shellfish. Shellfish digestive organ tissues are routinely consumed by Canadians of various cultural and ethnic backgrounds. All analyzed samples and tissues have been subjected to the health assessment review process, the results have been publicly released and fisheries closures or consumption advisories have been put in place as necessary to protect all sectors of the Canadian public.

In response to new Canadian government regulatory initiatives, many pulp and paper mills have taken steps to limit the release of dioxins and furans to the environment. The Department of Fisheries and Oceans research efforts are continuing to further understand the process of recovery of contaminated fishery resource stocks and their habitats.