DIOXINS AND FURANS IN COLUMBIA RIVER MOUNTAIN WHITEFISH 1994

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1. Introduction

Preliminary fish tissue studies conducted in 1988 [1], 1989 [2] and 1990 [3] on the Columbia River in the vicinity of a pulpmill at Castlegar, demonstrated elevated levels of dioxin and other pulpmill related compounds, particularly in tissues of mountain and lake whitefish. This species, for reasons likely related to habitat utilization,

appeared to have sufficient levels of dioxins and furans to be of a concern from a human health point of view. The results of these early studies were reviewed by Health Canada and the BC Ministry of Health local Medical Health Officer, who later issued a consumption advisory on mountain and lake whitefish in January 1991.

As a result of improvements in pollution control works and process changes, levels of dioxins and furans in pulpmill effluent discharged to the Columbia River have steadily declined since 1990 (Figure 1). The federal and provincial government agencies and Celgar have monitored the subsequent recovery and improvement in the receiving environment, and more specifically levels of dioxins and furans in mountain whitefish tissue.

This paper is an update of the BC Environment report *Dioxins and Furans in Columbia River Mountain Whitefish, 1993* [4] and combines the 1994 federal and provincial data for a more comprehensive assessment of whitefish dioxin and furan levels since these studies began in 1988.

2. Methods

In July 1994 adult mountain whitefish (*Prosopium williamsoni*) were collected from two sites on the Columbia River (at Genelle, downstream from the Celgar pulpmill and at Beaver Creek, downstream from the Cominco smelter/fertilizer complex), and from a reference site on the Slocan River (Figure 2). The Department of Fisheries

and Oceans (DFO) analyzed muscle tissue samples from 10 individual fish per site. During the same study the B.C. Ministry of Environment, Lands and Parks (MELP) collected and analyzed 6 individual fish and 2 composite samples consisting of 8 fish each from the Genelle site only. The methods for collection and analysis of fish tissue data, including quality assurance and quality control procedures, can be found in Liebe et al. [4], Nener at al. [5], and Antcliffe et al. [6]

3. Results and Discussion

Figures 3 and 4 summarize the median and interquartile range for concentrations of 2,3,7,8-TCDF and 2,3,7,8-TCDD in Columbia River mountain whitefish muscle tissue from 1990 to 1994. The 1994 data combines the DFO and MELP samples collected at the Genelle site only. Figures 3 and 4 clearly illustrate the decline in concentrations of 2,3,7,8-TCDF and 2,3,7,8-TCDD in fish over the period 1990 to 1994. Results also show that dioxin and furan concentrations are still highly variable, and this may confound statistical interpretation of the significance of the declining trend.

Although the highest concentrations of 2,3,7,8-TCDF and 2,3,7,8-TCDD were found in 1991 data, these data were collected during January, whereas all other data were collected during July. This may indicate seasonal variation in dioxin and furan concentrations or variation associated with sampling methods (Liebe et al. [4]). Results from additional samples collected by DFO in March 1995, when available, will help address this issue of seasonal variation.

Table 1 shows 2,3,7,8-TCDD toxic equivalents (TEQs) calculated using International Toxicity Equivalency Factors (NATO [7]), as well as length and weight data for samples collected from 1990 to 1994. For all non-detectable levels of dioxin or furan, a value of one-half the detection limit was used to calculate the TEQs. The mean TEQs have decreased over time, from a maximum TEQ of 24.1 pg/g in 1990/91 to 5.5 pg/g in 1994.

Concentrations of 2,3,7,8-TCDF in fish from all three sites sampled in July 1994 are shown in Figure 5. For the DFO data (10 individuals per site), analysis of variance revealed significant differences among the three sites in mean concentrations of 2,3,7,8-TCDF, total TCDF, 2,3,7,8-TCDD, total TCDD, 2,3,4,7,8-PCDF, and total PCDF ($p<0.18$) (Lawrence [8]). In all cases, multiple comparison tests revealed that concentrations in fish from the Slocan River reference site were significantly lower than those from the Columbia River at Genelle and Beaver Creek, which did not differ significantly from one another. No statistically significant differences could be found between sampling locations for the remaining dioxin/furan congeners. As well, there were no statistical differences in mean age, fork length, percent lipid content, and condition index for fish collected at these sites by DFO (Lawrence[8]). The only statistically significant difference was in fish weight, as Slocan fish were found to weigh significantly less than fish from Beaver Creek ($p=0.034$)(Lawrence[8]).

Figure 5 also compares the federal and provincial data collected at the Genelle site. Results showed that the mean concentration of 2,3,7,8-TCDF (46.2 pg/g) in the 6 individual samples collected by MELP (MELP-A) was higher than that measured by DFO at Genelle or Beaver Creek (24.32 and 32.87 pg/g 2,3,7,8-TCDF, respectively). The MELP composite samples (MELP-B and MELP-C) however, were much lower than any of the other sites measured on the Columbia River and can probably be explained by the smaller size range of the fish that made up the composites. In addition, age and lipid content may also differ among the data sets and explain these apparent inconsistencies. In summary, both the federal and provincial data continue to document the declining trend in dioxin and furan concentrations in Columbia River mountain whitefish.

4. Conclusions and Recommendations

The upgrading and expansion of the Celgar pulpmill located in Castlegar, B.C. has substantially reduced the loading of dioxins and furans to the Columbia River to the extent that concentrations in final effluent are now below the existing analytical detection limits (at least 10 ppq or parts per quadrillion). Following these improvements the dioxin and furan concentrations in Columbia River mountain whitefish have declined to a level that prompted the local medical health officer to lift the consumption advisory for whitefish. Studies continue to show, however, there is a relatively high level of variability in the data. We therefore recommend that sampling continue for at least several more years to track the declining dioxin concentrations

and variability to confirm there are no human health concerns associated with consumption of this species.

5. References

1) Mah, F., D. MacDonald, S. Sheehan, T. Tuominen, and D. Valiela. 1989. Dioxins and Furans in Sediment and Fish from the Vicinity of Ten Inland Pulp Mills in British Columbia. Environment Canada. 77p.

2) BC Environment, 1989. Analysis of Preliminary Results of a Dioxin/Furan Survey of Columbia River Fishes. BC Ministry of Environment report, April 1990, 11p.

3) Crozier R. 1991. Preliminary report on dioxin and furan levels in Columbia River fish. BC Environment, Nelson, B.C. 192p.

4) Liebe, R., P. Cobban, B. Holms, J. Parchomchuk, T. Tripp, and J. Van Oostdam. 1994. Dioxins and Furans in Columbia River Mountain Whitefish. 1993. BC Environment.

5) Nener, J., D. Kieser, J.A.J. Thompson, W.L. Lockhart, D.A. Metner, and R. Roome. 1995. Columbia River Fish Health Study - July 1992 Report. Can. Tech. Rep. Fish. Aquat. Sci. 2036: in prep.

6) Antcliffe, B.L., D. Kieser, J.A.J. Thompson, W.L. Lockhart, D.A. Metner, and R. Roome. 1995. Columbia River Fish Health Study - July 1994 Report. Can. Tech. Rep. Fish. Aquat. Sci.: in prep.

7) NATO. 1988. International Toxicity Equivalency Factor (I-TEF) Method of Risk Assessment for Complex Mixture of Dioxin and Related Compounds, North Atlantic Treaty Organization (NATO), Committee on the Challenges of Modern Society, Report No. 176.

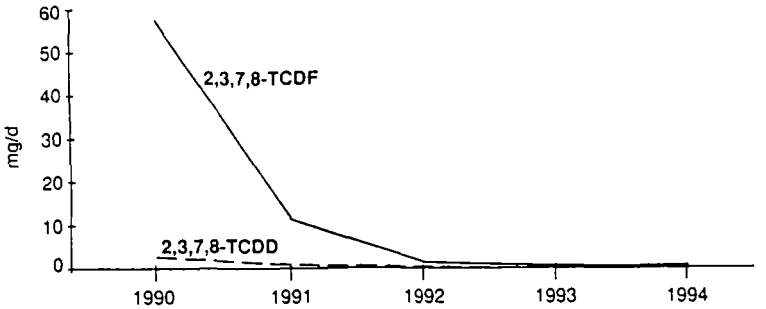
8) Lawrence, G. 1995. Columbia River Fish Health Study 1994: Data Summary and Statistical Analysis of Mountain Whitefish (*Prosopium williamsoni*) Health Related Information. Prepared for the Department of Fisheries and Oceans, Eastern B.C. Unit.

6. Tables and Figures

Table 1 Summary of muscle tissue 2,3,7,8 TCDD TEQ's in mountain whitefish collected between 1989 and 1994 from the Columbia River.

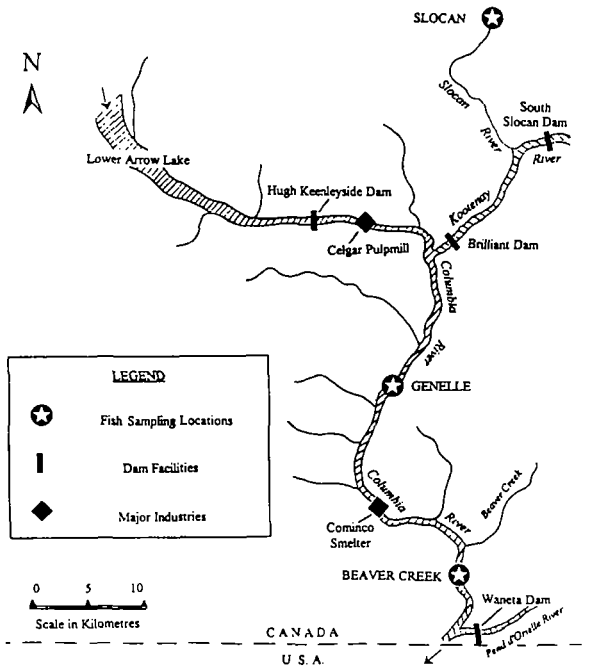
2,3,7,8-TCDD TEQ's (in pg/g)	1989 (BC Environment [3])	1990/91 (Liebe et al. [4])	1992 (Liebe et al. [4])	1993 (Liebe et al. [4])	1994
Mean	15.4	24.1	9.8	6.7	5.5
Range	3.7 - 22.8	2.1 - 59.2	0.9 - 44.9	5.5 - 8.4	0.3 - 34.6
n =	6	37	27	10	26
Weight (in gm)					
Mean	257.5	566	378	475	443.7
Range	185 - 385	336 - 1075	212 - 521	169 - 778	234 - 593
Length (in cm)					
Mean	n/a	34.2	31.8	33.7	33.6
Range	n/a	31 - 46	26 - 36.7	24 - 43.5	27 - 41.8

Figure 1 Average daily discharge loadings of TCDD and TCDF into the Columbia River from 1990 to 1994.



Dioxins and furans have been non-detectable in Celgar Pulp Company effluent since July 1993.

Figure 2
Study area and sampling locations of the 1994 DFO and MELP mountain whitefish survey.



Figures 3 and 4 Decreases in 2,3,7,8-TCDF and 2,3,7,8-TCDD TEQ's in mountain whitefish tissues between 1990 and 1994 (BCEnvironment and DFO data combined).

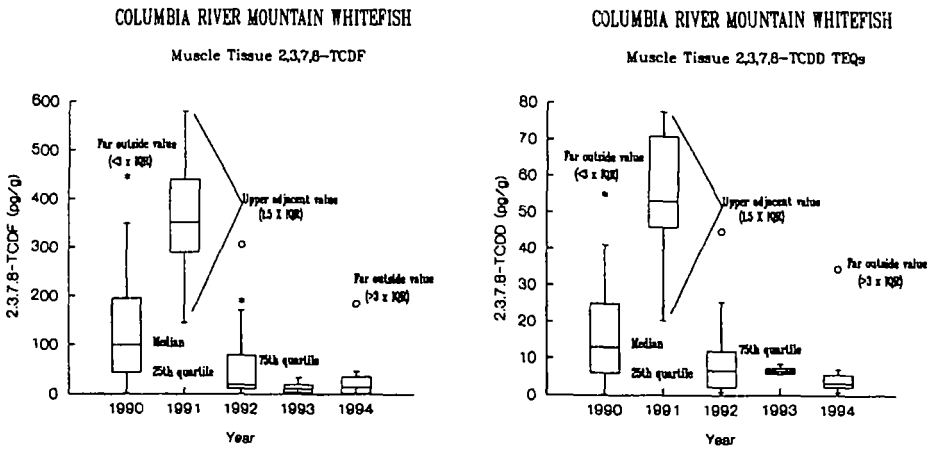


Figure 5 *Summary of all data collected in 1994 on the Columbia River.*