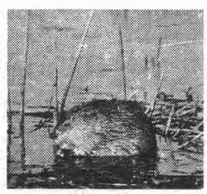
Canada Alberta Northwest Territories

Northern River Basins Study





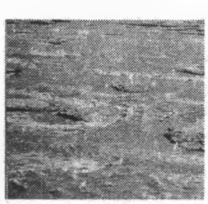


NORTHERN RIVER BASINS STUDY PROJECT REPORT NO. 101

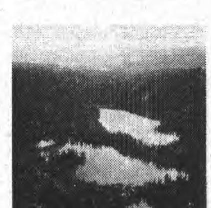
ENVIRONMENTAL CONTAMINANTS IN FISH:

POLYCHLORINATED BIPHENYLS, ORGANOCHLORINE PESTICIDES AND CHLORINATED PHENOLS,

PEACE, ATHABASCA AND SLAVE RIVER BASINS, 1992 TO 1994





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by

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PREFACE:

The Northern River Basins Study was initiated through the "Canada-Alberta-Northwest Territories Agreement Respecting the Peace-Athabasca-Slave River Basin Study, Phase II - Technical Studies" which was signed September 27, 1991. The purpose of the Study is to understand and characterize the cumulative effects of development on the water and aquatic environment of the Study Area by coordinating with existing programs and undertaking appropriate new technical studies.

This publication reports the method and findings of particular work conducted as part of the Northern River Basins Study. As such, the work was governed by a specific terms of reference and is expected to contribute information about the Study Area within the context of the overall study as described by the Study Final Report. This report has been reviewed by the Study Science Advisory Committee in regards to scientific content and has been approved by the Study Board of Directors for public release.

It is explicit in the objectives of the Study to report the results of technical work regularly to the public. This objective is served by distributing project reports to an extensive network of libraries, agencies, organizations and interested individuals and by granting universal permission to reproduce the material.

NORTHERN RIVER BASINS STUDY
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Whereas the above publication is the result of a project conducted under the Northern River Basins Study and the terms of reference for that project are deemed to be fulfilled,
IT IS THEREFORE REQUESTED BY THE STUDY OFFICE THAT;
this publication be subjected to proper and responsible review and be considered for release to the public.

(Dr. Fred J. Wrona, Science Director) — 6 June 96 (Date)

Whereas it is an explicit term of reference of the Science Advisory Committee "to review, for scientific content, material for publication by the Board",
IT IS HERE ADVISED BY THE SCIENCE ADVISORY COMMITTEE THAT;
this publication has been reviewed for scientific content and that the scientific practices represented in the report are acceptable given the specific purposes of the project and subject to the field conditions encountered.
SUPPLEMENTAL COMMENTARY HAS BEEN ADDED TO THIS PUBLICATION: [ ] Yes [ ] No

(Dr. P. A. Larkin, Ph.D., Chair) — 10 June/96 (Date)

Whereas the Study Board is satisfied that this publication has been reviewed for scientific content and for immediate health implications,
IT IS HERE APPROVED BY THE BOARD OF DIRECTORS THAT;
this publication be released to the public, and that this publication be designated for: **[ ] STANDARD AVAILABILITY [ ] EXPANDED AVAILABILITY**

(Lucille Partington, Co-chair) — June 6 / 96 (Date)

(Robert McLeod, Co-chair) — June 6/96 (Date)

ENVIRONMENTAL CONTAMINANTS IN FISH: POLYCHLORINATED BIPHENYLS, ORGANOCHLORINE PESTICIDES AND CHLORINATED PHENOLS, PEACE, ATHABASCA AND SLAVE RIVER BASINS, 1992 TO 1994

STUDY PERSPECTIVE

One of the main objectives of the Northern River Basins Study is to determine the effects of contaminants from industrial and municipal sources on the aquatic ecosystems of the Peace, Athabasca and Slave rivers. Historically, contaminant information from these basins was sparse. In response to the recent expansion of the pulp and paper industry, additional research was required to describe the nature and distribution of chemical contaminants entering the rivers. This information would allow scientists to assess contaminant fate and toxicity for aquatic life and people using these river systems. A previous NRBS project summarized and mapped the levels of dioxins and furans in water, sediment and biota from the upper Athabasca River. In addition to dioxins and furans, people are concerned about polychlorinated biphenyls (PCBs) and other organochlorine compounds because of their toxicity, persistence in the environment, and ability to bioaccumulate in the food chain. Further research was required to determine the current levels of these contaminants in fish, and whether these levels have changed from results found in previous studies between 1988 and 1992.

Related Study Questions

4a) *What are the contents and nature of the contaminants entering the system and what is their distribution and toxicity in the aquatic ecosystem with particular reference to water, sediments and biota?*

8) *Recognizing that people drink water and eat fish from these river systems, what is the current concentration of contaminants in water and edible fish tissue and how are these levels changing through time and by location?*

13b) *What are the cumulative effects of man-made discharges on the water and aquatic environment?*

This report summarizes and interprets the analytical results for PCBs, chlorinated phenolics and organochlorine pesticides in fish collected from the Peace, Athabasca and Slave River systems between 1992 and 1994. This study also compares the observed organochlorine levels with the regulatory limits set by Health Canada, and elaborates on the partitioning, fate and bioaccumulation of these groups of compounds in these rivers.

The major organochlorine groups detected were PCBs, DDT- and chlordane-related compounds, toxaphene and chlorinated phenolics. The chlorinated phenolics detected in fish tissues were indicative of a bleached kraft mill (BKM) source, with the highest levels observed in mountain whitefish and burbot collected immediately downstream from these sources. Concentrations of PCBs and organochlorine pesticides observed in mountain whitefish (average ranging from 9.4 to 30 ng/g) from sites downstream of the BKM effluent at Hinton were higher than levels in northern pike or longnose suckers. Concentrations of organochlorine compounds were much higher in burbot liver than in the muscle tissue of other species. Average concentrations of total PCBs ranged from 19-82 ng/g in the Athabasca River system, and ranged from 16-420 ng/g in the Peace River system. The lowest levels of total PCBs in burbot liver were generally recorded in fish collected from tributaries. Elevated levels of PCBs and organochlorine pesticides were observed in burbot liver, and to a lesser extent mountain whitefish and northern pike muscle, immediately downstream of BKM/municipal effluent sources on the upper Athabasca and Wapiti rivers. These higher levels may be due to localized sources (e.g., chemical spills, pesticide use) and/or higher productivity in nutrient-rich effluents, possibly causing changes in feeding preferences and greater bioaccumulation of contaminants. The lowest levels of organochlorine compounds were found in the muscle tissue of fish collected in or near the Peace-Athabasca Delta.

Based on Health Canada consumption guidelines, organochlorine levels in fish muscle reported in this study did not represent a human health hazard. Results from this project will form important linkages with research on contaminant fate and food chain modelling, ecosystem health, cumulative effects assessment and human health consumption advisory assessments. In addition, these data will provide baseline information to be used in future contaminant and biochemical analyses of fish in these river systems.

REPORT SUMMARY

This report summarizes the concentrations of polychlorinated biphenyls (PCBs) congeners, chlorophenolics (CPs), and organochlorine (OC) pesticides in fish collected from the Peace/Wapiti/Smoky, Slave and Athabasca River systems in 1992 to 1994. Five related studies were conducted with the general objective of determining spatial and, in some cases, temporal trends for a large suite of contaminants including PCBs, OC pesticides, CPs, and polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). The Reach Specific Study (RSS) project examined contaminants in mountain whitefish and northern pike muscle at six sample locations downstream and one upstream of Hinton (AB) on the Athabasca River. The General Fish Collection consisted of mountain whitefish and longnose suckers collected from two sites downstream of Hinton, and walleye and goldeye collected further downstream at five sites. Sampling at nine sites for burbot was carried out during September/October 1992 (Peace/Wapiti/Smoky only), and at 26 sites in the Peace and Athabasca basins, and at the Slave River delta, from September to December in 1994. Liver samples from long nose suckers collected downstream of Hinton in 1992 and from northern pike and longnose suckers collected on the Wapiti/Smoky/Peace system in 1994 were also analysed for PCBs and OC pesticides. A separate study was also conducted of PCB and OC pesticide contamination of the domestic fishery of Ft. Chipewyan during the winter of 1994-95. Results for PCDD/Fs in many of the same fish collected for the above studies in 1992 and 1994 are reported elsewhere (Pastershank and Muir 1995; 1996).

The major OC groups detected in fish muscle and liver samples in the five studies were PCBs, toxaphene, DDT- and chlordane-related compounds, and chlorophenolics. Chlorinated-veratroles (tetrachloroveratrole), and -anisoles (pentachloroanisole), and pentachlorophenol (PCP) were the most common chlorophenolics. Unlike the PCBs and OC pesticides, the CPs detected in fish muscles and livers were clearly indicative of a BKM source with highest levels in both mountain whitefish and burbot liver observed in samples caught immediately downstream of BKMs. An exception to this trend was PCP which was present in mountain whitefish muscle on the Athabasca River at similar levels upstream and downstream of the BKM at Hinton. Tetra-, tri- and di-chlorophenols, guaiacols and catechols were at or near detection limits (<0.2 ng g^{-1}) in mountain whitefish, northern pike muscle and burbot liver.

Higher levels of PCBs and OC pesticides were observed in mountain whitefish than in northern pike or longnose suckers from sites downstream of the bleached kraft pulp mill (BKM) at Hinton in the RSS project. Mean concentrations of ΣPCBs in mountain whitefish muscle were generally higher at the three sampling sites in spring 1992 (means ranging from 9.4 to 30 ng g^{-1}) immediately downstream of Hinton compared to the upstream site (11 ng g^{-1}). Similar trends were seen for OC pesticides. Penta-, hexa, and heptachlorobiphenyls accounted for 85 ± 8% of the total PCB levels in mountain whitefish and 90 ± 6% for northern pike. Levels of ΣPCBs were not significantly ($p<0.05$) different between mountain whitefish and northern pikes caught in the spring than the fall of 1992. In general fish size (length or weight) was correlated with concentrations of major OCs when all results for whitefish and pike downstream of Hinton were pooled by species.

Among all fish species from the Athabasca River sampled in spring or fall 1992, the lowest levels of organochlorines were found in the muscle samples of the goldeye and walleye collected near the

Athabasca River delta. Concentrations of all major groups of CPs, PCB homologues and OC pesticides were <1 ng g^{-1}.

Concentrations of ΣPCB and OC pesticides were also very low in muscle of walleye, lake whitefish, burbot and northern pike samples from the Ft. Chipewyan domestic fishery at three sites in the Peace/Athabasca delta. ΣPCB levels ranged from 1.1 to 9.9 ng g^{-1}. In general, levels were similar to those found in muscle of other species such as suckers and goldeye.

The concentrations of PCBs, CPs and OC pesticides observed in burbot liver were much higher than in muscle of pike, mountain whitefish and other species. This may reflect the high lipid content of the burbot liver (30 to 50%) and their trophic position. Adult burbot are generally piscivorous. Mean concentrations of ΣPCBs in burbot liver ranged from 19 to 82 ng g^{-1} from the Athabasca River (and tributaries) to 16 to 420 ng g^{-1} on the Peace andWapiti/Smoky River systems. Relatively high levels of ΣPCBs (150 ± 52 ng g^{-1}) were also seen in the livers of burbot from the sampling site in the Slave River delta. These concentrations were in good agreement with results from the Slave River monitoring study (Peddle et al. 1995). Lowest levels of ΣPCBs (≤ 54 ng g^{-1}) were generally seen in the livers of burbot from tributaries flowing into the Athabasca River (Pembina, Clearwater, and McLeod Rivers) and Peace River (Wabasca River). Temporal trends of ΣPCB and were examined at two sites on the Wapiti/Smoky system at which samples were collected in 1992 and in 1994. No significant differences in (log transformed) mean ΣPCB or ΣDDT were seen over the two year period, especially after lipid normalization of results. Toxaphene levels in burbot liver were lower than expected based on results from the Slave River and Great Slave Lake studies. An interlab comparison confirmed that the results for toxaphene were underestimated in burbot liver and cannot be compared to other work.

The reason for the elevated levels of PCBs and OC pesticides observed in burbot liver, and to a lesser extent mountain whitefish and northern pike muscle, immediately downstream of municipal/industrial sources (including BKMs) is unclear. One possible explanation is that the fish are feeding at a higher trophic level in these locations. Greater emissions of nutrients in the effluents of municipal/industrial sources may give rise to greater autochthonous organic carbon production in these reaches and ultimately in amounts of invertebrates and benthic forage fish. Food chains may be longer or at least more diverse at these locations. Local sources (pesticide use, past PCB spills) are also possible. Highest PCB levels in burbot liver and in mountain whitefish muscle were found in samples downstream from pulp mills on the Wapiti/Smoky and upper Athabasca rivers. Relatively high levels of PCBs in longnose sucker liver samples from the Smoky River suggest a contamination source, rather than biomagnification through the food web, because suckers feed at a lower trophic level than burbot or pike.

A preliminary assessment of the PCB and OC pesticide concentrations in fish muscle and liver was made using Health Canada's tolerable daily intake values and US EPA non-cancer hazard levels. The preliminary conclusion was that the organochlorine levels in fish muscle (mountain whitefish, pike, goldeye, walleye, longnose suckers) did not represent a human health hazard. Although higher levels of most contaminants were found in burbot liver, a 60 kg individual would have to consume 150g burbot liver per day to exceed the TDI for PCBs, assuming the worst case concentration of 400 ng g^{-1}. However, further evaluation taking into account all fish related tissues that may be consumed as part of the traditional diet (e.g., fish eggs, liver, fat) is needed.

Concentrations of PCBs and ΣDDT in muscle of all fish sampled were also well below US EPA criteria for protection of fish-eating wildlife by a factor of at least five to greater than 10-fold. But Mountain whitefish muscle samples from the upper Athabasca River exceeded draft Canadian Environmental Quality guidelines for ΣPCBs by 2 to10-times although they did not exceed the criteria for p,p'-DDE. Northern pike muscle from the RSS also had ΣPCB levels similar to the Canadian EQG while other species in the lower Athabasca had lower levels and did not exceed the EQG.

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1.0 INTRODUCTION

The Northern River Basin Study (NRBS) designed a comprehensive program to examine the impact of development on ecosystem health and integrity on three large river basins in Alberta and the Northwest Territories: Athabasca, Peace, and Slave. The project began in 1992 and completed in 1996. There are more than 100 projects in eight study areas: contaminants, nutrients, hydrology/hydraulics, drinking water, food chain, synthesis/modelling, traditional knowledge, and other uses.

This report summarizes the concentrations of polychlorinated biphenyls (PCBs) congeners, chlorophenolics (CPs), and organochlorine (OC) pesticides in fish collected from the Peace/Wapiti/Smoky and Athabasca River systems in 1992 to 1994.

The contaminant results for fish are divided into five separate projects. In all studies, spatial and in some cases, temporal trends were examined for a large suite of contaminants (metals, polyaromatic hydrocarbons, OC pesticides, CPs, PCBs, polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs)). The Reach Specific Study (RSS) project examined contaminants in mountain whitefish and northern pike muscle at six sample locations downstream of Hinton, AB on the Athabasca River. The General Fish Collection consisted of mountain whitefish and longnose suckers collected from two sites downstream of Hinton, and walleye and goldeye collected further downstream at five sites. The Burbot collection involved collections at nine sampling sites during September/October of 1992 (Peace and Wapiti only), and at 26 sites from September to December in 1994. Liver samples from fishes collected downstream of Hinton in 1992 and Grande Prairie in 1994were also analysed for PCBs and OC pesticides. A separate study was also conducted of PCB and OC pesticide contamination of the domestic fishery of Ft. Chipewyan during the winter of 1994-95. Results for PCDD/Fs in fish collected in 1992 and 1994 are reported elsewhere (Pastershank and Muir 1995; 1996).

Sources for PCBs, CPs, and OC pesticides in the Wapiti/Smoky, Peace and Athabasca rivers could come from industrial emissions, present or past use of pesticides in agriculture or by municipalities, and atmospheric deposition. Four bleached kraft pulp and paper mills (BKMs) are located in the study area: Weyerhaeuser Canada Ltd. (Grande Prairie), Daishowa Canada Ltd. (Peace River), Weldwood of Canada Ltd. (Hinton), and ALPAC (Athabasca). These mills have emitted CPs, PCDDs and PCDFs to the aquatic environment, in some cases for many years. Changes in the pulp bleaching technology to a 100% molecular chlorine substitution with chlorine dioxide have substantially reduced the emissions of CPs, PCDDs and PCDFs to the Peace, Wapiti and Athabasca Rivers during the past two to three years. While pulp mills are the most obvious source of the chlorinated chemicals determined in this study, atmospheric transport and deposition in rain, snow, or by gas absorption to surface waters, may be the major contributor of several contaminants especially PCBs and OC pesticides such as toxaphene and DDT. A limited number of chlorinated pesticides are still registered for use in Canada such as lindane (γHCH) and methoxychlor. These chemicals have been used within the watershed in the past (for example methoxychlor was used for blackfly control on the Athabasca River) and could still be used in the region for pest control.

This report first briefly reviews the properties, uses, and toxicity of the chlorinated chemicals measured in the three fish collection programs, examines the spatial trends of contaminant concentrations, and compares results to other ongoing or previous studies on contaminants in fishes.

2.0 BACKGROUND INFORMATION

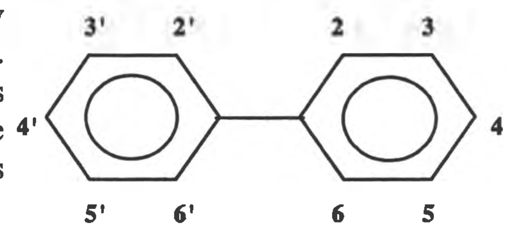
2.1 PCBs

2.1.1 PCB Sources

PCBs were first prepared by Schmidt and Shultz in 1881 and identified in environmental samples by Jensen (1972). Unique properties of PCBs promoted technical mixtures of different congeners to be made industrially for dielectric fluids, plasticizer, heat transfer agents, flame retardants, waterproofing, and paints. Their production peaked in the late 1960s with use prohibited in Canada in 1980 (Barrie et al. 1992). Between 1929 and 1977, it has been estimated that 1.2 million tonnes of PCBs have been produced (mainly in North America and western Europe) of which approximately 0.37 million tonnes or 31% has been released into the global environment (Tanabe 1988).

2.1.2 Physicochemical Parameters of PCBs

PCBs are a large family of chlorinated hydrocarbons consisting of 209 congeners (each congener having a different chlorine substitution pattern). The core molecule consists of two benzene rings joined at the 1,1' position (see structure below). The stereochemistry of the PCB molecule is influenced by chlorine positioning (Shaw et al. 1986). Chlorines on the *para* (4,4')and *meta* positions (3,3' or 5,5') cause the molecules to be relatively planar with stronger adsorption and bioaccumulation capacities. Non planar distortion of the aromatic rings occur with chlorines in the *ortho* (2,2' or 6,6') positions. Table 1 summarizes the PCB numbering and chlorine positioning of 62 congeners discussed in this report.



PCB Structure

PCBs are relatively nonvolatile, hydrophobic (insoluble in water), lipophilic (highly soluble in lipids and organic compounds), and have high dielectric constants. An increase in chlorine substitution correlates with a decrease in water solubility (C_s) and vapors pressure (P), and an increase in octanol-water partition coefficient (K_{ow}) (Table 2). The solubility of PCBs is influenced by the number and positioning of the chlorines on the biphenyl rings, and the properties of suspended particulate matter and dissolved organic carbon, such as, organic carbon content and the number of available sorption sites. Water solubilities range from 129.7 mmol m^{-3} for biphenyl, 13.24 to 35.66 mmol m^{-3} for monochlorobiphenyl to 1.44×10^{-2} mmol m^{-3} for decachlorobiphenyl (Mackay et al. 1992). Log K_{ow} for PCBs varies from 3.90 for biphenyl, 4.3 to 4.60 for monochlorobiphenyl to 8.26 for decachlorobiphenyl.

Table 1. Systematic Numbering of 62 PCB Compounds Measured in the NRBS Study[a]

No.	Structure	No.	Structure	NNo.	Structure
Dichlorobiphenyls		Pentachlorobiphenyls		174	2,2',3,3',4,5,6
5[b]	2,3	84	2,2',3,3',6	177	2,2',3,3',4',5,6
8[b]	2,4'	85	2,2',3,4,4'	180	2,2',3,4,4',5,5'
15	4,4'	87	2,2',3,4,5'	182[b]	2,2',3,4,4',5,6'
Trichlorobiphenyls		89	2,2',3,4,6'	183	2,2',3,4,4',5',6
16[b]	2,2',3	95	2,2'3,5',6	185	2,2',3,4,5,5',6
18	2,2',5	101	2,2',4,5,5'	187[b]	2,2',3,4',5,5',6
22	2,3,4'	105	2,3,3',4,4'	189	2,3,3',4,4',5,5'
28	2,4,4'	110	2,3,3',4',6	191	2,3,3',4,4',5',6
31	2,4',5	118	2,3',4,4',5	Octachlorobiphenyls	
32[b]	2,4',6	126	3,3',4,4'5	194	2,2',3,3',4,4',5,5'
33	2',3,4	Hexachlorobiphenyls		195[b]	2,2',3,3',4,4',5,6
Tetrachlorobiphenyls		128	2,2',3,3',4,4'	196[b]	2,2',3,3',4,4',5',6
40	2,2',3,3'	129	2,2',3,3',4,5	201	2,2',3,3',4',5,5',6
44	2,2',3,5'	137	2,2',3,4,4',5	202	2,2',3,3',5,5',6,6'
49	2,2',4,5'	138	2,2',3,4,4',5'	203[b]	2,2',3,4,4',5,5',6
52	2,2',5,5'	141	2,2',3,4,5,5'	205	2,3,3',4,4',5,5',6
56[b]	2,3,4,4'	146	2,2',3,4',5,5'	Nonachlorobiphenyls	
60[b]	2,3,3',4'	149	2,2',3,4',5',6	206	2,2',3,3',4,4',5,5',6
65[b]	2,3,5,6	151	2,2',3,5,5',6	207	2,2',3,3',4,4',5,6,6'
70[b]	2,3',4',5	153	2,2',4,4',5,5'	208[b]	2,2',3,3',4,5,5',6,6'
76[b]	2',3,4,5	169	3,3',4,4',5,5'	Decachlorobiphenyl	
77	3,3',4,4'	Heptachlorobiphenyls		2209	2,2',3,3',4,4',5,5',6,6'
		170	2,2',3,3',4,4',5	2	
		171[b]	2,2',3,3',4,4',6		

[a] Data obtained from Ballschmiter and Zell (1980).
[b] Coelutions: 56/60, 5/8, 16/32, 70/76, 65/95, 56/60, 182/187, 171/202, 196/203, 195/208

2.1.3 International Toxicity Equivalent Factors (I-TEFS)

International Toxicity Equivalent Factors (I-TEFs) have been assigned to 13 of the most toxic PCBs by the WHO-European Centre for Environment and Health (WHO-ECEH) and the International Programme on Chemical Safety (IPCS) (Ahlborg et al. 1994). These PCB compounds are believed to cause toxic responses similar to 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD). 2,3,78-TCDD is considered to be the most toxic congener and its I-TEF is set one. I-TEFs for the non-ortho and mono-ortho (dioxin-

Table 2. Summary of Selected Physical Properties of Some PCB Congeners at 25 EC (Mackay et al. 1992)

IUPAC No.	Congener	MW g mol^{-1}	Vapour pressure[a] P_S Pa	P_L Pa	Water solubility[b] C_S g m^{-3}	C_S mmol m^{-3}	C_L mmol m^{-3}	log K_{ow}	H (P_S/C_S)[c] Pa m^3 mol^{-1}
8	2,4'-	223.1			1	4.48	6.73	5.1	
15	4,4'-	223.1	4.80e-03	8.00e-02	0.06	0.269	4.56	5.3	17
18	2,2',5-	257.5	1.43e-01	2.20e-01	0.4	1.550	2.390	5.6	92.21
28	2,4,4'-	257.5			0.16	0.621	1.28	5.8	
33	2',3,4-	257.5	1.36e-02	3.00e-03	0.08	0.311	0.69	5.8	43.67
40	2,2',3,3'-	292	2.25e-03	2.00e-03	0.03	0.103	0.91	5.6	21.94
44	2,2',3,5'-	292			0.1	0.342	0.565	6	
49	2,2',4,5-	292			0.016	0.0548	0.133	6.1	
52	2,2',5,5'-	292	4.90e-03	2.00e-03	0.03	0.103	0.42	6.1	47.59
60	2,3,4,4'-	292						6.31	
65	2,3,5,6-	292						5.94	
87	2,2',3,4,5'-	326.4	3.04e-04	2.30e-03	0.004	0.0123	0.927	6.5	24.81
101	2,2',4,5,5'-	326.4	1.09e-03	3.50e-03	0.01	0.0306	0.0986	6.4	35.48
105	2,3,3',4,4'-	326.4						6	
110	2,3,3',4',6-	326.4			0.004			6.3	
128	2,2',3,3',4,4'-	360.9	1.98e-05	3.40e-04	0.0006	0.00166	0.0286	7	11.91
129	2,2',3,3',4,5-	360.9			0.0006	0.00166	0.0065	7.3	
153	2,2',4,4',5,5'-	360.9	1.19e-04	7.00e-04	0.001	0.00277	0.0163	6.9	42.9
171	2,2',3,3',4,4',6-	395.3	2.73e-05	2.50e-04	0.002	0.00506	0.046	6.7	5.4
185	2,2',3,4,5,5',6-	395.3			0.00045	0.00114	0.0191	7	
194	2,2',3,3',4,4',5,5'-	429.8			0.0002	0.00047	0.0098	7.4	
202	2,2',3,3',5,5',6,6'-	429.7	2.66e-05	6.00e-04	0.0003	0.0007	0.0158	7.1	38.08
206	2,2',3,3',4,4',5,5',6-	464.2	1.96e-07	1.20e-05	0.00011	0.000237	0.0146	7.2	82.2
207	2,2',3,3',4,4',5,6,6'-	464.2						7.52	
208	2,2',3,3',4,5,5',6,6'-	464.2			0.000018	0.000038	0.00141	8.16	
209	2,2',3,3',4,4',5,5',6,6'	498.7	5.00e-08	3.00e-05	0.000001	0.000002	0.014	8.26	20.84

[a] P_S = Solid vapour pressure; P_L = sub-cooled liquid vapour pressure
[b] C_S = solubility of the solid; C_L= solubility of the sub-cooled liquid
[c] H= Henry's Law Constant

like) PCBs are summarized in Table 3. Provisional I-TEF values for mono- and di-ortho-substituted PCBs were given 0.01 and 0.00002, respectively (Safe 1992). With I-TEFs, the toxicity of PCBs in an organism can be expressed as a single Toxic Equivalent (TEQ) value: $TEQ = \Sigma ([PCB]_i \times I\text{-}TEF)$, where $[PCB]_i$ = concentration of a specific PCB congener, and I-TEF = $I\text{-}TEF_i$ value of PCB_i.

Table 3. WHO/IPCS Interim I-TEFs for PCB Congeners [a]

Type	IUPAC No.	Structure	I-TEF
Non-*ortho*	77[b]	3,3',4,4'-TCB	0.0005
	126[b]	3,3',4,4'5-PeCB	0.1
	169[b]	3,3',4,4',5,5'-HxCB	0.01
Mono-*ortho*	105[b]	2,3,3',4,4'-PeCB	0.0001
	114[d]	2,3,4,4',5-PeCB	0.0005[b,c]
	118[b]	2,3',4,4',5-PeCB	0.0001
	123	2,3,4,4',5-PeCB	0.0001
	156[d]	2,3,3',4,4'5-HxCB	0.0005
	157[d]	2,3,3',4,4',5'-HxCB	0.0005[c]
	167	2,3',4,4',5,5'-HxCB	0.00001[b]
	189[b]	2,3,3',4,4',5,5'-HpCB	0.0001[b]
Di-*ortho*	170[b]	2,2',3,3',4,4',5-HpCB	0.0001[b]
	180[b]	2,2',3,4,4',5,5'-HpCB	0.00001[b]

[a] Adapted from an original table in Ahlborg et al. (1994)
[b] PCB congeners analyzed for during the NRBS Study
[c] Based on limited data
[d] IUPAC 114, 156, 157 are expected to have similar I-TEF values based on similar responses (AHH inducers).

2.1.4 PCB Toxicity

The relative concentration and toxicity of each PCB congener will be important in addressing the impact of PCBs to humans and the environment. A recent report by Ahlborg et al. (1994) has reviewed current literature on the toxicities of planar PCBs. Some toxic effects induced by PCBs in fish and wildlife include dermal toxicity, immunotoxicity, reproductive deficits, teratogenicity, endocrine toxicity, carcinogenicity/tumour production, and fetotoxicity (Ahlborg et al. 1994, Harris et al. 1994). It is believed that planar PCBs bind to Ah-receptors (specific binding sites located on the endoplasmic reticulum in cells) like 2,3,7,8-TCDD due to similar molecular configurations (Ahlborg et al. 1994). The nominal concentrations of 2,3,7,8-TCDD, and PCB 126, 81, and 77 (three *ortho*-substituted PCB congeners) required to generate a 50% lethality (LD_{50}) in medaka (*Oryzias latipes*) embryo were 20 ng L^{-1}, 215 ng L^{-1}, 15,585 ng L^{-1}, and >250,000 ng L^{-1}, respectively (Harris et al. 1994). Limited research indicates that non planar PCBs, such as PCB 126, appear to be responsible for most of the tumour promotion associated with higher chlorinated mixtures (Ahlborg et al. 1994).

2.1.5 Environmental Persistence of PCBs

PCBs are environmentally stable and persistent compounds. PCBs are relatively inert toward acids, alkalies and other corrosive chemicals, stable toward oxidation, and resist combustion at temperatures above their boiling points (Roberts et al. 1978). The major pathways of degradation of PCBs in the aquatic environment are photolysis, and biodegradation (Sawhney 1987). In the northern hemisphere, photodegradation of PCBs in aquatic environments is restricted to the summer months.

Sunlight photolysis is an important pathway of degradation of PCBs in environmental samples. Most PCB compounds have UV absorption spectra that overlap with the high energy end of the solar spectrum reaching the earth's surface (i.e., between 280 and 300 nm) (Sawhney 1987). Photolysis can cause chlorine to be cleaved from the biphenyl molecule. Steric properties, such as the positioning of the chlorine atoms on the biphenyl ring, affect photolysis rates; e.g., *ortho*-chlorines cleave at a faster rate than *meta*-chlorines and *para*-chlorines. Factors that affect the photodegradation of PCBs in water are irradiation time, degree of chlorination (i.e., higher chlorinated PCBs breakdowns faster), and the presence of dissolved organic materials (DOM) that sensitize photoreactions (i.e., humic acids). Surface films are believed to be an important location for PCB degradation and volatilization (Södergren et al. 1990).

PCBs with one to three chlorine atoms have been shown to break down under laboratory incubations with microorganisms within one day (Furukawa and Matsumura 1976). Hydroxylation and ring cleavage are the main biodegradative mechanisms caused by microorganisms. Cometabolism of mono-, di- and tri-chlorobiphenyls has also been shown for microorganisms in sediment cultures (Baxter et al. 1975).

Highly chlorinated PCB congeners, i.e., tetra- and penta-chlorobiphenyls, are extremely resistant to aerobic biodegradation in sediments or water (Baxter et al. 1975, Metcalfe et al. 1975). However, anaerobic dechlorination of PCBs (Aroclor 1242 and 1260) was measured in sediments (Beurskens et al. 1993; Brown et al. 1987). Chlorines in the meta and para positions were preferentially removed. Therefore, higher levels of ortho-substituted mono-, di-, tri- and tetra-chlorobiphenyls have a tendency to accumulate in the sediments. However, dechlorination of PCBs in sediments appears to be confined to sites with very high ($\mu g\ g^{-1}$) levels of contamination.

2.1.6 Fate and Transport of PCBs

The dominant PCB congeners in the in the vapour phase of the atmosphere is 8+5, 18, 17, 16, 32 (Duinker and Bouchertall 1989, Hermanson and Basu 1991). Atmospheric deposition of PCBs has been reported to account for the major load to the Great Lakes, remote Ontario Lakes, and Antarctica (Larsson et al. 1992, MacDonald et al. 1991, Strachan and Eisenreich 1988).

The two major removal processes of PCBs from the water column are volatilization and sedimentation (Macdonald and Metcalfe 1991). A half-life of 10 hours has been calculated for PCBs to disappear from the water column of rivers of one meter depth (Mackay and Leinonen 1975). Environmental parameters, such as temperature, season, suspended particulate matter characteristics, and precipitation, will affect the dynamic equilibrium of PCBs in the water, sediment, and air phases. Rates of vaporization of PCBs from water are higher than those obtained for soil or sediment.

2.1.7 Bioaccumulation of PCBs

Biomagnification of PCBs in aquatic ecosystems has been well documented in studies by Oliver and Niimi (1988) and Rasmussen et al. (1990). The degree of chlorination and the positioning of the chlorine molecules affect bioaccumulation of PCBs by aquatic organisms. Chlorine atoms in the 2,4, and 5 position on at least one phenyl ring has been identified to be important in the accumulation of PCBs in aquatic organisms (Gagnon et al. 1990). PCBs with adjacent unsubstituted *meta-*, *para-* positions carbons are metabolized by mixed function oxidases enzymes in fishes and possibly in invertebrates. Elimination half-lives for tetra- and penta-chlorobiphenyls in yellow eels (*Anguilla anguilla*) under natural lake conditions ranged from 340 to 1,450 days (deBoer et al. 1994). Elimination was not observed for hexa-, hepta- and octa-chlorobiphenyls under the same conditions. Shorter half-lives were seen for guppies in a study by Bruggeman (1984). Half-lives ranged from 6.3 days for a dichlorobiphenyl (CB 9) to 220 days for an octochlorobiphenyl. deBoer et al. (1993) also present evidence that supports metabolic transformation of PCB 77 and 126 in the tissue and liver of yellow eel (*A. anguilla*).

Bioaccumulation of PCBs also correlates with the lipid content of an organism (Oliver and Niimi 1988, Gagnon et al. 1990) and length of the food chain (Rasmussen et al. 1990). Trophic positioning also influences the accumulation of different PCB congeners. Hexa- and hepta-chlorobiphenyls preferentially accumulate in higher trophic levels. In water and lower trophic levels, tri- and tetra-chlorobiphenyls made up most of the total PCBs assemblage. Whereas, penta- and octa-chlorobiphenyls congeners had a fairly uniform pattern in the water and different trophic levels. Oliver and Niimi (1988) showed that most of the differential fractionation of PCBs occurred at the lower trophic levels (i.e., water to plankton to mysid). Their results also showed PCBs to move in a fairly uniform composition mixture at the higher trophic levels (i.e., mysid to smelt to salmonid). CBs 101, 138, 153, and 180 are present in the highest concentration in predatious fishes (Niimi and Oliver 1988). These congeners are also common in terrestrial and aquatic mammals.

In the past 20 years PCB levels have declined in Great Lakes biota. Lower levels were seen in lake trout (*Salvelinus nameycush*) sampled from Lake Ontario in 1990 compared with samples from 1975 (Borgmann and Whittle 1991). Declining concentrations of PCBs have also been observed in lake trout in Lakes Michigan and Superior (DeVault et al. 1986). Similar declines were observed in pike from Lake Storinveld in northern Sweden receiving only atmospheric inputs of PCBs (Bignert et al. 1993). Temporal trends of PCBs in fishes in other lakes in Canada are unknown.

2.2 CHLOROPHENOLICS

2.2.1 Chlorophenolic Sources

Chlorophenolics are produced at BKMs, wood processing and treatment plants, and sewage treatment plants. Low concentrations of chlorophenolics are often emitted into the atmosphere with SO_2 during the burning of waste materials (e.g., industrial smoke stacks or plastic burning).

The annual production of chlorophenolics was estimated to be 200,000 tonnes in Canada in 1978 (Bunce and Nakai 1989). Pentachlorophenol (PCP), was common as a wood preservative, and accounted for 45% of the total production of CPs during the 1970s. Another common wood preservative and fungicide still used in United States and Canada is tetrachlorophenol (Expert Panel 1994). CPs was first used as antiseptics. Some CPs are used as chemical intermediates to produce fungicides, herbicides, and insecticides. Other uses are biocides, dyes, and industrial and medical applications (CCREM 1987).

In BKM pulp, chlorinated guaiacols and catechols range from 1 to 20 g/tonne of pulp production and mono- to penta-chlorophenols ranged from 0.3 to 1.4 g/tonne of pulp production. At the Grande Prairie Mill, the total chlorophenolic concentrations in effluent decreased by 98% with a substitution of chlorine dioxide from 70 to 100% (Swanson et al. 1992).

Methylation of chlorophenols by microorganisms can produce anisoles, guaiacols, catechols and veratroles (Neilsen et al. 1983; 1984). This is important because these CP groups are more hydrophobic and have higher bioaccumulation potential than their phenolic analogues. Taste and odour problems can occur in natural waters if veratroles and anisoles are present at sub-µg L^{-1} concentrations. Four chloroanisole/veratroles, 2,4,6-trichloroanisole (TCA), 4,5-dichloroveratrole (DCV), 3,4,5-trichloroveratrole (TCV) and tetrachloroveratrole (TCV), were found in BKM effluent at levels of 1, 7, 7, and 1 ng L^{-1}, respectively (Brownlee et al. 1993).

2.2.2 Physicochemical Properties of Chlorophenolics

Table 4 summarizes the available information on the physicochemical properties of chlorophenolics. Generally an increase in chlorine substitution results in lower water solubility and vapor pressures, and higher lipophilicity (Expert Panel 1994). PCP is the most "acid-like" of all chlorophenol congeners. The log K_{ow} of PCB varies with pH. At pH 4, PCP has a log K_{ow} of four. At pH 8, PCP is completely water soluble, and has a log K_{ow} of zero. The anisoles and veratroles are neutral compounds and have relatively high log K_{ow}'s (Table 4). Pentachloroanisole (PCA) is a widely dispersed metabolite of PCP (Hoff et al. 1992).

2.2.3 Fate of Chlorophenolics

CPs have low vapor pressures and Henry's Law Constants and, as anions at neutral pH, they do no volatilize from water. CPs are mainly removed from sediments and soils by biodegradation (Expert Panel 1994). Aerobic biodegradation is most rapid for mono- and dichlorophenolics and much slower for tetra- and pentachlorophenol (Baker and Mayfield 1980). Half-lives of CPs in aquatic ecosystems vary from less than one week for some chlorinated phenols and chlorinated catechol to a few weeks for chlorinated guaiacols (Expert Panel 1994). Higher chlorinated CPs has been found weakly associated with sediments. Chlorocatechols can form complexes with metal cations in the sediment (Bunce and Nakai 1989). Chloroguaiacols have a strong affinity for the organic carbon in sediments.

Volatilization may account losses of CPs following biomethylation to corresponding anisoles or veratroles which are semi-volatile compounds (Neilson et al. 1983). The anisoles and veratroles are also readily O-demethylated back to the corresponding phenolic. Atmospheric breakdown of CPs proceeds via photolysis and hydroxyl radical reactions (Bunce and Nakai 1989). Higher chlorinated CPs are susceptible to photolytic breakdown, whereas, lower chlorinated phenols are more sensitive to hydroxyl radical attack. Atmospheric transport is important in the global movement of these compounds. Air concentrations of PCA in southern Ontario ranged from <0.1 to 130 $pg \cdot m^{-3}$ in a one year monitoring study and were highest during the summer months (Hoff et al. 1992).

2.3.4 Toxicity of Chlorophenolics

Chlorinated phenols and resin acids account for most of the toxicity associated with the effluent of BKMs (Expert Panel 1994). Chlorinated phenols can act as uncouplers of bacterial and mitochondrial oxidative phosphorylation. This property is thought to be related to the degree to which these compounds can accept electrons and interfere with the electron transport system in the mitochondrion. Toxicities of chlorophenolics increase with the degree of chlorination and at lower pH (Expert Panel 1994). Tetrachloroguaiacol is the most toxic guaiacol congener (Kringstad and Lindstrom 1984). Catechols are also quite toxic to fish (Kringstad and Lindstrom 1984). However, catechols and guaiacols can be toxic but have limited bioaccumulation potential in aquatic organisms due to their low K_{ow} values (Xie et al. 1984).

2.3.5 Bioaccumulation of Chlorophenolics

Low molecular weight organochlorines, as seen in the chlorophenolic family, can be rapidly accumulated across fish gills but are also rapidly eliminated (Expert Panel 1994). 3,4,5-Trichloroguaiacol was the most common chlorophenolic found in fish near a BKM (Kirkegaard and Renberg 1988). Accumulation of PCP was greatest in acidified, low pH, lakes where more of the compound was in the undisassociated state (Larsson et al. 1993). A study by Landner et al. (1977) showed rapid uptake of trichlorophenol, trichloroguaiacol, and tetrachloroguaiacol with half-lives less than a few days. Half-lives of CPs in mountain whitefish were estimated to be less than 8 days (Owens et al. 1994).

Table 4. Physicochemical Properties for some Chlorophenolic Compounds

Compound	Water Solubility (mol m^3)[a]	Log K_{ow}[b]	Vapor Pressure (Pa)[a]	H[a] Pa m^3 mol^{-1}
2-chlorophenol	222		316	1.425
4-chlorophenol	318		20	0.06285
2,3-dichlorophenol		3.15		
2,4-dichlorophenol	4.45	3.21	18	0.4044
2,5-dichlorophenol		3.24		
2,6-dichlorophenol		2.84	12.9	
3,4-dichlorophenol		3.44		
3,5-dichlorophenol		3.56		
2,3,6-trichlorophenol	4.85	3.63		
2,4,5-trichlorophenol	13.1	4.10	2.48	0.1887
2,4,6-trichlorophenol	6.11	3.75	1.48	0.2424
3,4,5-trichlorophenol		4.36		
2,3,4,5-tetrachlorophenol		4.82		
2,3,4,6-tetrachlorophenol	1.2	4.42	0.28	0.2337
2,3,5,6-tetrachlorophenol		4.39		
pentachlorophenol (PCP)	1.55	5.04	0.231	0.2615
4,5-dichloroguaiacol		3.18	1.54	
3,4,5-trichloroguaiacol		4.11	0.64	
4,5,6-trichloroguaiacol		3.74	0.25	
tetrachloroguaiacol (TCG)		4.45		
3,4,5-trichlorocatechol		3.79		
3,4,6-trichlorocatechol		3.67		
tetrachlorocatechol (TCC)		4.19	0.14	
2,4,6-trichloroanisole		4.23	29	
3,4,5-trichloroanisole	0.01	4.23	40	
Pentachloroanisole		5.65		800
tetrachloroveratrole (TCV)	0.0025	4.93	110	

[a] Data obtained from Xie et al. (1994)
[b] Data obtained from Brownlee et al. (1993)
[C] Data obtained from Suntio et al. (1988a)

2.3 ORGANOCHLORINE PESTICIDES

2.3.1 Sources of Organochlorine Pesticides

Organochlorine pesticides have been used globally since the 1940s and used primarily as insecticides and fungicides (Barrie et al. 1992, Miller et al. 1992). During the 1970s and early 1980s, most developed countries, including Canada, prohibited or restricted the use of many organochlorine pesticides due to their toxicity (including carcinogenicity), and environmental persistence (Barrie et al. 1992). During the '70s, Canada placed restrictions on the use dieldrin, heptachlor, lindane. DDT, toxaphene, and mixed

HCH isomers were banned between 1971 and 1986. Chlordane was prohibited from agricultural uses in 1985. Although some compounds like DDT has been banned in Canada, USA, and Europe, other countries such Africa, Central America, South America, and southern Asia still use DDT (Voldner and Ellenton 1987; Voldner and Li 1993).

Aldrin was used as an insecticide and fumigant. Dieldrin was used as insecticide and in processing wool. It is also an oxidation product of aldrin. Endrin is used as an insecticide and a minor constituent of dieldrin. Methoxychlor is a target insecticide specifically for mosquito larvae and house flies. Chlordane behaves as a nonsystemic insecticide. Toxaphene is a pesticide that is used on cotton crops, cattle, swine, corn, soybeans, wheat and peanuts, and low uses on other food crops (i.e., tomatoes and lettuce). Hexachlorobenzene (HCB) was used as a wood preservative, fungicides, seed treatment and is formed while producing PCP. Endosulfan is used to kill insects that destroy vegetable crops.

Some persistent OCs are produced as byproducts during the synthesis of pesticides or during a metabolic breakdown of other organochlorine pesticides. For example, HCB is often a by-product during the production of lower chlorinated benzenes, and the pesticides Dacthal, pentachloronitrobenzene, and PCP. Dieldrin can also be producted by oxidation of aldrin by soil bacteria, insects and mammals. DDE is a persistent metabolite produced by dehydrochlorination of DDT.

OC pesticides are often available in complex mixtures. For example, in one technical mixture of chlordane, 45 compounds were detected including *cis*-chlordane, *trans*-chlordane, *trans*-nonachlor, and oxychlordane (Pyysalo et al. 1981). Hexachlorocyclohexane (HCH) consists of six isomers of which only γ-HCH is insecticidally active and sold as the product lindane. The main constituents of dichlorodiphenyltrichloroethane (DDT) mixtures are p,p'-DDT (≥ 70%) and o,p'-DDT (≤ 30%). Toxaphene is made up of a mixture of at least 300 congeners including chlorinated bicyclic terpenes, mainly chlorinated bornanes, with an approximate formula of $C_{10}H_{10}Cl_8$ (Zhu and Norstrom 1994).

2.3.2. Toxicity of OC pesticides.

Most persistent organochlorine pesticides were designed to act as neurotoxins in insects. Differences between the nervous systems of vertebrates and invertebrates allowed some specificity of action. In general, these compounds act by two main mechanisms; interaction with a specific receptor, either as a mimic of the natural compound that binds to the receptor or as an agonist or antagonist to this substance or by the blocking of specific enzymes. DDT and other neurotoxic insecticides, such as cyclodienes, toxaphene and lindane are understood to act on the nerve axon via binding to a receptor associated with the sodium/potassium gate in the membrane. DDT, toxaphene, lindane, and dieldrin are most frequently associated with adverse effects on fish. Acute lethality is rare, however, and the major impacts of chlorinated pesticides are associated with the sublethal effects of chronic exposure to the compounds or their persistent metabolites. A significant number of chlorinated pesticides have been shown to have high toxicity to wildlife, including DDT, aldrin and dieldrin (Stickel, 1975).

Some OC pesticides and their metabolites (e.g., p,p'-DDE) may have effects on reproduction. Developmental effects in fishes have been reported in some studies with organochlorine compounds (methoxychlor; Holdway and Dixon, 1987). However, the exact mechanisms of action are not well understood. Some organochlorines, such as o,p′-DDT, kepone, methoxychlor, and PCBs have estrogenic activity in humans and wildlife. The estrogenic actions of DDT have been investigated extensively in mammals and birds (Kupfer and Bulger 1980).

2.3.3 Physicochemical Parameters of Organochlorine Pesticides

Organochlorine pesticides have diverse physicochemical properties, toxicities, environmental persistence, and uses. Table 5 summarizes some of the physicochemical properties of the organochlorine pesticides measured in this study. In general, these compounds have high log K_{ow}, low water solubility and relatively low vapor pressures. While most OCs are solid at room temperature, they can volatilize into the air, for example, from farm fields following pesticide applications. They will also volatilize from surface waters following deposition in rain, snow or in aerosol particles (Barrie et al. 1992). These "semi-volatile" properties, combined with slow rates of degradation by sunlight, result in movement of OCs long distances in the atmosphere. Major toxaphene sources for Canada have been shown to be emissions from previously treated farm fields in the southern US based on 5-day back trajectories of air mass movement (Hoff et al. 1992).

2.3.4 Bioaccumulation of OC Pesticides

Suedel et al. (1994) reviewed studies that looked at the biomagnification potential of OC compounds in aquatic ecosystems. There is some evidence that DDT, DDE, dieldrin, endrin, *trans*-nonachlor and toxaphene can biomagnify in aquatic food chains. For other OCs such as *trans*-chlordane, endosulfan, heptachlor, and lindane there is no evidence of biomagnification in aquatic organisms. Low biomagnification potentials occurred for compounds that can rapidly depurate (i.e., endosulfan) or metabolize/transform (i.e., *cis*- and *trans*-chlordanes (Pyysalo et al. 1981).

Temporal levels of OC compounds in the Great Lakes from 1977 to 1988 were dependent on the congener (Borgmann and Whittle 1991). OCs, such as PCBs, showed two peaks, one in 1977 and the other between 1982 and 1984. Their study showed they are decreasing at half-lives of 10 years. Level of chlordane in Great Lake fishes has remained constant. Level of DDT in fish decreased rapidly from 1977 to 1980 and has remained constant to 1988.

A study by Rasmussen et al. (1990) showed most of the variability in the concentration of OCs could be explained by lipid content of fish, length of the food chain, and position in the food chain. Other factors explaining less variability were dissolved organic carbon, suspended solids and the trophic status of the lake. Borgmann and Whittle (1991) showed PCBs, DDE, chlordane, mirex and dieldrin increased with the age of the fish, and body size across the age classes.

Table 5. Physicochemical Properties for Organochlorines[a]: MW (Molecular Weight), Water Solubility, Log K_{ow} (Octanol-Water Partition Coefficient), Vapour Pressure (VP)

	MW	Water Solubility (mg L^{-1})	Log K_{ow}	VP (Pa)
Dieldrin[a]	380.9	0.11	3.7	5.0×10^{-4}
Methoxychlor[b]	345.7	0.045	4.68	1.9×10^{-4}
Mirex[a]	546	6.5×10^{-5}	6.90	1.3×10^{-4}
DDT o,p'-[a]	354.5	0.003	6.00	1.0×10^{-4}
DDT p,p'-[a]	354.5	0.003	6.00	2.6×10^{-4}
DDD p,p'-[a]	320.0	0.05	6.22	1.0×10^{-4}
DDE p,p'-[a]	318.0	0.04	6.96	1.7×10^{-3}
Endosulfan I[a]	407.0	0.15		3.5×10^{-3}
γ-HCH[a]	290.9	6.5	3.80	3.0×10^{-3}
Chlordane (*cis* + *trans*) [a,b]	409.8	0.056	5.54	1.1×10^{-3}
Hexachlorobenzene[a]	284.8	0.04		1.0×10^{-3}
Toxaphene[b]	414(Avg)	0.55	4.92	8.9×10^{-4}

[a] Data obtained from Suntio et al. (1988b)
[b] Data obtained from Howard (1991)

2.4 HISTORICAL LEVELS OF OCs IN ALBERTA FISHES AND WILDLIFE

In 1980, the Alberta Environmental Centre measured organochlorine pesticides and PCBs in four southern Alberta Rivers (Bow, South Saskatchewan, Oldman, and St. Mary Rivers). PCBs were found at low ng g^{-1} levels in 12 fish species including mountain whitefish, northern pike, longnose suckers, and burbot (Chovelon et al. 1983).

Heavy metals and organochlorine data for livers of burbot from Slave River at Fort Smith, NWT were collected in The Slave River Environmental Quality Monitoring Program conducted between 1990 (Peddle et al. 1995). The Slave River receives waters from three southern provinces; British Columbia, Alberta, and Saskatchewan. Toxaphene and PCBs were the major organochlorines in Slave River burbot. Concentrations in burbot liver ranged from 61 to 1,887 ng g^{-1} (wet wt) for toxaphene, and from 13 to 800 ng g^{-1} for ΣPCB.

PCBs and OC pesticides were measured for lake trout fillets from 14 lakes in the continental divide region of Alberta and British Columbia and two lakes in Saskatchewan in 1992 (Donald et al. 1993). Total PCB concentrations varied from < 4 to 210 ng g^{-1} (wet wt). The most common OC pesticides in the lake trout fillets were ΣDDT with concentrations ranging from 5 to 140 ng g^{-1}, DDE from 4 to 64 ng g^{-1}, and toxaphene from < 4 to 300 ng g^{-1}.

In Alberta, wildlife at the top of aquatic food chains, such as waterfowls and otters, contained low levels of DDE and PCBs (ng g^{-1}). DDE and PCBs were detected in the tissues of five species of grebes (eared grebe, western grebe, pied-billed grebe, red-necked grebe, and horned grebe) from Alberta, Saskatchewan, and Manitoba (Forsyth et al. 1994). DDE levels on a geometric means basis, ranged from below the detection limit of 0.01 to 7.4 ng g^{-1} (wet wt). Geometric means for PCBs also ranged from below the detection limit of 0.01 to 21 ng g^{-1} (wet wt). Somers et al. (1987) measured PCBs and OC pesticides in otters (Lutra canadensis) from northeastern Alberta. Otters are consumers of fish, invertebrates and small aquatic mammals. PCBs ranged from 0.1 to 1.39 ng g^{-1} (wet wt) in fat tissue of adult male otters and from 0.1 to 0.33 ng g^{-1} in adult females.

2.5 REGULATORY LIMITS

Health Canada has set regulatory limits for PCBs and OC pesticides in fish flesh used for human consumption. The limit set for commercial fish for total PCB is 2,000 ng g^{-1}. Default limits (ng g^{-1}) have been given for ΣDDT of 5000 ng g^{-1}, and other OC pesticides of 100 ng g^{-1}. US Environmental Protection Agency has developed guideline limits for PCBs and major OC pesticides for use in environmental risk assessment (USEPA 1995a,b)(Table 6).

Environment Canada is preparing Environmental Quality Guidelines (EQG) for PCBs, and OC pesticides for water, sediment, and biota for non human consumption (Environment Canada 1996). The draft Canadian Environmental Quality Guidelines for protection of animals (freshwater wildlife) that consume aquatic biota is 7.6 ng g^{-1} for total PCB congeners and 6.3 ng g^{-1} for DDE. The International Joint Commission has set the protection limit for total PCBs to be 100 ng g^{-1} for predators (obtained from Gagnon et al. 1990). EPA has derived criteria for a limited number of organochlorines for protection of wildlife. Fish tissue criteria are 160 ng g^{-1} for PCBs (as Aroclor 1254) and 39 ng g^{1} for ΣDDT (US EPA 1995b). Both the USEPA and Canadian EQG values are based on an evaluation of all available toxicological data related to establishing a No Observable Adverse Effects level concentration in the most sensitive species.

Table 6. Risk levels for PCBs and major OC pesticides in fish flesh (US EPA 1995a,b)[a].

Compound	Concentration (ng g^{-1})	Compound	Concentration (ng g^{-1})
PCBs (Aroclor 1254)	220	dieldrin	540
DDT	5400	methoxychlor	54,000
Chlordane	650	HCB	8600

[a] For noncancer hazard to humans:

$$\text{Concentration} = \frac{AT \cdot BW \cdot RFD \cdot Ci}{IR \cdot EF \cdot ED}$$

where AT = averaging time (70 yrs x 365 days); BW = body weight (70 kg); RFD = reference dose (mg·kg body $wt^{-1} \cdot day^{-1}$); Ci = conversion factor (g to kg); IR = ingestion rate (6.5 g·day^{-1}); EF = exposure frequency (365 day yr^{-1}); ED = exposure duration (70 yrs).

3.0 METHODOLOGY

3.1 SITE LOCATIONS AND SAMPLE DESCRIPTIONS

3.1.1 Reach Specific Study (RSS) Survey (Project No. 3119 - May 1992)

Mountain whitefish (Family Salmonidae, *Prosopium willamsoni* (Girard)), and northern pike (Family Esocidae, *Esox lucius* (Linnaeus)) samples were collected from the Athabasca River in May of 1992 at five sampling sites within 176 km downstream from the Weldwood of Canada Ltd. pulp and paper mill and one site 10 km upstream (Table 7 and Figure 1). During September and October of 1992, the RSS sampling sites were revisited and mountain whitefish was collected from the upstream site, Weldwood Haul Road Bridge, Obed Coal Bridge, Emerson Lake, and Knight Bridges and northern pike were collected from Weldwood Haul Road Bridge, Emerson Lake, Knight and Windfall Bridges. In February of 1993, mountain whitefish were collected from the upstream site and three sites immediately downstream: Weldwood Haul Road Bridge, Obed Coal Bridge, and Emerson Lake.

Muscle samples of mountain whitefish and northern pike samples from 1992 were analyzed for PCBs, OCs, and CPs. Samples collected in February 1993 were analysed only for PCDDs and PCDFs. Sampling sites for the RSS Survey are summarized in Table 7.

3.1.2 General Fish Collection (Project No. 3117 - May 1992)

Longnose suckers (Family Catostomidae, *Catostomus catostomus* (Forster)) and mountain whitefish samples were collected from two sites on the Athabasca River: Weldwood Haul Road Bridge and Whitecourt (200 km downstream of Hinton, AB) in the period from May 5 to May 20, 1992 (Figure 1). Goldeye (Family Hiodontidae, *Hiodon alosoides* (Rafinesque)) and walleye (Family Percidae, *Stizostedion vitreum* (Mitchill)) muscle samples were collected from an additional seven sites: Goose Island, Jackfish Lake Fishing Village, and five other sites located 230.4, 299.8, 627, 630, and 633.8 km downstream from Hinton. Jackfish Lake Fishing Village is located 1208 km downstream from the Weldwood Pulp and Paper Mill (35 km before Lake Athabasca). Goldeye and walleye were collected from May 5 to June 11, 1992.

Muscle samples of long-nose sucker, mountain whitefish, goldeye, and walleye were analyzed for PCBs, OCs and CPs.

3.1.3 Special Burbot Collection (Oct to Nov 1992 and Sept to Dec 1994)

Between October and November 1992, burbot (Family Gadidae, *Lota lota* (Linnaeus)) were caught at six sites located downstream from a BKM on the Peace River (sites F1, G3, H1, I1, J3, and K1), one site on the Wapiti River (site D2) downstream from a BKM, and three sites on the Smoky River (sites A3,

Figure 1. General Map Showing 1992 Study Area[a]

[a] On the Athabasca River km are measured downstream of Hinton, whereas on the Peace and Wapiti-Smoky Rivers, km are upstream of Peace River-Lake Athabasca confluence. All values in brackets ( ) are kilometers.

Table 7. Six sampling sites of the RSS Survey, May 1992.

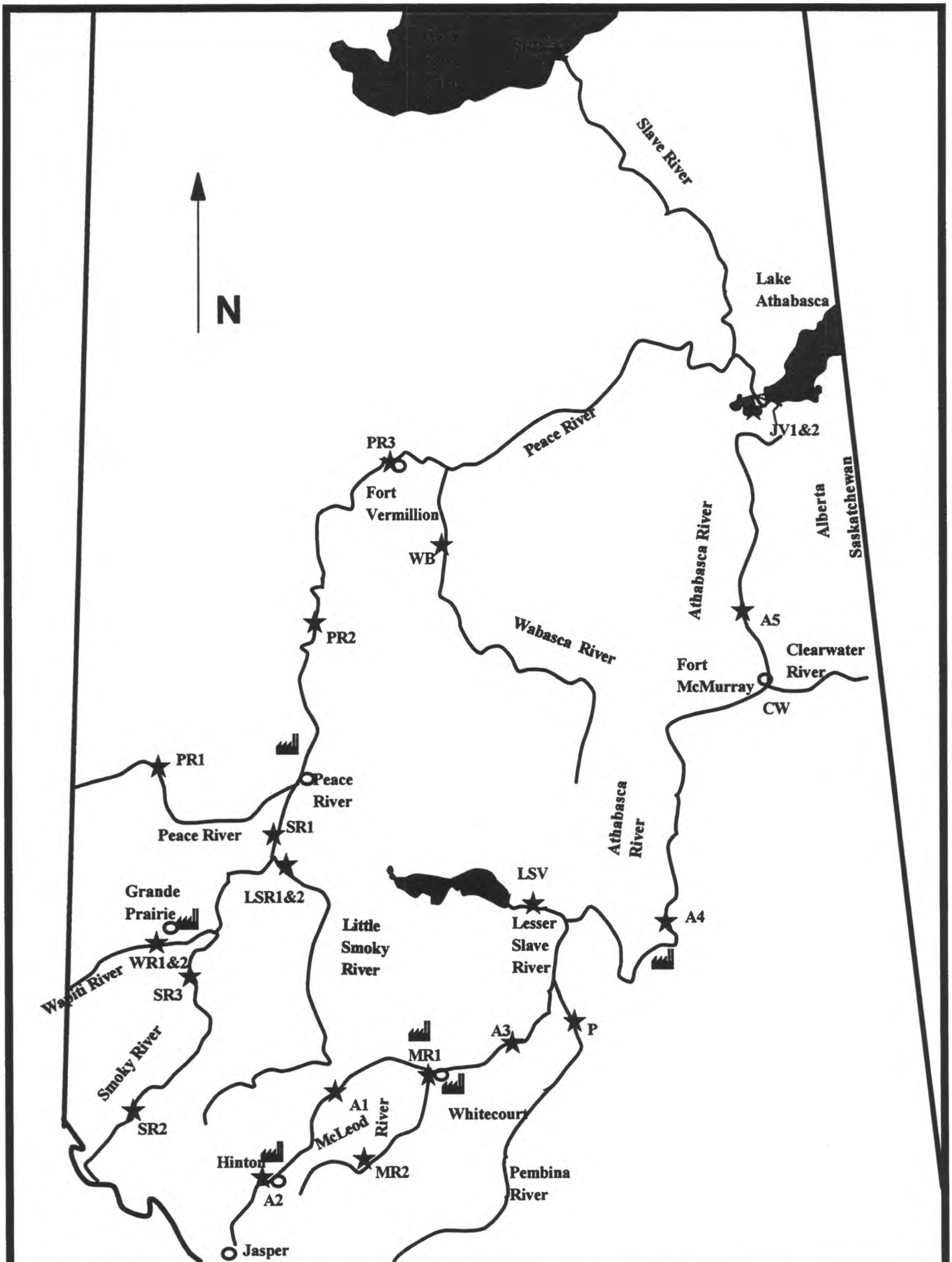
Site	Code	Description of Sampling Sites:	Distance (km) Relative to Hinton, AB
A	REF	Upstream	10 km upstream
B	HB	Weldwood Haul Road Bridge	1 km downstream
C	OB	Obed Mountain Coal Bridge	19 km downstream
D	EL	Emerson Lakes Road Bridge	48 km downstream
E	KB	Knight Bridge	116 km downstream
F	WB	Windfall Bridge	176 km downstream

Table 8. Sampling Locations of Burbot Caught on the Peace and Wapiti/Smoky River Systems, October to November 1992.

River System		Description of Location	km upstream of Peace/Slave confluence
Smoky	A3	Canfor main haul road bridge crossing	908
Smoky	B3	Hwy 34 bridge crossing	848
Smoky	C1	Near Watino (Hwy 49 bridge crossing)	755
Wapiti	D2	Below Weyerhaeuser Canada Ltd.	873
Peace	F1	Below Daishowa Marubeni International	692
Peace	G3	Near mouth of Notikewin River	551
Peace	H1	Near Carcajou	476
Peace	I1	Near Beaver Ranch Indian Reserve	313
Peace	J3	Near John d' or Prairie Indian Reserve	273
Peace	K1	Near Fox Lake Indian Reserve	240

B3, and C1) (Figure 1). These sampling sites are summarized in Table 8. Between September and December 1994, burbot was also collected from 26 sites along 12 major rivers and deltas in central Alberta (Figure 2). Sampling site descriptions are summarized in Table 9. Concentrations of PCBs, OC pesticides and CPs were determined in burbot livers

Figure 2. Locations of Sampling Sites for the Fall 1994 collection of Burbot



3.1.4 Longnose sucker and Northern Pike liver analysis (Spring 1992 and Sept to Dec 1994)

A set of 22 liver samples from Longnose suckers collected in spring 1992 as part of the General Fish Collection downstream of Hinton on the Athabasca River were analysed for OC pesticides and PCB congeners, including non-ortho PCBs. In addition, longnose sucker and northern pike were sampled from upstream from Dunvegan (PR1), downstream from Daishowa (PR2), downstream from the confluence of the Wapiti River (SR1), and upstream from Grande Prairie (WR1). PCBs and OC pesticides were determined in northern pike liver.

Table 9. Fish Collection Sites in the Northern River Basins Study Area, September to December 1994[a]

River/Delta	Site	Description
Peace	PR1	Upstream from Dunvegan (near Many Islands)
	PR2	Downstream from Diashowa (near Notikewin River)
	PR3	Near Fort Vermillion
Smoky	SR1	Downstream from the confluence of Wapiti R. (Near Highway 49
	SR2	Upstream from confluence of Wapiti R. (Near Grande Cache)
	SR3	Upstream from confluence of Wapiti R. (Near Canfor main haul bridge)
Wapiti	WR1	Upstream from Grande Prairie (near Pipestone Creek Provincial Park)
	WR2	Upstream from Grande Prairie (near O'Brian Provincial Park)
Little Smoky	LSR1	Near Highway 744 crossing
	LSR2	Downstream from Highway 744 crossing
Wabasca	WB	Near Highway 67 crossing
Athabasca	A1a	Downstream from Hinton (near Highway 947 crossing)
	A1b	Downstream from Hinton (near Berland River)
	A2	Upstream from Hinton
	A3	Downstream from Whitecourt (near Fort Assiniboine)
	A4	Downstream from ALPAC (near Calling River)
	A5	Near Fort MacKay
McLeod	MR1	Near Eagle Campground
	MR2	At Big Eddy upstream from Edson
Pembina	P	Near Jarvie
Lesser Slave	LSV	Downstream from Slave Lake Pulp
Clearwater	CW	Upstream from Fort McMurray
Peace-Athabasca	JV1	Near Jackfish Village
	JV2	Near Big Eddy
Slave River Delta	SRD1	Upstream from Nagle Channel
	SRD2	At mouth of Nagle Channel

[a] Burbot were collected at all sites (Sept.-Dec. 1994) and longnose sucker and northern pike at PR1, PR2, SR1 and WR1only.

3.1.5. <u>Fort Chipewyan Domestic Fishery (Project No. 3145 - Fall 1994)</u>

Burbot, northern pike, lake whitefish (*Coregonus clupeaformis*), Goldeye (Family Hiodontidae, *Hiodon alosoides* (Rafinesque)), walleye (Family Percidae, *Stizostedion vitreum* (Mitchill)) were collected from three sites in the Peace-Athabasca delta region: Quatre Fourches, Jackfish Lake Fishing Village, and Potato Island (Lake Athabasca) in the Fall of 1994 and winter of 1995. Jackfish Lake Fishing Village is located 1208 km downstream from the Weldwood Pulp and Paper Mill (35 km from Lake Athabasca) while Potato Island is in Lake Athabasca south of Fort Chipewyan (Figure 2).

Composite muscle samples from 8 to 10 individual fish of each species from each of the three sites (plus burbot liver composites) were analyzed for PCBs and OC pesticides.

3.2 FIELD AND LABORATORY METHODOLOGIES

Fish sampling procedures are outlined in a NRBS report by EnviResource Consulting Ltd (1995). PCBs, CPs, and other OCs in fish tissues and livers were determined by Zenon Environmental Laboratories. Analytical methodologies are summarized in a report by of Zenon Environmental Laboratories (1992). All contaminant data are presented as ng g^{-1} (wet wt). Detection limits were determined separately for each fish tissue and each organochlorine analyzed.

3.3 ORGANOCHLORINE AND PCB ANALYSIS FOR FISH TISSUE

In brief, OCs and PCBs were extracted from the samples by the following procedure (Zenon Environmental Laboratories 1992):

1. Extracted contaminants into an organic solvent
   - add surrogates to tissue; grind with sodium sulphate (Na_2SO_4) and Soxhlet extract with dichloro methane (DCM)
   - gel permeation chromatography (GPC) cleanup with SX-3 biobeads to remove lipids
   - F1 Hexane fraction contains PCBs, some toxaphene and OCs
   - F2 Hexane:DCM (85:15) fraction contains most toxaphenes and some OCs
   - F3 Hexane:DCM (50:50) fraction contains the rest of the OCs
   - concentrate extracts to 1 mL using a rotary evaporator
2. Measured contaminants by capillary gas chromatography/electron capture detector (GC/ECD)
   - match Aroclor standard for total PCBs and individual PCBs using standards from NRC Marine Analytical Standards Program, Halifax NS.

Detection limits for major organochlorine pesticides (ng g^{-1} wet wt) are listed in Table 10. Detection limits for 62 PCB congeners ranged from 0.3 ng g^{-1} for dichlorobiphenyls and 0.02 to 0.05 ng g^{-1} for tri- to deca-chlorobiphenyls.

Table 10. Detection Limits (DL) for OC Pesticides in Fish Muscle (ng g^{-1} wet wt).

Congener	DL	Congener	DL	Congener	DL	Congener	DL
HCB	0.1	Heptachlor	0.2	Heptachlor Epoxide	0.4	α,β,γ,Δ-HCH	0.2
Aldrin	0.2	Dieldrin	1	Endrin	1	α-Chlordane	1
Oxychlordane	1	*trans*-Nonachlor	1	p,p'-DDT	1	p,p'-DDE	0.5
p,p'-DDD	1	o,p'-DDT	1	Methoxychlor	2	Mirex	2
Endosulfan 1	1	Endosulfan 2	1	Endosulfan Sulfate	2	Toxaphene	50

Coplanar PCBs were extracted from samples by the following methods:

1. Extracted contaminants into an organic solvent
   - add labelled surrogates to tissue (^{13}C-CBs 77, 126, and 169)
   - grind with Na_2SO_4 and Soxhlet extract with DCM
   - GPC cleanup with SX-3 biobeads on Autoprep system
   - cleanup on 2% water deactivated Florisil
   - elute Florisil column directly onto carbon column discarding the 20 mL DCM eluate
   - invert carbon column and elute with 4 mL of toluene
   - concentrate toluene to near dryness under a stream of nitrogen
   - make up to 25 μL with toluene containing an internal standard D10 - anthracene
2. Measured individual congeners by low resolution gas chromatography mass spectrometry (GC/MS) using selected ion monitoring
   - each compound corrected for surrogate recovery of the ^{13}C-labelled compound CB 77
3. Detection limits - coplanar PCBs = ~ 0.005 ng g^{-1}.

3.4 CHLOROPHENOLIC ANALYSIS

Chlorinated phenols, guaiacols and catechols were extracted from fish tissues by the following procedures (Zenon Environmental Laboratories 1992):

1. Extracted contaminants into an organic solvent
   - add ^{13}C-labelled surrogates to tissue (2,4-dichlorophenol, pentachlorophenol, 4,5-dichlorocatechol, tetrachlorcatechol, 4-chloroguaiacol, 4,5,6-trichloroguaiacol, 3,4,5,6-tetrachloroguaiacol, and 5-chlorovanillin)
   - grind with Na_2SO_4 ; Soxhlet extract with DCM and GPC cleanup to remove lipids
   - back extract with 0.1 N potassium carbonate to isolate CPs
   - acetylate in hexane with acetic anhydride and concentrate extract to 100 μL
   - add ascorbic acid to prevent oxidation of the catechols; reduce in volume to 0.5 mL
2. Measured contaminants by GC/MS using selected ion monitoring
3. Detection limits - phenols = 0.2 ng g^{-1}; guaiacols and catechols = 0.4 ng g^{-1}

Levels of chlorinated anisoles and veratroles in fish tissues were determined as described for OC analysis except that labelled surrogates (2,4-dibromoanisole, 2,4,6-tribromoanisole) were added prior to extraction.

1. Extracts were concentrated to 100 μL using rotary evaporator and nitrogen
2. Measure individual congeners by capillary GC/MS using selected ion monitoring
3. Detection limits - anisole = 0.2 ng g^{-1}; veratroles = 0.4 ng g^{-1}

3.5 QUALITY ASSURANCE

Quality assurance protocols for organics in fish analysis are described in analytical data reports by Zenon Environmental Laboratories. In brief, key features of the Zenon's laboratory QA/QC program include the use of surrogates for each compound class to accurately track recoveries for all chemicals analysed. Spiked recoveries were measured for all analytes to demonstrate analytical proficiency of the methods and analytes. One in every 14 samples was analyzed in duplicate. Blanks were run with every sample batch. Low detection limits were attained by using selected ion monitoring for coplanar PCBs and chlorophenolics and electron capture detection for PCBs, OCs, and toxaphene. Labelled copies of all chromatograms and GC/MS scans were provided for all samples and standards. Zenon laboratories participates in inter lab comparisons (Canadian Association of Pesticide Control and US EPA) for pesticides and organic compounds.

The individual organochlorine components routinely analysed in fish samples is given in Appendix A. This list included 10 chlorophenolics, 22 OC pesticide-related components (chlorobenzenes, hexachlorocyclohexanes, chlordane-related compounds, the DDT-group, mirex, methoxychlor and the endosulfan group) and 62 PCB congeners. Further details can be obtained in Zenon Environmental Laboratories (1992). For reporting purposes PCB congeners were summed to yield total PCBs (ΣPCB) and PCB homologs (ΣTri, tetra etc). Other groups (e.g. total DDT-related compounds; ΣDDT) were also summed for reporting purposes and for univariate statistical analysis.

3.6 STATISTICAL ANALYSIS

Mean concentrations of PCB congener/ homologs, and individual OC pesticides and CPs, were calculated assuming non-detect concentrations were zero. This decision was based on the fact that levels of many individual components were low, with the exception of burbot liver, and there was insufficient justification for assuming levels at or near detection limits as was done with PCDD/Fs (Pastershank and Muir 1995).

The Student's t-tests ($p = 0.05$) or non-parametric tests were used to compare levels of selected CPs, OC pesticides and PCBs in mountain whitefish and northern pike (fall 1992) at each site and to examine differences between spring 1992 and fall 1992 concentrations. The Univariate Procedure was used to test the normality of all data. If the assumptions of normality or homogeneity of variances were not met, the data was analyzed with the nonparametric Wilcoxon Rank Sum test or Mann-Whitney U test (at $p = 0.05$). Proc Corr (SAS 1991) was used to determine if the levels of major groups (e.g. ΣPCBs, ΣDDT) correlated with the length, wet weight, and age of the fish for each site. To test the effect of location (upstream vs. downstream BKM sits) on the bioaccumulation CPs, OC pesticides and PCB in mountain whitefish and northern pike the "post hoc" comparison procedure chose was Wilcoxon Rank Sum test (PROC NPAR1WAY, $p = 0.05$) was chosen.

Data for ΣPCB, ΣDDT, PCB congener 153 and p,p'-DDE in burbot liver were compared using Analysis of Covariance (ANCOVA) following the approach of Hebert and Keenleyside (1995). To avoid spurious correlations from substituting detection limit value or zero, random numbers between the detection limit (0.01 ng g^{-1}) and 0.003 ng g^{1} were used. For ANCOVA all concentrations were log transformed to reduce skewness. Where results of the ANCOVA showed that lipid was a significant covariate but no significant lipid-site interaction comparisons among locations were made with least-square mean concentrations adjusted by the common slope of lipid vs OC group derived from the ANCOVA (Hebert and Keenleyside 1995). Where no significant effect of lipid or lipid-site interaction was observed comparisons between sites were made using Tukey's multiple means test using the mean square error from the ANCOVA (SAS 1991).

4.0 RESULTS FOR THE REACH SPECIFIC STUDY (upper Athabasca River)

Mean concentrations of all CPs, OC pesticides, and PCBs congeners detected in fish from RSS spring 1992 collection are summarized in Appendix A, Tables A1 to A3, respectively. In the fall of 1992, the same sites were revisited and approximately half as many mountain whitefish and northern pike were caught. For the fall samples only OC and PCB analysis was conducted. Mean concentrations are summarized in Appendix A, Tables A4 and A5, respectively.

Tables 11 and 12 summarize the total sum of each major organochlorine group for mountain whitefish and northern pike, respectively. Results are tabulated as mean concentrations (± SD). Specific OC groups are discussed below. On a ng g^{-1} wet wt basis, PCBs were the major organochlorines found in mountain whitefish and northern pike, followed by OC pesticides and then CPs.

4.1 CHLOROPHENOLICS

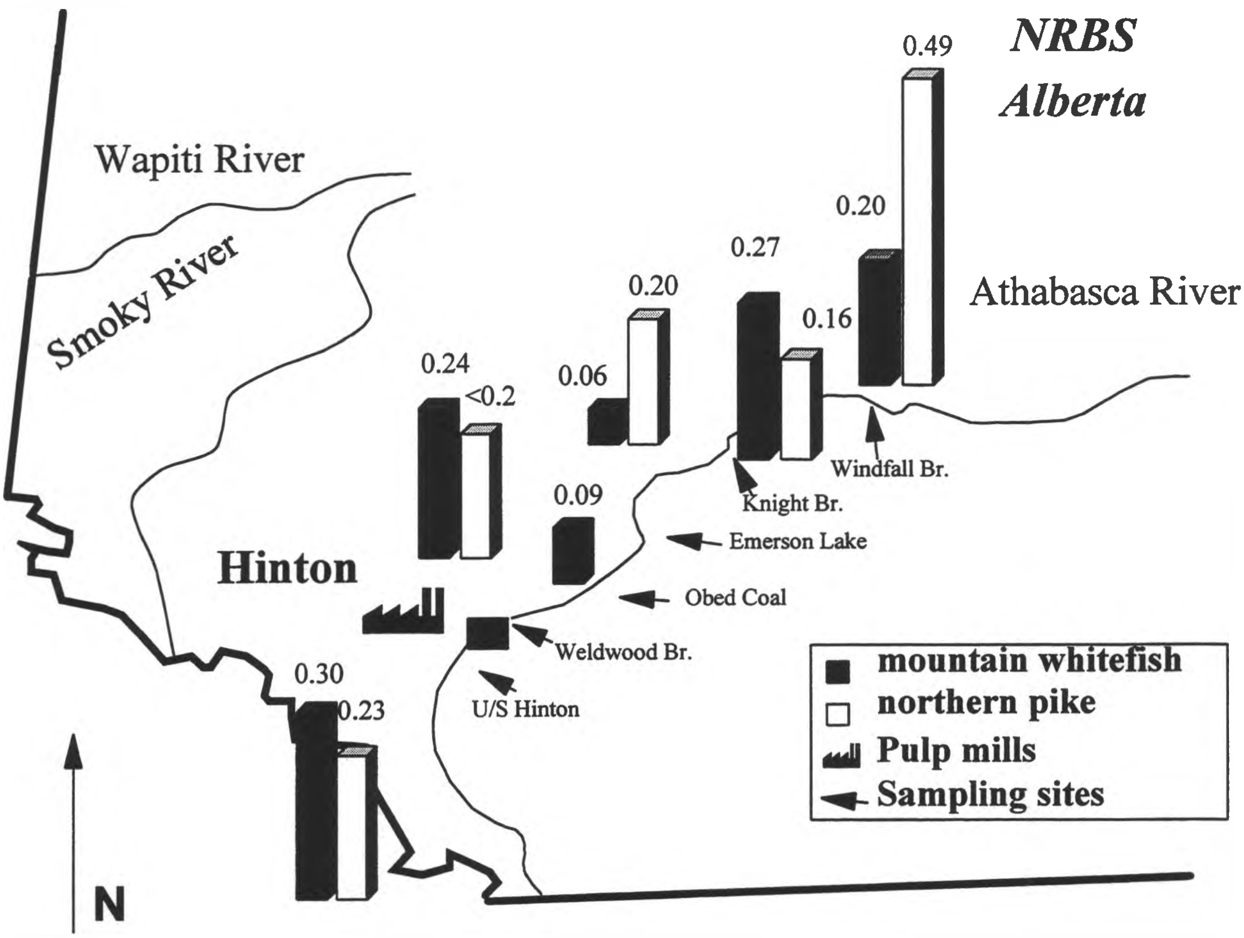
Chlorophenolic analysis was conducted only for mountain whitefish and northern pike collected in the spring 1992 collection. These results are presented below.

4.1.1. Phenols.

PCP was detected in the muscle of mountain whitefish and northern pike from the upstream and downstream sites (Table 11 and 12; Figure 3). Upstream concentrations were as high as downstream levels for both fish species. PCP was found in 40% of the mountain whitefish from the upstream site at a mean concentration of 0.3 ng g^{-1}. At the downstream sites, PCP was found in 13 to 82% of the mountain whitefish at individual levels from 0.1 to 0.3 ng g^{-1} and 50 to 60% of the northern pike at the downstream sites at mean levels of 0.3 to 0.5 ng g^{-1}. PCP was also found in 33% of the northern pike from the upstream site with a mean concentration of 0.2 ng g^{-1}. There were no significant differences (NPAR1WAY, $p > 0.05$) in the levels of PCPs between mountain whitefish and northern pike at the upstream site, Weldwood Haul Road Bridge, and Knight and Windfall Bridges (Table 13).

Tetra-, tri- and di-chlorophenols were always below the detection limits of <0.2 ng g^{-1} in mountain

Figure 3. Levels of PCP ($ng \cdot g^{-1}$ wet wt) in Mountain Whitefish and Northern Pike, Athabasca River, Spring 1992.



whitefish and northern pike muscle. These congeners were 2,3,4,6-, 2,3,4,5- and 2,3,4,5-tetrachlorophenol, 2,3,4-, 2,3,6-, 2,4,5- and 2,4,6-trichlorophenol, and 2,4- and 2,6-dichlorophenol.

4.1.2. Guaiacols.

Guaiacols were rarely detected in mountain whitefish muscle and not detected in northern pike. Two mountain whitefish from the Obed Coal site contained 3,4,5-trichloroguaiacol of 0.5 ng g^{-1} in their muscle tissue. Six guaiacol congeners were not detected in mountain whitefish or northern pike; tetra-, 3,4,5-, 3,4,6- and 4,5,6-trichloroguaiacol, 4,5- and 4,6-dichloroguaiacol, and 4-chloroguiacol with detection limits of 0.4 ng g^{-1}.

Table 11. Concentrations of CPs, OC pesticides and PCBs Homologs (ng g^{-1} wet wt) in Mountain Whitefish Muscle, Athabasca River, Spring 1992[a].

	Sites					
	U/S	Weldwood Haul Br.	Obed Coal	Emerson Lake	Knight Br.	Windfall Br.
CPs:	(n=10)	(n=11)	(n=10)	(n=8)	(n=9)	(n=10)
PCP	0.3 ± 0.4	0.2 ± 0.2	0.1 ± 0.2	0.1 ± 0.2	0.3 ± 0.2	0.2 ± 0.3
TCV	0.8 ± 0.8	4.0 ± 2.7	3.6 ± 2.7	6.7 ± 2.9	1.6 ± 1.0	2.7 ± 0.9
PCA	<0.4	0.9 ± 0.7	0.7 ± 0.5	0.8 ± 0.4	0.2 ± 0.2	0.1 ± 0.2
OC Pesticides:	(n=10)	(n=10)	(n=10)	(n=8)	(n=10)	(n=4)
ΣHCH	1.3 ± 1.4	0.1 ± 0.2	2.6 ± 1.9	0.2 ± 0.2	0.0 ± 0.1	0.1 ± 0.1
ΣCHLOR	5.4 ± 5.5	0.1 ± 0.3	3.0 ± 3.3	0.2 ± 0.4	<1	0.5 ± 0.6
HCB	0.4 ± 0.4	0.8 ± 0.3	33.6 ± 30.0	1.2 ± 0.5	0.5 ± 0.3	0.8 ± 0.2
o,p'-, p,p'-DDT	2.8 ± 3.0	0.6 ± 1.3	3.0 ± 3.7	0.3 ± 0.7	<1	<1
p,p'-DDE	1.8 ± 3.7	0.6 ± 0.5	0.8 ± 0.6	0.8 ± 0.9	0.1 ± 0.3	0.3 ± 0.7
p,p'-DDD	1.8 ± 2.0	<1	2.6 ± 3.0	<1	<1	0.3 ± 0.5
Σtoxaphene	21.0 ± 36.0	<50	<50	<50	<50	<50
PCBs:	(n=10)	(n=9)	(n=10)	(n=8)	(n=9)	(n=4)
ΣPCB	11.1 ± 7.3	17.2 ± 9.8	23.6 ± 11.1	30.0 ± 14.2	9.4 ± 7.5	20.0 ± 14.1
Σdi	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Σtri	0.7 ± 1.0	0.7 ± 1.1	2.1 ± 2.4	0.1 ± 0.4	0.1 ± 0.2	3.3 ± 4.5
Σtetra	0.5 ± 0.8	1.2 ± 2.4	1.8 ± 1.6	1.4 ± 1.0	0.1 ± 0.4	1.6 ± 2.8
Σpenta	2.1 ± 2.1	4.0 ± 2.8	5.3 ± 2.3	7.2 ± 2.3	2.4 ± 2.7	3.5 ± 3.6
Σhexa	4.4 ± 2.9	7.8 ± 4.4	9.5 ± 5.2	15.3 ± 8.7	4.2 ± 2.5	7.9 ± 5.6
Σhepta	2.1 ± 1.5	2.8 ± 1.2	3.2 ± 1.1	5.2 ± 2.1	2.2 ± 2.0	3.2 ± 3.9
Σocta	0.6 ± 0.5	0.6 ± 0.5	0.5 ± 0.4	0.8 ± 0.4	0.2 ± 0.3	0.4 ± 0.7
Σnona	0.2	0.1 ± 0.3	0.0 ± 0.1	0.1 ± 0.2	<0.02	0.1 ± 0.2
Σdeca	0.0 ± 0.1	0.0 ± 0.1	<0.02	<0.02	<0.02	<0.02

[a] Concentrations of individual components are given in Appendix A1.

4.1.3. Catechols.

Tetrachlorocatechol (TCC) and 3,4,5-trichlorocatechol were detected in some mountain whitefish from two sites; the upstream and Obed Coal sites. TCC (0.8 ± 0.8 ng g^{-1}) was detected in six mountain whitefish out of 10 from the upstream site. At this site 5 out of ten mountain whitefish also contained low levels of 3,4,5-trichlorocatechol (0.5 ± 0.6 ng g^{-1}). Five out of 10 mountain whitefish contained TCC (0.9 ± 1.5 ng g^{-1}) at the Obed Coal site. One of these fish also contained 1.2 ng[1] g of 3,4,5-trichlorocatechol. TCC, 3,4,5-trichlorocatechol, and 3,5- and 4,5-dichlorocatechol were also detected in the muscle of a few northern pike from two sites; the upstream and Windfall Bridge sites. At the upstream site, one northern pike out of six had concentrations of TCC and 3,4,5-trichlorocatechol of 4.5 and 2.7 ng g^{-1}, respectively. Another northern pike from the upstream site had levels of TCC, 3,4,5-trichlorocatechol, and 3,5- and 4,5-dichlorocatechol of 7.7, 7.2, 2.4, and 3.5 ng g^{-1}, respectively. TCC was detected in two northern pike (0.5 and 1.0 ng g^{-1}) out of ten from the Windfall Bridge site.

Table 12. Concentrations of CPs, OC pesticides and PCB Homologs (ng g^{-1} wet wt) in Northern Pike Muscle, Athabasca River, Spring 1992[a].

	Sites				
	U/S	Weldwood Haul Br.	Emerson	Knight Br.	Windfall Br.
CPs:	(n=6)	(n=1)	(n=2)	(n=10)	(n=10)
PCP	0.2 ± 0.4	<0.2	0.2 ± 0.3	0.2 ± 0.2	0.5 ± 0.5
TCV	0.9 ± 2.1	<0.4	0.7 ± 0.0	0.1 ± 0.2	0.1 ± 0.2
PCA	0.1 ± 0.3	<0.2	0.1 ± 0.1	<0.2	<0.2
OC Pesticides:	(n=6)	(n=1)	(n=1)	(n=10)	(n=0)
ΣHCH	0.4 ± 0.4	<0.2	0.2	0.1 ± 0.1	
ΣCHLOR	0.4 ± 0.4	<1	0.2	0.1 ± 0.1	
HCB	0.3 ± 0.4	0.1	0.4	0.5 ± 0.2	
o,p'-, p,p'-DDT	0.3 ± 0.8	<1	<1	<1	
p,p'-DDE	0.2 ± 0.3	0.5	0.4	0.1 ± 0.5	
p,p'-DDD	0.3 ± 0.5	<1	<1	0.1 ± 0.3	
Σtoxaphene	8.3 ± 20.0	<50	<50	<50	
PCBs:	(n=6)	(n=1)	(n=1)	(n=10)	(n=0)
ΣPCB	4.5 ± 2.8	<1	7.5	3.5 ± 3.4	
Σdi	<0.3	<0.3	<0.3	<0.3	
Σtri	0.2 ± 0.6	<0.5	0.5	0.1 ± 0.2	
Σtetra	0.1 ± 0.2	<0.4	0.6	<0.4	
Σpenta	0.7 ± 0.7	<0.3	1.5	0.7 ± 0.7	
Σhexa	1.6 ± 1.1	<0.02	3.9	2.2 ± 2.0	
Σhepta	0.4 ± 0.2	<0.02	0.8	0.6 ± 0.6	
Σocta	0.0 ± 0.0	<0.02	<0.02	0.1 ± 0.1	
Σnona	<0.02	<0.02	<0.02	<0.02	
Σdeca	<0.02	<0.02	<0.02	<0.02	

[a] Concentrations of individual components are given in Appendix A2 and A3.

Table 13. Concentrations of PCP (± SD) in Northern Pike and Mountain Whitefish Muscle from the Athabasca River, May/June 1992.

Location	Northern pike Conc.[a] ng g^{-1} (wet wt)	Northern pike Sample Size	Mountain whitefish Conc.[a] ng g^{-1} (wet wt)	Mountain whitefish Sample Size	NPAR1WAY[a,b,c] ($p < 0.05$)
U/S Hinton (-10 km)	0.2 ± 0.4	6	0.3 ± 0.4	10	NS
Weldwood Haul Bridge (1 km)	<0.2	2	0.2 ± 0.2	9	N/A
Obed Coal Bridge (19 km)	ND[c]	0	0.1 ± 0.2	10	N/A
Emerson Lake (48 km)	0.0 ± 0.3	1	0.1 ± 0.2	8	N/A
Knight Bridge (116 km)	0.2 ± 0.2	10	0.3 ± 0.2	9	NS
Windfall Bridge (176 km)	0.5 ± 0.6	10	0.2 ± 0.2	10	NS

[B] Average concentrations and statistical tests were based on all fish from a sample site, including the fish where zero was substituted for non detects.
[B] This column tests significant differences between the levels of PCP in mountain whitefish and northern pike.
[C] Symbols: NS = Not Significant; ND = No Data; N/A = Not Applicable.

4.1.4 Veratroles and Anisoles.

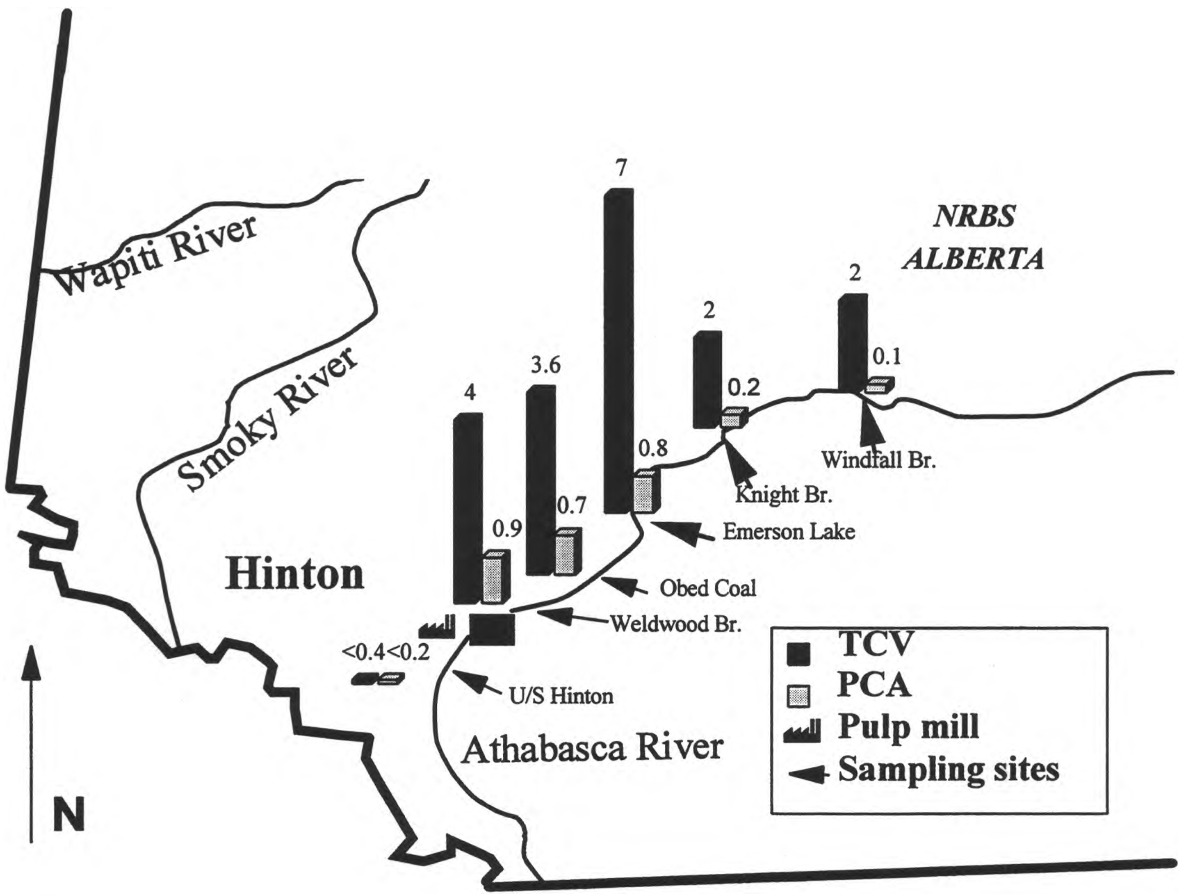
Tetrachloroveratrole (TCV) and pentachloroanisole (PCA) were the major chlorophenolics found in mountain whitefish muscle (Figure 4). Levels of TCV and PCA are summarized in Tables 11 and 12 for mountain whitefish and northern pike, respectively.

TCV and PCA were detected in most mountain whitefish muscle at the five sites downstream of Hinton. At the Emerson Lake site, 100% of the fish contained these two congeners. At this site, mean concentrations of TCV and PCA were 7 ± 3 ng g^{-1} and 0.7 ± 0.5 ng g^{-1}, respectively.

Mean TCV levels in northern pike muscle were highest at the upstream site (0.9 ± 2 ng g^{-1}). TCV accumulated in two out of six northern pike from the upstream site. At the downstream sites, TCV was detected in both fish from the Emerson Lake site (0.7 ng g^{-1}), three out of ten fish at the Knight Bridge site (0.4, 0.4 and 0.6 ng g^{-1}, respectively), and two out of ten fish at the Windfall Bridge site (0.4 and 0.5 ng g^{-1}, respectively). PCA was detected in one northern pike from the upstream site at concentrations of 0.7 ng g^{-1} and one from the Emerson Lake site at concentrations of 0.2 ng g^{-1}.

Mountain whitefish contained significantly higher levels (NPAR1WAY, $p < 0.01$) of TCV than northern pike at the Knight and Windfall Bridge sites (Table 14). Levels of TCV in northern pike were not significantly different from mountain whitefish at the Weldwood Haul site. PCA was also significantly higher in mountain whitefish at Knight and Windfall Bridge (results not shown). Comparison could not be made between levels of TCV and PCA in the two species at the upstream, Obed Coal and Emerson Lake sites because of sites with limited sample sizes or TCV levels below the detection limits.

Figure 4. Levels of TCV and PCA (ng·g^{-1} wet wt) in Mountain Whitefish muscle samples from the Athabasca River, Spring 1992.



4.1.5 Other CPs.

CP congeners not detected in mountain whitefish or northern pike were 2,6- dichlorosyringaldehyde, 2-chlorosyringaldehyde, 3,4,5-trichlorosyringol, trichloromethoxybenzene, 5,6-dichlorovanillin and 6-chlorovanillin. Detection limits for each of these congeners were 0.4 ng g^{-1}.

Table 14. Levels of TCV (± SD) in Northern Pike and Mountain Whitefish Muscle from the Athabasca River, May/June 1992.

	Northern pike		Mountain whitefish		
Location	Conc.[a] ng g^{-1} (wet wt)	Sample Size	Conc.[a] ng g^{-1} (wet wt)	Sample Size	NPAR1WAY[a,b,c] ($p < 0.05$)
U/S Hinton (-10 km)	1.3 ± 2.9	6	<0.4	10	N/A
Weldwood Haul Bridge (1 km)	< 0.4	2	4.1 ± 0.3	9	NS
Obed Coal Bridge (19 km)	ND[c]	0	3.7 ± 3.0	10	N/A
Emerson Lake (48 km)	0.7 ± 0	1	6.7 ± 2.9	8	N/A
Knight Bridge (116 km)	0.1 ± 0.2	10	1.6 ± 1.0	9	**
Windfall Bridge (176 km)	0.1 ± 0.2	10	2.7 ± 1.6	10	**

[a] Average concentrations and statistical tests were based on all fish from a sample site, including the fish where zero was substituted for non detects

[b] This column tests significant differences between the levels of TCV in mountain whitefish and northern pike.

[c] Symbols: NS = Not Significant; ND = No Data; N/A = Not Applicable; * *= highly significant at the $p < 0.01$ level.

4.2 ORGANOCHLORINE PESTICIDES

OC pesticide analysis was conducted on the muscle tissue of mountain whitefish and northern pike collected in the spring and fall, 1992. These results are presented in Tables 11 and 12 (spring 1992) and Tables 15 and 16 (fall 1992).

4.2.1 Spring 1992.

Most OC pesticides were detected in mountain whitefish and northern pike at the upstream and downstream sites in low ng g^{-1} concentrations. The most common HCH isomer detected in mountain whitefish and northern pike was α-HCH, and less common were β- and γ-HCH. HCB was detected in low levels (< 1 ng g^{-1}) in all mountain whitefish and most northern pike sampled. Four chlordane related compounds detected in some mountain whitefish were *cis-* and *trans-* chlordane, *trans*-nonachlor, and oxychlordane. The highest concentrations of total chlordane (ΣCHLOR) were seen in mountain whitefish and northern pike at the upstream site than the downstream sites.

Mountain whitefish from the upstream site generally had higher concentrations of DDT related congeners (mean concentrations between 1.8 and 2.8 ng g^{-1}) than the downstream sites (mean concentrations of 0.8 ng g^{-1}) (Table 11). p,p'-DDE (the persistent metabolic breakdown product of p,p'-DDT) and p,p'-DDT was commonly detected in mountain whitefish and northern pike. There were no significant differences (NPAR1WAY, $p > 0.05$) in levels of p,p'-DDE between mountain whitefish and northern pike from any of the sample sites (Table 17). Zenon Laboratories had analytical problems when analyzing for o,p'-DDT. o,p'-DDT may have co-eluted with *cis*-nonachlor and related compounds under GC conditions used.

OC pesticides not detected in mountain whitefish and northern pike muscle were dieldrin, endrin, heptachlor and heptachlor epoxide, mirex, *delta*-HCH, and endosulfan I & II and endosulfan sulphate. In addition, *trans*-nonachlor and oxychlordane were not detected in muscle of northern pike.

Toxaphene was only found in the muscle of mountain whitefish (21 ± 36 ng g^{-1}) and northern pike (8.3 ± 20 ng g^{-1}) from the upstream site. Zenon Laboratories had difficulty in quantifying toxaphene. An interlaboratory comparison between three analytical laboratories, including Zenon, found good agreement between the two other labs on the analysis of toxaphene (Appendix E1). These labs generally reported higher concentrations of toxaphene than Zenon for the samples in the interlab comparison and lower detection limits. The lack of agreement between Zenon and the other labs is probably related to the use of GC-ECD to determine toxaphene in the NRBS fish samples. This procedure is not as specific nor as sensitive as the mass spectrometry techniques used by the other labs.

4.2.2 Fall 1992.

Like the Spring 1992 collection, concentrations of OC pesticides in mountain whitefish and northern pike were generally in the low ng g^{-1} concentration range (Table 15 and 16). Toxaphene levels in mountain whitefish were lowest at the upstream site (5.0 ± 5.8 ng g^{-1}) and highest at the site closest to the BKM at the Weldwood Haul Road site (28 ± 15 ng g^{-1}). These toxaphene results are opposite to those obtained for the spring collection where the only detectable levels of toxaphene were seen from the mountain whitefish and northern pike from the upstream site. The analytical detection limits for toxaphene were better in the fall fish collections (10 ng g^{-1}) than in the spring collection (50 ng g^{-1}). For northern pike, one fish contained concentration of toxaphene above the detection of 10 ng g^{-1}. This northern pike was caught at the Weldwood Haul Road sit at a concentration of 20 ng g^{-1}. The fall concentrations of ΣCHLOR in mountain whitefish was made solely up of *trans*-nonachlor, whereas the spring concentrations of ΣCHLOR were made up of a combination of *cis*- and *trans*-chlordane, oxychlordane, and *trans*-nonachlor.

4.3 PCBS IN MOUNTAIN WHITEFISH AND NORTHERN PIKE MUSCLE

4.3.1 Spring 1992

Elevated levels of PCBs were seen in mountain whitefish and northern pike at the sites immediately downstream of Hinton (Table 11, 12, 15 and Figure 5). ΣPCB levels were highest for mountain whitefish from the Weldwood Haul Road Obed Coal, and Emerson Lake sites, slightly lower at the Knight Bridge site, and no mountain whitefish from Windfall Bridge were analyzed. ΣPCB levels mountain whitefish at the upstream site (11 ± 7.3 ng g^{-1}) were significantly higher than at the Obed Coal (24 ± 11 ng g^{-1}) and Emerson Lake 30 ± 14 ng g^{-1} sites (NPAR1WAY, $p<0.05$). A similar pattern was seen for northern pike, except that no fish were sampled from the ObedCoal site and ΣPCB levels in northern pike at the upstream site (4.5 ± 2.8 ng g^{-1}) did not differ significantly (NPAR1WAY, $p<0.05$) from those at Emerson Lake (7.5 ± 4.9 ng g^{-1}). Significantly higher levels (NPAR1WAY, $p<0.05$) of ΣPCBs were seen in mountain whitefish than northern pike only at the Knight Bridge site otherwise concentrations were similar (Table 18).

Similar patterns of PCB homologs were seen in mountain whitefish and northern pike from the upstream and five downstream sites. Penta-, hexa, and heptachlorobiphenyls accounted for $85 \pm 8\%$ of the total PCB levels in mountain whitefish and $90 \pm 6\%$ for northern pike. Proportion of tri- and tetrachlorobiphenyls were slightly higher in northern pike ($12 \pm 8\%$) than in mountain whitefish muscle ($9 \pm 7\%$). Differences between whitefish and pike were most obvious in the case of octachloro-congeners. The percent of octachlorobiphenyls was $3.0 \pm 1.5\%$ in whitefish and $0.65 \pm 0.70\%$in pike. Dichloro-congeners, as well as nona- and decachloro- congeners were rarely detected in mountain whitefish and were consistently below detection limits in pike muscle. PCB congeners commonly found in mountain whitefish were PCB 110, 138, 149, 153, and 180. This was also true for northern pike except that PCB 110 was not as prevalent.

4.3.2 Fall 1992

Concentrations of ΣPCBs in mountain whitefish muscle collected in fall 1992 were higher than in the spring samples (Table 11 and 15), however, the differences were not significantly different (NPAR1WAY, $p<0.05$) because of high variance among individual samples and small sample sizes. Higher ΣPCBs were seen at the upstream site compared with the four downstream locations. Northern pike muscle from fall 1992 also had higher ΣPCBs. At Knight Bridge, the only site at which statistical comparison could be made, mean concentrations did not differ significantly ($p >0.05$) because of high variance especially among individual pike from the spring collection. There was no spatial trends discernable in ΣPCB levels in northern pike in the four sampling sites downstream of Hinton. Samples of pike were not available from upstream site in fall 1992.

4.4 CORRELATION OF AGE, LENGTH, AND WEIGHT WITH MAJOR OCs

Tables 18 and 19 present the correlation coefficients of each major OC detected in mountain whitefish and northern pike with fish age, length, and weight at each sampling location.

Table 15. Levels of OC pesticides and PCB Homologs (ng g^{-1} wet wt) in Mountain Whitefish Muscle, Athabasca River, Fall 1992[a]

	Sites				
	U/S	Weldwood	Obed	Emerson	Knight
OC Pesticides:	(n=4)	(n=4)	(n=5)	(n=4)	(n=3)
ΣHCH	1.4 ± 0.56	0.95 ± 0.62	0.66 ± 0.13	0.83 ± 0.34	1.3 ± 1.1
ΣCHLOR	<1	2.8 ± 3.0	2.2 ± 2.5	6.0 ± 6.68	<1
HCB	0.55 ± 0.38	1.3 ± 0.77	0.44 ± 0.17	1.1 ± 0.49	2.3 ± 2.9
o,p'-, p,p'-DDT	<1	0.75 ± 0.96	0.4 ± 0.89	0.75 ± 0.96	<1
p,p'-DDE	0.68 ± 0.17	1.5 ± 0.79	1.3 ± 0.55	1.8 ± 0.67	0.93 ± 0.42
p,p'-DDD	<1	0.25 ± 0.5	<1	<1	<1
Σtoxaphene	5.0 ± 5.8	28 ± 15	16 ± 8.9	12.5 ± 9.6	10 ± 10
PCBs:	(n=4)	(n=4)	(n=5)	(n=4)	(n=3)
ΣPCB	14 ± 6.2	65 ± 47	47 ± 34	77 ± 79	12 ± 5.3
Σdi	<0.3	1.4 ± 1.1	0.24 ± 0.34	<0.3	<0.3
Σtri	0.75 ± 0.75	2.9 ± 2.4	1.5 ± 1.4	2.8 ± 3.4	0.21 ± 0.19
Σtetra	0.0	13 ± 12	9.9 ± 8.9	0.05 ± 0.06	2.5 ± 1.9
Σpenta	4.0 ± 2.0	26 ± 21	20 ± 15	53 ± 34	4.8 ± 3.6
Σhexa	3.6 ± 2.4	10 ± 6.4	8.9 ± 4.8	35 ± 45	2.3 ± 0.77
Σhepta	3.3 ± 1.9	8.9 ± 4.7	6.2 ± 3.6	6.1 ± 5.4	1.9 ± 0.81
Σocta	0.36 ± 0.30	1.4 ± 1.6	0.97 ± 0.73	0.84 ± 0.99	0.38 ± 0.26
Σnona	<0.02	0.18 ± 0.31	0.11 ± 0.13	0.10 ± 0.13	0.01 ± 0.01
Σdeca	<0.02	<0.02	<0.02	<0.02	<0.02

[a] Concentrations of individual components are given in Appendix A4 and A5.

Table 16. Levels of OC pesticides and PCB Homologs (ng g^{-1} wet wt) in Northern Pike Muscle, Athabasca River, Fall 1992.

	Weldwood	Emerson	Knight	Windfall
OC Pesticides:	(n=1)	(n=3)	(n=3)	(n=6)
ΣHCH	0.70	0.87 ± 0.51	0.08 ± 0.18	<0.02
ΣCHLOR	<1	0.67 ± 1.2	<1	<1
HCB	1.1	0.67 ± 0.60	0.10 ± 0.10	0.12 ± 0.07
o,p'- and p,p'-DDT	<1	<1	<1	<1
p,p'-DDE	0.80	1.4 ± 1.8	0.16 ± 0.36	0.90 ± 1.4
p,p'-DDD	<1	<1	<1	<1
Σtoxaphene	20	<10	<10	<10
PCBs:	(n=1)	(n=3)	(n=3)	(n=6)
ΣPCB	26	12 ± 9.1	6.0 ± 2.4	8.7 ± 8.1
Σdi	<0.3	<0.3	<0.3	<0.3
Σtri	0.10	0.10 ± 0.18	<0.05	0.03 ± 0.06
Σtetra	0.01	1.5 ± 0.44	0.39 ± 0.22	1.7 ± 2.3
Σpenta	11	5.9 ± 7.2	1.9 ± 0.69	3.6 ± 3.5
Σhexa	4.9	2.6 ± 1.3	1.9 ± 1.1	2.0 ± 1.4
Σhepta	4.0	2.0 ± 1.0	1.5 ± 0.7	1.2 ± 0.89
Σocta	0.34	0.34 ± 0.37	0.20 ± 0.03	0.28 ± 0.32
Σnona	<0.02	<0.02	<0.02	0.01 ± 0.02
Σdeca	<0.02	<0.02	<0.02	<0.02

[a] Concentrations of individual components are given in Appendix A4 and A5.

Figure 5. Levels of ΣPCBs ($ng{\cdot}g^{-1}$ wet wt) in Mountain Whitefish, Northern Pike, and Long-Nose Suckers from the Athabasca River, Spring 1992

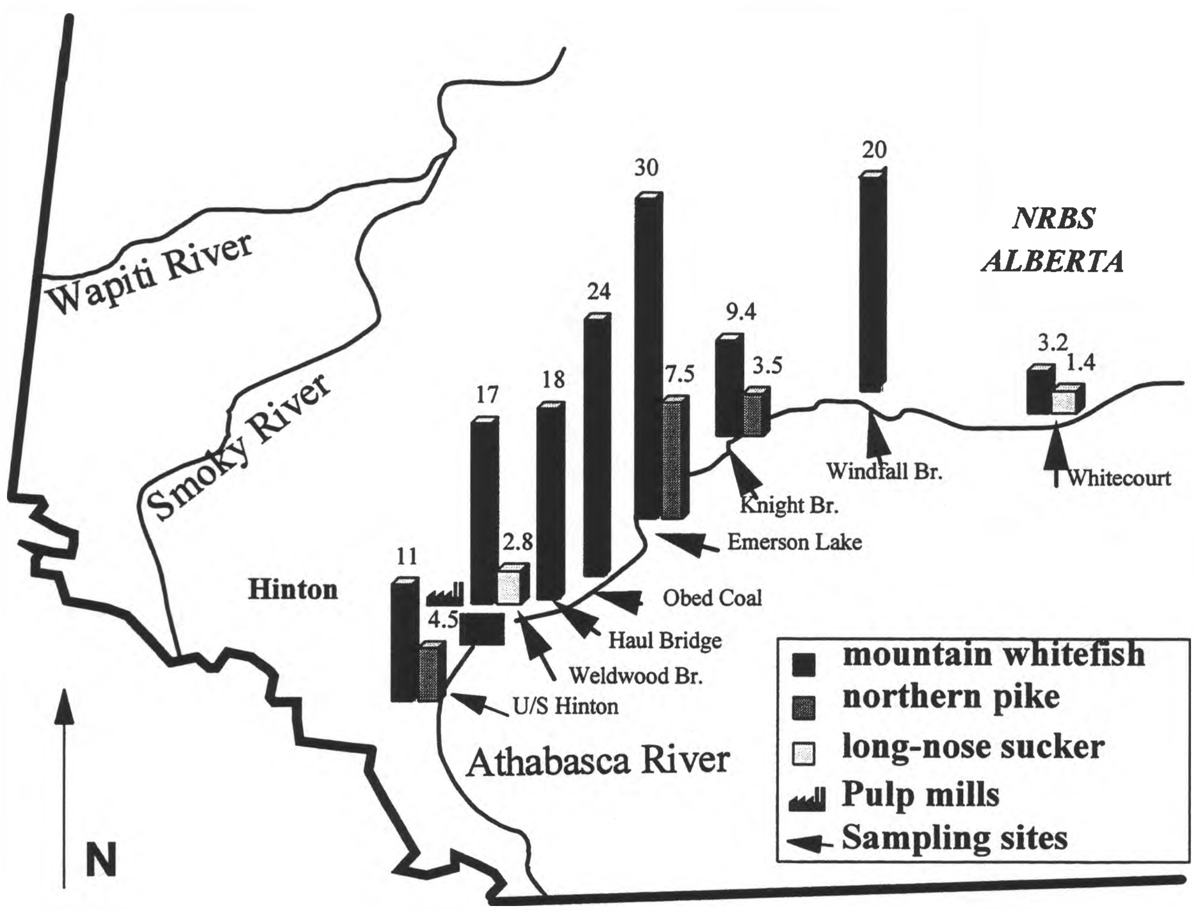


Table 17. Concentrations of ΣPCB (± SD) in Northern Pike and Mountain Whitefish Muscle from the Athabasca River, May/June 1992[a]

	Northern pike		Mountain whitefish		
Location	Conc.[a] ng g^{-1} (wet wt)	Sample Size	Conc.[a] ng g^{-1} (wet wt)	Sample Size	NPAR1WAY[b,c] (p = 0.05)
U/S Hinton (-10 km)	4.5 ± 2.8	6	11 ± 7.3	10	NS
Weldwood Haul Bridge (1 km)	<1	2	17 ± 9.8	9	N/A
Obed Coal Bridge (19 km)	ND[c]	--	24 ± 11	10	N/A
Emerson Lake (48 km)	7.5 ± 4.9	1	30 ± 14	8	NA
Knight Bridge (116 km)	3.5 ± 3.4	10	9.4 ± 7.5	9	**
Windfall Bridge (176 km)	ND	--	20 ± 14	10	N/A

[a] Average concentrations and statistical tests were based on all fish from a sample site, including the fish where zero was substituted for non detects. Individual congener results are presented in Appendix 3.
[b] This column tests significant differences between the levels of PCB in mountain whitefish and northern pike.
[c] Symbols: NS = Not Significant; ND = No Data; N/A = Not Applicable; ** = highly significant at the p > 0.01 level.

Table 18. Pearson Correlation Coefficients (r) for PCP, TCV, and ΣPCB in Northern Pike Muscle with Age, Length, and Weight

		N	Age	Length	Weight
Knight	PCP	10	-0.583(NS)	-0.408(NS)[a]	-0.410(NS)
	TCV	10	-0.583(NS)	0.641*	0.855**
	ΣPCB	10	0.596(NS)	0.747*	0.945**
Windfall	PCP	10	-0.450(NS)	-0.3324(NS)	-0.311(NS)
	TCV	10	0.926**	0.860**	0.910**

[a] Symbols: NS = Not Significant (p=0.05), * significant at the p<0.05 level,; * *= highly significant at the p < 0.01 level.

For northern pike at the Knight and Windfall Bridge sites, TCV concentration in muscle correlated significantly ($p<0.05$) with age, length, and weight of the fish. The same results were obtained for northern pike for 2,3,7,8-TCDD and -TCDF (Pastershank and Muir 1995). This correlation was not seen for PCA, PCP, HCB, ΣPCB, DDE, and ΣDDT. For mountain whitefish, there were fewer significant correlations between fish attributes and concentration of contaminants. In general fish size (length or weight) was correlated with concentrations of major OCs when all results for whitefish and pike downstream of Hinton were pooled by species.

Table 19. Pearson Correlation Coefficients (r) for Selected Organochlorines in Mountain Whitefish Muscle with Age, Length, and Weight.

		N	Age	Length	Weight
US	HCB	10	-0.267(NS)[a]	-0.778**	-0.337(NS)
Weldwood	PCP	9	-0.288(NS)	-0.751*	-0.856**
Obed	p,p'-DDE	10	-0.729(NS)	0.452(NS)	0.724*
	HCB	10	-0.769**	-0.559(NS)	-0.438(NS)
Emerson	ΣPCB	8	0.202(NS)	0.670(NS)	0.756*
	ΣDDT	8	0.442(NS)	0.783*	0.818*
Knight	PCA	9	-0.731*	-0.717*	-0.737*
Windfall	PCA	10	0.196(NS)	0.797**	0.781**

[a] Symbols: NS = Not Significant (p=0.05), * significant at the $p<0.05$ level,; * *= highly significant at the $p < 0.01$ level.

5.0 RESULTS FOR THE GENERAL FISH COLLECTION STUDY

Table 20 summarizes concentrations of the major OCs found in muscle of mountain whitefish and longnose sucker from the Athabasca River during 1992. Tables B1 to B3 in Appendix B summarize the mean and standard deviations of all the individual OC components and PCB congeners detected in mountain whitefish and longnose suckers from each site. As observed in the RSS study, PCBs accounted for majority of the OCs in fish muscle and the levels exceeded the detection limits by 2- to 10-fold. OC pesticides and CPs were detected at levels close to their detection limits except for TCV. High levels of TCV were seen at the Weldwood Haul Road site (4.6 ± 1.4) and lower at Whitecourt site (2.0 ± 1.7). Lower levels were seen for longnose sucker at both sites 1.6 ± 0.8 and 1.0 ± 1.0, respectively. Penta-, hexa- and hepta-CBs were the most prevalent homolog groups detected in mountain whitefish and longnose sucker muscles. Tetrachloroveratrole was the predominant CP seen in fish downstream of the BKM. Walleye and goldeye had OCs, CPs, and PCBs levels generally below the detection limits. These fish were caught furthest downstream from the BKM, in the Peace-Athabasca Delta and Lake Athabasca.

5.1 CHLOROPHENOLICS

5.1.1. Phenols.

About 50% of the mountain whitefish and longnose sucker muscle samples from the Weldwood Haul Road and Whitecourt sites contained PCP levels near the detection limits of 0.2 ng g^{-1}. The remaining fish had PCP levels below the detection limits.

Table 20. Levels of CPs, OC pesticides, and PCB Homologs (ng g^{-1} wet wt) in Mountain Whitefish and Longnose Sucker Muscle, Athabasca River, Spring 1992[a].

	Mountain Whitefish		Longnose Sucker	
	Weldwood	Whitecourt	Weldwood	Whitecourt
CPs:	(n=11)	(n=10)	(n=10)	(n=10)
PCP	0.2 ± 0.2	0.2 ± 0.4	0.2 ± 0.3	0.2 ± 0.3
TCV	4.6 ± 1.4	2.0 ± 1.7	1.6 ± 0.8	1.0 ± 1.0
PCA	0.	0.2 ± 0.2	0.1 ± 0.2	0.1 ± 0.1
OC Pesticides:	(n=11)	(n=10)	(n=10)	(n=10)
ΣHCH	0.1 ± 0.1	0.2 ± 0.2	<0.2	<0.2
ΣCHLOR	<1	<1	<1	<1
HCB	0.4 ± 0.1	0.4 ± 0.2	0.1 ± 0.1	0.3 ± 0.1
o,p'-, p,p'-DDT	0.1 ± 0.3	<1	<1	
p,p'-DDE	0.8 ± 0.5	0.2 ± 0.4	<0.05	0.1 ± 0.2
p,p'-DDD	0.2 ± 0.4	<1	<1	0.2 ± 0.6
Σtoxaphene	<50	<50	<50	<50
PCBs:	(n=11)	(n=10)	(n=10)	(n=10)
ΣPCB	16.9 ± 5.9	3.2 ± 3.3	2.8 ± 1.5	1.4 ± 1.3
Σdi	<0.3	<0.3	<0.3	<0.3
Σtri	0.4 ± 1.2	<0.05	0.0 ± 0.1	<0.05
Σtetra	2.2 ± 1.1	0.3 ± 0.8	0.2 ± 0.3	0.0 ± 0.1
Σpenta	3.3 ± 1.2	0.6 ± 0.8	0.4 ± 0.3	0.3 ± 0.3
Σhexa	6.5 ± 1.6	1.9 ± 1.5	1.5 ± 0.5	1.0 ± 0.6
Σhepta	3.6 ± 1.6	0.6 ± 0.5	0.5 ± 0.2	0.3 ± 0.2
Σocta	0.7 ± 0.4	0.0 ± 0.1	0.0 ± 0.0	0.0 ± 0.0
Σnona	0.1 ± 0.2	<0.02	<0.02	<0.02
Σdeca	<0.02	<0.02	<0.02	<0.02

[a] Concentrations of individual components are given in Appendix B1 - B3.

The other ten chlorophenolic congeners were below the detection limits of 0.2 ng g^{-1}: 2,3,4,6-,2,3,5,6-, and 2,3,4,5-teCl-Phenol, 2,3,4-, 2,3,5-, 2,3,6-, 2,4,5-, 2,4,6-triCl-Phenol, and 2,4- and 2,6-diCl-Phenol.

5.1.2. Guaiacols.

Guaiacols were rarely detected in longnose suckers or mountain whitefish muscle. 4,5-dichloroguaiacol was detected in one out of ten longnose suckers sampled at the Whitecourt site. At the Weldwood Haul Road site, four out of eleven longnose suckers contained 3,4,5-trichloroguaiacol with a mean concentration of 0.41 ± 0.64 ng g^{-1}. At this site, one longnose sucker also contained 0.4 ng g^{-1} of 4,5,6-trichloroguaiacol. One sample out of ten longnose suckers from the Whitecourt site had detectable levels of 3,4,5-trichloroguaiacol (1.3 ng g^{-1}) and 4,5- dichloroguaiacol (1.7 ng g^{-1}).

No guaiacol congeners were detected in mountain whitefish from the Whitecourt site. At the Weldwood Haul site, eight out of ten mountain whitefish contained levels of 3,4,5-trichloroguaiacol averaging 0.95 ± 0.85 ng g^{-1} and four out of ten fish contained levels of 4,5,6-trichloroguaiacol of 0.32 ± 0.42 ng g^{1}.

5.1.3. Catechols,Veratroles and Anisoles.

Catechol congeners were not detected in mountain whitefish or longnose sucker from either site. Tetrachloroveratrole (TCV) was the most common CP congener detected in mountain whitefish and longnose suckers in the General Fish Collection. At least 70% of all longnose suckers and 100% of all mountain whitefish contained detectable levels of TCV.

TCV levels for mountain whitefish were 4.6 ± 1.4 and 2.0 ± 1.7 ng g^{-1} at the Weldwood Haul Road and Whitecourt sites, respectively. Although TCV levels of longnose suckers were at least twofold lower than the levels seen for mountain whitefish, they were not significantly different (NPAR1WAY, p>0.05) (Table 21).

Low levels of PCA were detected in less than 50% of the longnose suckers caught from the Weldwood Haul Road site (0.13 ± 0.16 ng g^{-1}) and Whitecourt site (0.06 ± 0.15 ng g^{1}). PCA was only seen in mountain whitefish at the Whitecourt site.

In summary, most CPs congeners were below or slightly above the detection limits for mountain whitefish and longnose suckers from the General Fish Collection. The only exception was seen for TCV where the levels varied from approximately 2 to 10 times higher than the detection limit for mountain whitefish and northern pike.

Table 21. Levels of TCV (± SD) in Longnose Suckers and Mountain Whitefish Muscle from the Athabasca River, May/June 1992[a].

	Longnose Sucker		Mountain whitefish		
Location	Conc. [B] ng g^{-1} (wet wt)	Sample Size	Conc. [B] ng g^{-1} (wet wt)	Sample Size	NPAR1WAY[b,c] (p = 0.05)
Weldwood Haul Road	1.6 ± 0.81	10	4.6 ± 1.4	10	NS
Whitecourt	0.99 ± 0.98	10	2.0 ± 1.7	10	NS

[B] Average concentrations and statistical tests were based on all fish from a sample site, including the fish where zero was substituted for non detects. Concentrations of individual components are given in Appendix B1.

[b] This column tests significant differences between the levels of TCV in mountain whitefish and northern pike.
[c] Symbols: NS = Not Significant; ND = No Data; N/A = Not Applicable.

5.2 OC PESTICIDES

Higher concentrations of OC pesticides were seen in the muscle of mountain whitefish than longnose suckers (Table 20). Nine OC pesticides were generally detected in mountain whitefish (aldrin, α-HCH, γ-HCH, p,p'-DDT, p,p'-DDD, p,p'-DDE, methoxychlor, *delta*-HCH, and HCB) compared with only five or less in longnose suckers (endrin, p,p'-DDE, p,p'-DDD, methoxychlor, and HCB). HCB was detected in the muscle of mountain whitefish from the Weldwood Haul Road site (0.37 ± 0.13 ng g^{-1}) and at the Whitecourt site (0.36 ± 0.16 ng g^{-1}). Lower levels of HCB were seen in longnose suckers of 0.15 ± 0.05 and 0.28 ± 0.10 ng g^{-1} from the two sites, respectively.

At the Weldwood Haul Road site, one longnose sucker out of eleven sampled contained endrin at the detection limits of 1 ng g^{-1}, and two fish out of eleven contained methoxychlor at the detection limits of 2 ng g^{-1}. At the Whitecourt site, one longnose sucker out of ten contained 0.6 ng g^{-1} of p,p'-DDE and 2 ng g^{-1} of p,p'-DDD.

Aldrin, p,p'-DDD and p,p'-DDT were seen at levels near the detection limits in great than 70% of the mountain whitefish. At the Whitecourt site, γ-HCH was seen in one out of ten mountain whitefish at the detection limit of 0.2 ng g^{-1}. Methoxychlor was detected in nine out of 10 mountain whitefish from the Weldwood Road site at a mean concentration of 4.4 ± 1.6 ng g^{-1}. Methoxychlor was also seen in two longnose suckers out of 10 at the Weldwood Haul Road site. Methoxychlor was only seen in one out of 10 mountain whitefish at the Whitecourt site at its detection limits of 2 ng g^{-1}.

5.3 PCBs

Higher levels of ΣPCBs were seen in mountain whitefish than longnose suckers at the Weldwood Haul Road and Whitecourt sites (Table 20). Levels of ΣPCBs in mountain whitefish at the Weldwood Haul Road and Whitecourt sites were 17 ± 5.9 and 3.2 ± 3.3 ng g^{-1}, respectively. Lower levels were seen in longnose suckers at these two sites of 2.8 ± 1.5 and 1.4 ± 1.3, respectively. ΣPCBs levels were significantly higher (NPAR1WAY, $p < 0.05$) for mountain whitefish than longnose suckers at the Weldwood Haul Road site (Table 22). This difference was not found between the fish species at the Whitecourt site.

PCB congeners commonly detected in longnose suckers were PCB 138, 153 and 180. Common PCBs in mountain whitefish were PCB 101, 87, 151, 153, 141, 138, 128, 174, 180, and 170. Higher chlorinated PCBs were seen in fish downstream of the BKMs. Of the total PCBs, 86 ± 8.1 % were penta-, hexa-, hepta-PCBs. Penta-, hexa-,and hepta-PCBs in longnose suckers accounted for 92 ± 5.2 % of the total. Tri- and tetra-PCBs accounted for 12 ± 4.4 % of the total PCBs in mountain whitefish and 5.4 ± 6.1% for longnose suckers. Di-, octa-, nona- and deca-PCBs were generally not detected in either fish species.

Table 22. Comparison of ΣPCB levels in Longnose Suckers and Mountain Whitefish Muscle from the Athabasca River, May/June 1992[a].

	Longnose Sucker		Mountain whitefish		
Location	Conc. ng g^{-1} (wet wt)	Sample Size	Conc. ng g^{-1} (wet wt)	Sample Size	NPAR1WAY[b,c] ($p = 0.05$)
Weldwood Haul Road	2.8 ± 1.5	10	17 ± 5.9	10	**
Whitecourt	2.8 ± 1.5	10	1.4 ± 1.3	10	NS

[a] Average concentrations and statistical tests were based on all fish from a sample site, including the fish where zero was substituted for non detects. Concentrations of individual components are given in Appendix B3.

[b] This column tests significant differences between the levels of PCB in mountain whitefish and northern pike.

[c] Symbols: NS = Not Significant; ** =highly significant at the $p < 0.01$ level.

5.4 PCBS, OC PESTICIDES, AND CP LEVELS IN GOLDEYE AND WALLEYE MUSCLE SAMPLES

Tables 23 and 24 summarize the mean concentrations (± SD) of PCBs, OC pesticides, and CPs found in the muscle of walleye and goldeye. Results for individual components are included with other species in Appendix B1, B2 and 3. Walleye and goldeye were caught further upstream than mountain whitefish and northern pike. The sampling locations were located between 230 and 633.8 km upstream of Hinton, at Jackfish Lake and at Goose Island at Lake Athabasca. Goldeye and walleye muscle samples had the lowest levels of CPs, OCs, and PCB congeners/homologs of all the fish species caught in the spring of 1992 (see Table 23 and 24). These fish were also caught furthest downstream from the BKM source. HCB and p,p'-DDE were the most common individual organochlorines found in goldeye and walleye. Levels of both compounds were in the low ng g^{-1} range, close to detection limits.

6.0 <u>SPECIAL BURBOT COLLECTION. FALL - 1992 and 1994</u>

Mean concentrations (±SD) of CPs, OCs, and PCBs in burbot livers from 1992 and 1994 are summarized in Tables 25 and 26 and in Appendix C1 to C5.

6.1 CHLOROPHENOLICS (FALL 1992)

Pentachlorophenol (PCP) was the most commonly detected chlorophenol in burbot livers, followed by tetrachloroveratrole (Table 25). Guaiacols, catechols, and anisoles were detected in low concentrations in burbot livers from the Wapiti and Peace Rivers. The highest levels of TCV were seen at the site downstream of Grande Prairie at the Cellulose site (D2) and Peace River at the Daishowa site (F1), of 13 ± 21 and 4.2 ± 3.2 ng g^{-1}, respectively. Levels of CPs generally declined further downstream of these two sites. Spatial trends for PCP and TCV in the 1992 samples are illustrated in Figures 6 and 7, respectively.

Table 23. Levels of CPs, OCs and PCBs Homologs (ng g^{-1} wet wt) in Walleye Muscle, Athabasca River, Fall 1992[a].

	(Km. 627 to 633.8)	(Km. 299.8)	(Km. 230.4)	Jackfish Lake Fishing Village	Lake Athabasc Goose Island
CPs:	(n=6)	(n=10)	(n=3)	(n=9)	(n=4)
PCP	<0.2	0.1 ± 0.2	<0.2	0.6 ± 0.6	0.3 ± 0.3
TCV	<0.4	0.1 ± 0.2	<0.4	0.1 ± 0.2	<0.4
PCA	<0.2	<0.2	<0.2	<0.2	<0.2
OC Pesticides:	(n=9)	(n=10)	(n=3)	(n=9)	(n=4)
ΣHCH	<0.2	<0.2	<0.2	0.3 ± 0.2	0.1 ± 0.2
ΣCHLOR	<1	<1	<1	1.0 ± 1.2	<1
HCB	<0.1	0.1 ± 0.1	<0.1	0.4 ± 0.2	0.2 ± 0.1
o,p'-, p,p'-DDT	<1	<1	<1	<1	<1
p,p'-DDE	<0.5	<0.5	<0.5	1.6 ± 1.6	0.2 ± 0.4
p,p'-DDD	<1	<1	<1	<1	<1
Σtoxaphene	<50	<50	<50	<50	<50
PCBs:	(n=9)	(n=10)	(n=3)	(n=9)	(n=4)
ΣPCB	<1	0.3 ± 0.7	<1	3.7 ± 3.3	0.5 ± 1.0
Σdi	<0.3	<0.3	<0.3	<0.3	<0.3
Σtri	<0.05	0.1 ± 0.3	<0.05	<0.05	<0.05
Σtetra	<0.04	<0.04	<0.04	<0.04	<0.04
Σpenta	<0.03	0.0 ± 0.1	<0.05	0.5 ± 0.7	0.1 ± 0.1
Σhexa	<0.02	0.2 ± 0.4	<0.02	2.2 ± 1.7	0.6 ± 0.5
Σhepta	<0.02	0.1 ± 0.1	<0.02	0.9 ± 0.8	0.1 ± 0.2
Σocta	<0.02	<0.02	<0.02	0.2 ± 0.3	<0.02
Σnona	<0.02	<0.02	<0.02	<0.02	<0.02
Σdeca	<0.02	<0.02	<0.02	<0.02	<0.02

[a] Concentrations of individual components are given in Appendix B1 - B3.

Table 24. Levels of CPs, OCs and PCBs Homologs (ng g^{-1} wet wt) in Goldeye Muscle, Athabasca River, Spring 1992[a].

	(Km. 627 to 633.8)	(Km. 299.8)	(Km. 230.4)	Jackfish Lake Fishing Village
CPs:	(n=6)	(n=7)	(n=7)	(n=13)
PCP	0.4 ± 0.6	0.3 ± 0.5	0.3 ± 0.3	0.2 ± 0.4
TCV	0.7 ± 0.9	1.0 ± 0.6	0.1 ± 0.3	0.4 ± 0.5
PCA	<0.2	<0.2	<0.2	<0.2
OC Pesticides:	(n=6)	(n=7)	(n=7)	(n=13)
ΣHCH	0.1 ± 0.3	<0.1	<0.1	0.3 ± 0.3
ΣCHLOR	<1	<1	<1	<1
HCB	0.3 ± 0.3	0.4 ± 0.3	0.3 ± 0.3	0.5 ± 0.2
o,p'-, p,p'-DDT	<0.1	<0.1	<0.1	<0.1
p,p'-DDE	<0.5	<0.5	0.3 ± 0.7	<0.05
p,p'-DDD	<1	<1	<0.1	<0.1
Σtoxaphene	<50	<50	<50	<50
PCBs:	(n=6)	(n=7)	(n=7)	(n=13)
ΣPCB	<1	<1	0.6 ± 1.5	0.3 ± 0.6
Σdi	<0.3	<0.3	<0.3	<0.3
Σtri	<0.05	<0.05	<0.05	<0.05
Σtetra	<0.04	<0.04	<0.04	<0.04
Σpenta	<0.03	<0.03	<0.03	<0.03
Σhexa	0.1 ± 0.2	0.0 ± 0.1	0.2 ± 0.6	0.0 ± 0.1
Σhepta	<0.02	<0.02	0.4 ± 0.9	0.5 ± 0.4
Σocta	<0.02	<0.02	<0.02	0.2 ± 0.3
Σnona	<0.02	<0.02	<0.02	<0.02
Σdeca	<0.02	<0.02	<0.02	<0.02

[a] Concentrations of individual components are given in Appendix B1 - B3.

Table 25. Levels of PCB homologs, OC pesticides, PCP, TCV and PCA (ng g^{-1}) in Burbot Livers, Fall 1992 collection[a].

	Smoky River Hwy 34 (B) km 848	Wapiti River Cellulose (D) km 873	Smoky River Canfor (A) km 908	Smoky River Watino (C) km 755	Peace River Daishowa (F) km 692	Peace River Notikewin (G) km 551	Peace River Carcajou (H) km 476	Peace River Beaver (I) km 313	Peace River John d'Or (J) km 273	Peace River Fox (K) km 240
CPs:	(n=10)	(n=9)	(n=9)	(n=10)	(n=8)	(n=8)		(n=10)	(n=8)	(n=10)
PCP	13.1 ± 37.6	3.4 ± 3.9	0.6 ± 0.9	12.5 ± 37.8	3.1 ± 2.9	4.8 ± 3.3	3.3 ± 7.3	1.1 ± 1.0	2.6 ± 5.5	1.2 ± 1.8
TCV	3.3 ± 3.4	13.2 ± 20.7	<0.4	0.2 ± 0.7	4.2 ± 3.2	1.1 ± 1.4	1.8 ± 1.5	0.8 ± 0.6	1.8 ± 1.5	1.1 ± 1.0
PCA	0.2 ± 0.4	1.0 ± 1.2	<0.2	0.1 ± 0.3	0.6 ± 0.6	<0.2	0.4 ± 0.5	0.1 ± 0.2	0.4 ± 0.5	0.3 ± 0.4
OC Pesticides:	(n=10)	(n=10)	(n=11)	(n=10)	(n=9)	(n=8)	(n=9)	(n=10)	(n=10)	(n=10)
ΣHCH	1.8 ± 1.8	4.3 ± 6.0	0.7 ± 0.4	1.9 ± 3.8	2.5 ± 2.2	3.4 ± 2.8	3.2 ± 2.5	2.0 ± 1.6	1.9 ± 3.4	1.1 ± 1.2
ΣCHLOR	14.3 ± 9.4	27.1 ± 43.9	1.9 ± 1.1	3.5 ± 3.5	15.4 ± 6.8	4.2 ± 2.7	8.5 ± 12.4	2.8 ± 2.0	0.5 ± 1.0	9.1 ± 15.3
HCB	5.3 ± 1.7	4.9 ± 5.8	1.7 ± 0.5	2.0 ± 1.5	4.1 ± 5.0	<0.1	<0.1	<0.1	<0.1	2.4 ± 2.2
o,p'-, p,p'-DDT	3.4 ± 3.3	<1	<1	<1	1.6 ± 2.1	<1	<1	<1	<1	0.4 ± 1.0
p,p'-DDE	6.6 ± 11.0	<0.5	5.4 ± 10.9	14.1 ± 14.5	59.9 ± 100	15.6 ± 22.7	11.1 ± 11.2	16.9 ± 13.2	2.3 ± 2.6	14.3 ± 22.6
p,p'-DDD	<1	7.5 ± 16.5	0.3 ± 0.9	0.7 ± 2.2	9.0 ± 21.6	3.0 ± 2.6	3.7 ± 3.6	0.8 ± 1.3	<1	2.8 ± 3.6
Σtoxaphene	<50	46.0 ± 150	<50	<50	<50	<50	<50	<50	<50	<50
PCBs:	(n=10)	(n=10)	(n=11)	(n=11)	(n=9)	(n=8)	(n=9)	(n=10)	(n=10)	(n=10)
total PCB	750 ± 600	270 ± 220	40.0 ± 50.0	290 ± 220	230 ± 170	79.0 ± 65.0	61.0 ± 45.0	16.0 ± 21.0	9.7 ± 9.2	34.0 ± 38.0
Σdi	<0.3	<0.3	0.9 ± 2.7	1.4 ± 4.2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Σtri	0.5 ± 1.0	1.9 ± 2.0	5.0 ± 3.7	0.2 ± 0.6	15.0 ± 43.0	19.0 ± 33.0	<0.05	0.5 ± 1.6	<0.05	<0.05
Σtetra	43.0 ± 35.0	26.0 ± 21.0	11.0 ± 29.0	28.0 ± 21.0	12.0 ± 9.3	<0.04	11.0 ± 17.0	<0.04	<0.04	3.1 ± 4.8
Σpenta	350 ± 280	66.0 ± 46.0	8.5 ± 8.8	100 ± 75.0	81.0 ± 66.0	8.6 ± 15.0	17.0 ± 8.6	3.4 ± 3.4	1.0 ± 1.2	5.8 ± 7.4
Σhexa	310 ± 260	130 ± 160	11.0 ± 9.8	130 ± 120	94.0 ± 88.0	45.0 ± 45.0	28.0 ± 20.0	42.0 ± 53.0	6.4 ± 6.3	16.0 ± 18.0
Σhepta	42.0 ± 29.0	40.0 ± 46.0	3.0 ± 3.4	22.0 ± 18.0	24.0 ± 20.0	7.2 ± 9.2	8.1 ± 5.3	5.9 ± 5.0	1.9 ± 2.2	6.0 ± 7.0
Σocta	4.4 ± 2.8	1.5 ± 2.0	3.0 ± 0.7	2.0 ± 2.6	4.3 ± 4.0	2.3 ± 4.3	1.1 ± 1.3	0.7 ± 1.3	0.1 ± 0.2	1.5 ± 2.3
Σnona	<0.20	<0.20	<0.20	<0.20	0.4 ± 0.0	<0.20	0.9 ± 1.3	<0.20	<0.20	<0.20
Σdeca	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20

[a] Distances are measured from the mouth of the Peace River.

Table 26. Levels of OC pesticides and PCB homologs in Burbot Livers (ng g^{-1} wet weight), Sept to Dec 1994[a]

	Athabasca R. A1	Athabasca R. A2	Athabasca R. A3	Athabasca R. A4	Athabasca R. A5	Clearwater R. CW	Lesser Slave R. LSV	McLeod R. MR1
OC Pesticides:	(n=7)	(n=8)	(n=15)	(n=12)	(n=12)	(n=4)	(n=18)	(n=2)
ΣHCH	2.7 ± 2.5	5.3 ± 6.1	4.0 ± 3.0	3.2 ± 1.7	1.7 ± 1.0	2.0 ± 0.3	6.1 ± 4.3	<0.2
ΣCHLOR	3.2 ± 2.2	13.0 ± 5.3	19.0 ± 11.3	11.0 ± 4.2	8.2 ± 5.4	3.5 ± 4.4	14.0 ± 4.5	7.9 ± 7.7
HCB	5.4 ± 1.1	3.8 ± 1.4	5.8 ± 2.0	4.8 ± 1.2	2.9 ± 1.6	2.4 ± 1.8	7.6 ± 22.0	1.0 ± 0.3
o,p'-, p,p'-DDT	2.7 ± 3.9	12.0 ± 6.3	4.2 ± 6.9	1.3 ± 1.9	0.3 ± 0.7	<1	1.2 ± 1.8	3.5 ± 2.1
p,p'-DDE	20.8 ± 18.2	16.0 ± 6.0	26.0 ± 20.0	16.0 ± 8.0	38.0 ± 63.0	4.0 ± 1.8	13.7 ± 8.0	8.9 ± 8.6
p,p'-DDD	<1	0.9 ± 1.1	1.1 ± 2.1	<1	0.9 ± 1.5	<1	0.5 ± 0.8	<1
Σtoxaphene	10.0 ± 26.0	10.0 ± 18.0	<10	5.0 ± 16.0	<10	<10	11.0 ± 26.0	<10
PCBs:	(n=7)	(n=8)	(n=9)	(n=10)	(n=9)	(n=4)	(n=18)	(n=2)
ΣPCB	260 ± 190	150 ± 90.0	190 ± 84.0	95.0 ± 37.0	94.0 ± 46.0	7.0 ± 1.8	88.3 ± 38.4	40.0 ± 8.5
Σdi	<0.3	0.4 ± 1.0	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Σtri	3.2 ± 2.2	1.3 ± 2.8	1.7 ± 2.8	1.1 ± 2.0	1.6 ± 2.5	<0.05	5.4 ± 4.4	<0.05
Σtetra	10.0 ± 3.1	8.2 ± 8.0	8.8 ± 7.9	2.1 ± 1.9	0.8 ± 0.8	<0.03	4.3 ± 2.6	< 0.03
Σpenta	52.0 ± 39.0	34.0 ± 23.0	34.0 ± 15.0	15.0 ± 5.4	11.0 ± 7.2	<0.03	15.7 ± 7.7	7.8 ± 4.9
Σhexa	97.0 ± 70.0	58.0 ± 32.0	77.0 ± 38.0	34.0 ± 15.0	21.0 ± 13.0	5.6 ± 1.4	34.0 ± 15.0	15.0 ± 5.0
Σhepta	89.0 ± 79.2	37.6 ± 30.2	63.8 ± 31.7	33.5 ± 21.8	42.4 ± 37.5	1.6 ± 0.7	22.8 ± 12.3	15.0 ± 1.1
Σocta	9.4 ± 8.3	5.4 ± 3.1	7.7 ± 4.3	2.9 ± 2.7	1.8 ± 1.5	<0.02	3.1 ± 2.0	2.1 ± 2.9
Σnona	0.8 ± 1.2	0.6 ± 0.7	0.9 ± 1.2	0.4 ± 1.0	0.2 ± 0.4	<0.02	0.1 ± 0.6	<0.02
Σdeca	<0.02	<0.02	<0.02	<0.02	0.1 ± 0.3	<0.02	<0.02	<0.02

	Pembina R. P	Peace R. PR2	Peace R. PR3	Smoky R. SR1	Slave R. Delta SRD	Wabasca R. WAB1	Wapiti R. WR1	Wapiti R. WR2
OC Pesticides:	(n=2)	(n=2)	(n=2)	(n=16)	(n=20)	(n=4)	(n=2)	(n=9)
ΣHCH	5.0 ± 6.8	2.1 ± 0.5	1.4 ± 2.0	4.6 ± 2.5	3.4 ± 2.0	7.6 ± 5.3	1.8 ± 0.6	2.5 ± 1.5
ΣCHLOR	7.8 ± 5.9	17.0 ± 5.7	3.5 ± 4.9	34.2 ± 18.0	80.8 ± 41.4	11.9 ± 5.9	10.0 ± 5.7	26.0 ± 27.0
HCB	2.2 ± 1.9	1.6 ± 2.2	0.4 ± 0.6	2.5 ± 1.0	13.0 ± 2.9	1.7 ± 1.2	3.0 ± 0.4	3.8 ± 1.1
o,p'-, p,p'-DDT	<1	4.1 ± 1.3		<	5.1 ± 4.4	5.3 ± 6.7	<1	1.3 ± 2.3
p,p'-DDE	9.5 ± 2.1	49.0 ± 20.0	9.0 ± 0.4	25.0 ± 28.0	27.0 ± 16.0	10.5 ± 9.3	34.0 ± 34.0	54.0 ± 36.0
p,p'-DDD	<1	<1	<1	<	0.9 ± 1.9	<1	0.5 ± 0.7	0.4 ± 1.1
Σtoxaphene	<10	<10	<10	<10	12.0 ± 30.0	20.0 ± 40.0	<10	<10
PCBs:	(n=2)	(n=2)	(n=2)	(n=4)	(n=17)	(n=4)	(n=2)	(n=9)
ΣPCB	38.0 ± 35.4	160 ± 63.6	47.5 ± 34.6	150 ± 50.0	390 ± 340	16.3 ± 14.4	260 ± 28.0	420 ± 180
Σdi	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Σtri	<0.05	1.2 ± 0.3	31.0 ± 38.0	2.0 ± 3.0	1.5 ± 1.6	3.0 ± 6.0	0.6 ± 0.8	5.8 ± 4.4
Σtetra	0.6 ± 0.8	5.0 ± 1.9	<0.03	26.0 ± 22.0	12.0 ± 27.0	1.4 ± 2.7	10.0 ± 8.3	87.0 ± 74.0
Σpenta	6.5 ± 3.5	43.0 ± 18.0	4.7 ± 1.9	160 ± 150	23.0 ± 7.0	2.8 ± 4.9	91.0 ± 85.0	110 ± 33.0
Σhexa	17.0 ± 14.8	65.0 ± 26.0	9.5 ± 3.3	170 ± 140	110 ± 43.0	6.7 ± 6.3	96.0 ± 81.0	98.0 ± 35.0
Σhepta	13.3 ± 16.3	31.2 ± 12.4	1.5 ± 2.1	40.0 ± 41.0	13.0 ± 6.5	0.9 ± 1.6	61.0 ± 58.0	160 ± 160
Σocta	1.3 ± 1.7	3.7 ± 1.1	<0.02	3.0 ± 3.2	0.9 ± 1.5	<0.01	2.1 ± 2.9	1.7 ± 1.9
Σnona	<0.02	1.1 ± 0.9	<0.02	.02	0.2 ± 0.6	<0.02	<0.02	<0.02
Σdeca	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

[a] Concentrations of individual components are presented in Appendix C1-C3.

Figure 6. Levels of PCP (ng ·g $^{-1}$wet wt) in Burbot Livers from the Peace River Basin, Fall 1992.

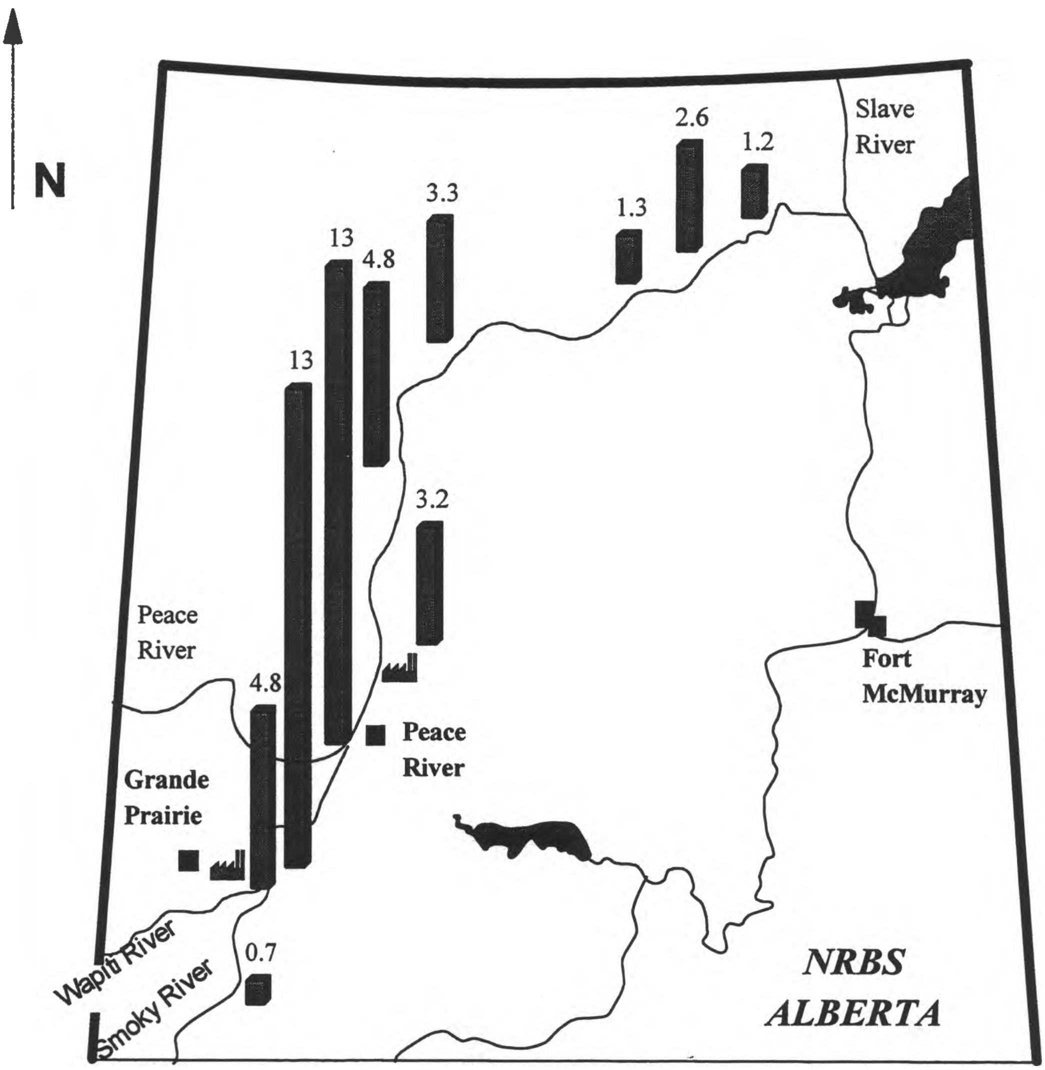
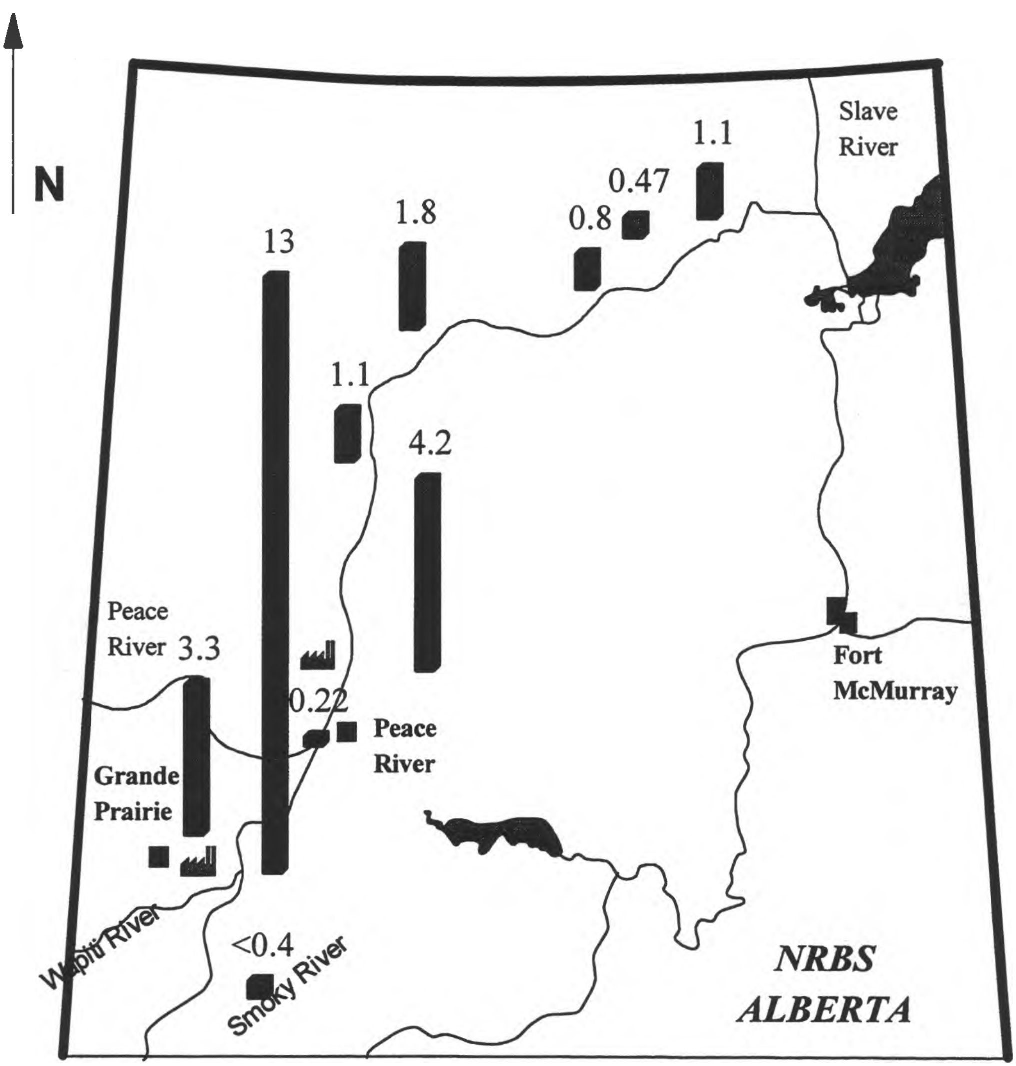


Figure 7. Levels of TCV (ng·g $^{-1}$wet wt) in Burbot Livers from the Peace River Basin, Fall 1992.



6.2 OC PESTICIDES IN BURBOT LIVER (FALL 1992 AND 1994)

Mean concentrations of major OC pesticides in burbot liver collected in the Fall of 1992 and 1994 are summarized (as arithmetic means) in Tables 25 and 26, respectively. Major OC pesticide contaminants in burbot liver were p,p'-DDE, chlordane-related compounds (mainly *cis*-chlordane and *trans*-nonachlor), toxaphene and HCB. In 1992 samples, levels of p,p'-DDE varied from <0.5 ng g^{-1} from site D2 on the Wapiti River to 60 ± 100 ng g from site F1 on the Peace River downstream of the Daishowa Maurubeni International (Figure 8). Concentrations of p,p'-DDE in the 1994 burbot liver samples had a similar range of mean values, from 4 ± 1.8 ng g^{-1} in the Clearwater River sample to 54 ± 36 ng g^{-1} at WR2 on the Wapiti River (Figure 9). For the 1994 burbot livers, levels of o,p'- and p,p'-DDT varied from <1 ng g^{-1} at site PR3 on the Peace River and SR1 on the Smoky River to 12 ± 6.3 ng g^{-1} at site A2 on the Athabasca River (Table 26). As was observed in the 1992 samples, highest levels of DDT-related compounds in 1994 were found in samples from collected downstream (or immediately upstream in the case of WR2) of pulp mills and municipal effluents. Levels of p,p'-DDD in the 1994 burbot livers were often near the detection limits (~1 ng g^{-1}).

For the 1992 burbot, concentrations of ΣHCH (sum of αHCH, βHCH and γHCH) varied from 0.7 ± 0.4 ng g^{-1} from site A3 on the Smoky River to 4.3 ± 6.0 ng g^{-1} from site D2 on the Wapiti River (Figure 10). A similar range of concentrations of ΣHCH was observed in the 1994 burbot liver samples (Table 26). The highest concentrations of ΣHCH (7.6 ± 5.3 ng g^{-1}) were seen at the Wabasca River and the lowest (1.7 ± 1.0 ng g^{-1}) in the lower Athabasca River (A5).

Concentrations of HCB in 1992 burbot livers varied from <1 ng g^{-1} at four sites on the Peace River (G3, H1, I3, and J3) to 5.3 ± 1.7 ng g^{-1} at site B3 on the Smoky River. Concentrations of HCB were similar to those measured in the 1994 burbot livers. In 1994, levels of HCB varied from 1 ng g^{-1} at the site on McLeod River (MR1) to 13 ± 29 ng g^{-1} at the Slave River delta (SRD).

ΣCHLOR (sum of *cis*-chlordane, *trans*-nonachlor and oxychlordane) was present at similar concentrations to ΣDDT in burbot liver. In 1992 concentrations varied from 0.5 in burbot livers from site J3 on the Peace River to 27 ± 44 ng g^{-1} from site D2 on the Wapiti River (Figure 11). Concentrations of ΣCHLOR in the 1994 burbot livers were highest at the Slave River delta (81 ± 1.0 ng g^{-1}). Lowest ΣCHLOR levels (<5 ng g^{-1}) were found at sites in the lower Athabasca River (A5), the lower Peace (PR3), McLeod River and the Clearwater River (Figure 11).

Toxaphene levels in the 1992 burbot samples were often below the detection limits (<50 ng g^{-1}) and only burbot livers from one site near Grande Prairie had measurable toxaphene levels (46 ± 150 ng g^{-1}). Levels of toxaphene in the 1994 burbot livers varied from 5.0 ± 16 ng g^{-1} at one site on the Athabasca River (A4) to 20 ± 28 ng g^{-1} at the site on the Wabasca River. The detection limits for toxaphene in 1994 were lower at 10 ng g^{-1}. The reported levels in burbot liver likely underestimate actual toxaphene concentrations considerably (Appendix E1). Toxaphene is the major OC pesticide in burbot liver from the Slave River (Peddle et al. 1995) and in Great Slave Lake burbot (Evans 1994).

Figure 8. Levels of ΣDDT, p,p'-DDE, and p,p'-DDD ($ng \cdot g^{-1}$ wet wt) in Burbot Livers from the Peace River Basin, Fall 1992

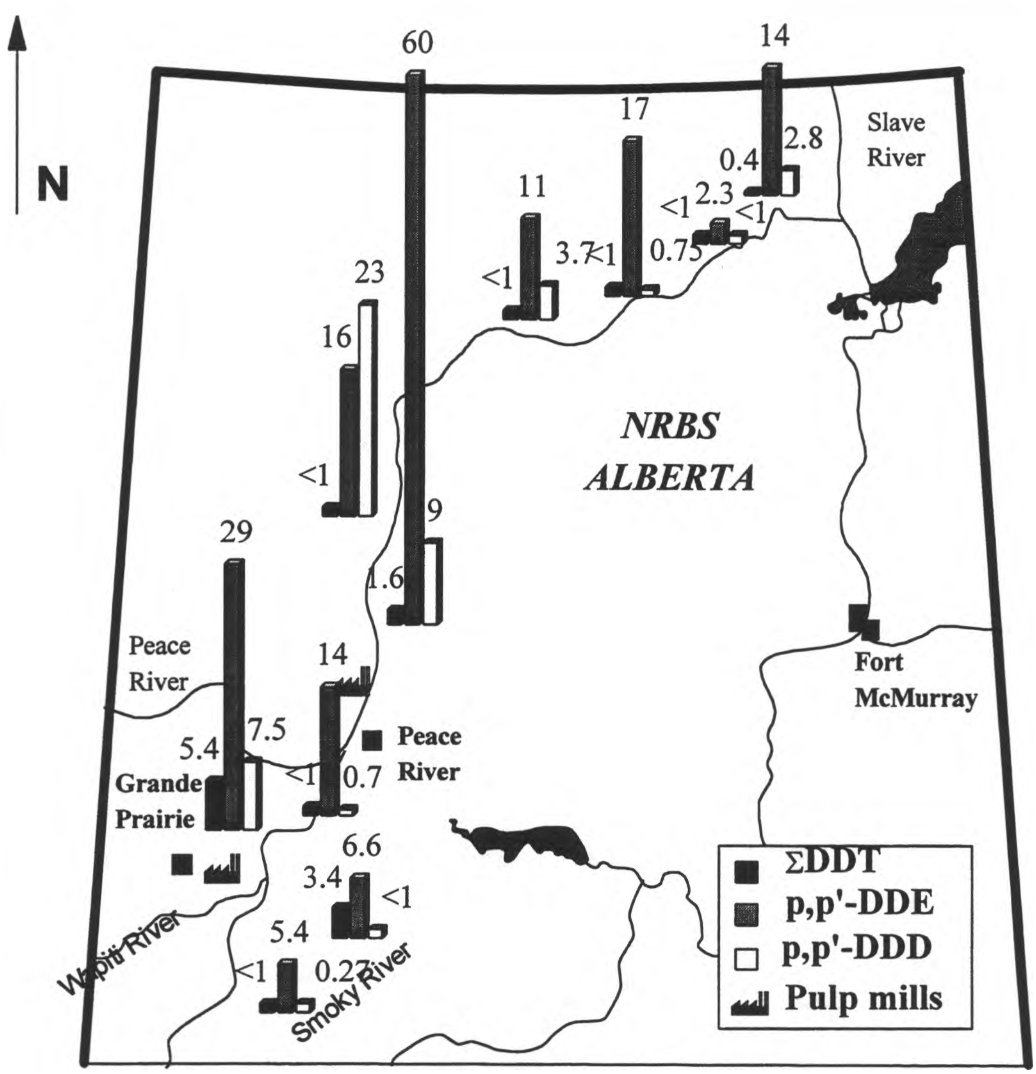


Figure 9. Levels of p,p'-DDE in Burbot Livers (ng·g $^{-1}$wet wt), September to December 1994.

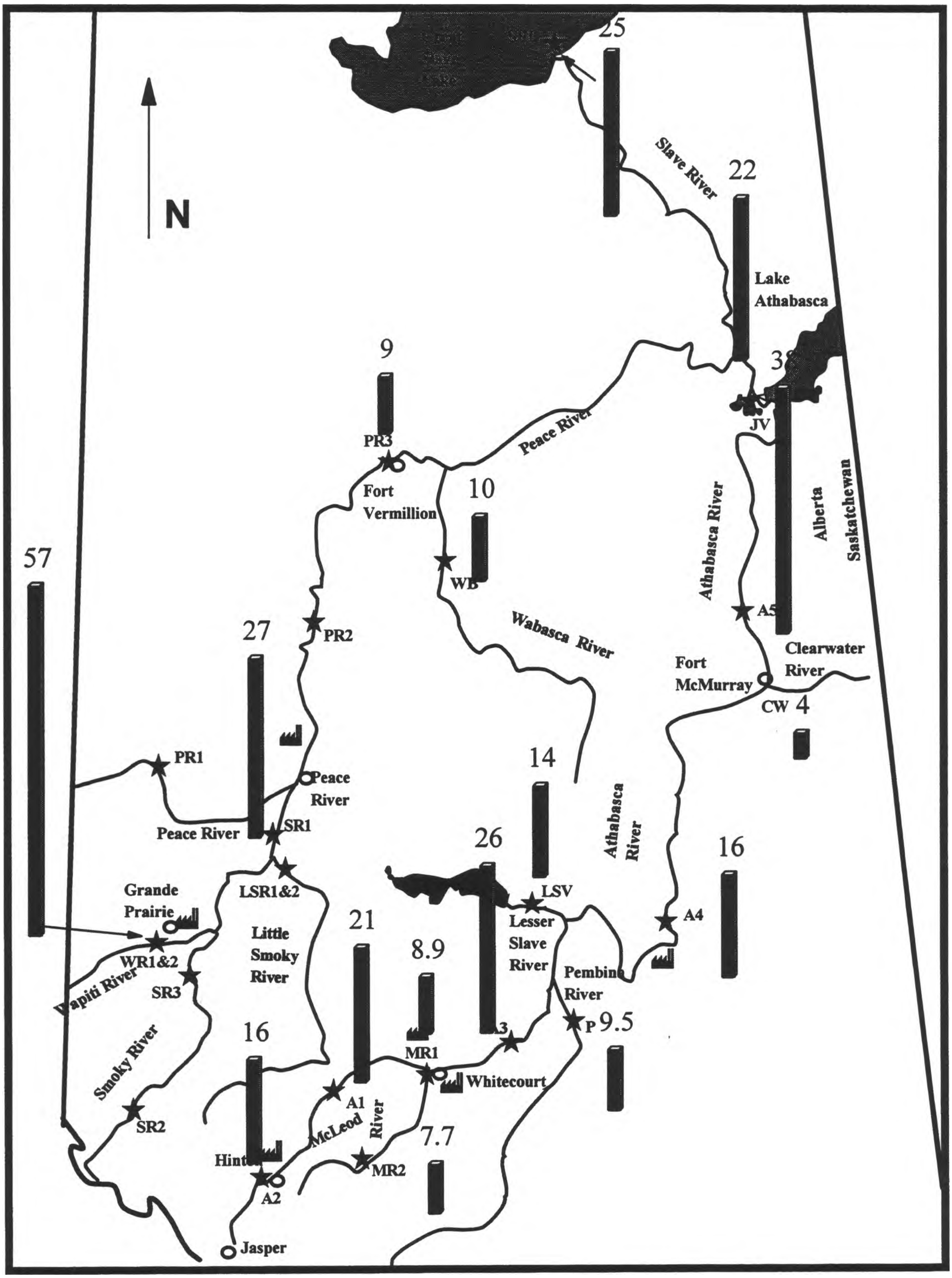


Figure 10. Levels of ΣHCH, ΣCHLOR, and HCB (ng·g^{-1} wet wt) in Burbot livers from the Peace River Basin, Fall 1992

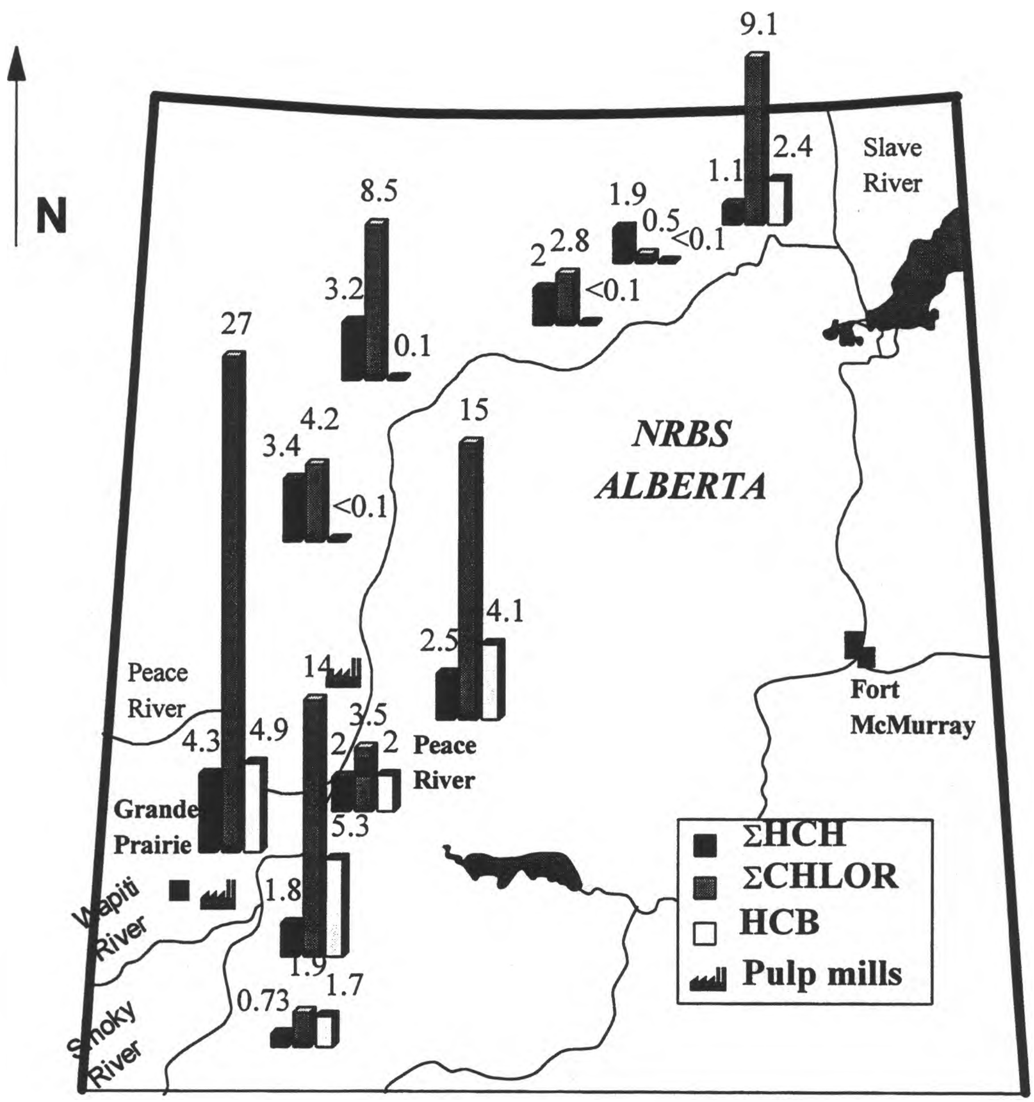
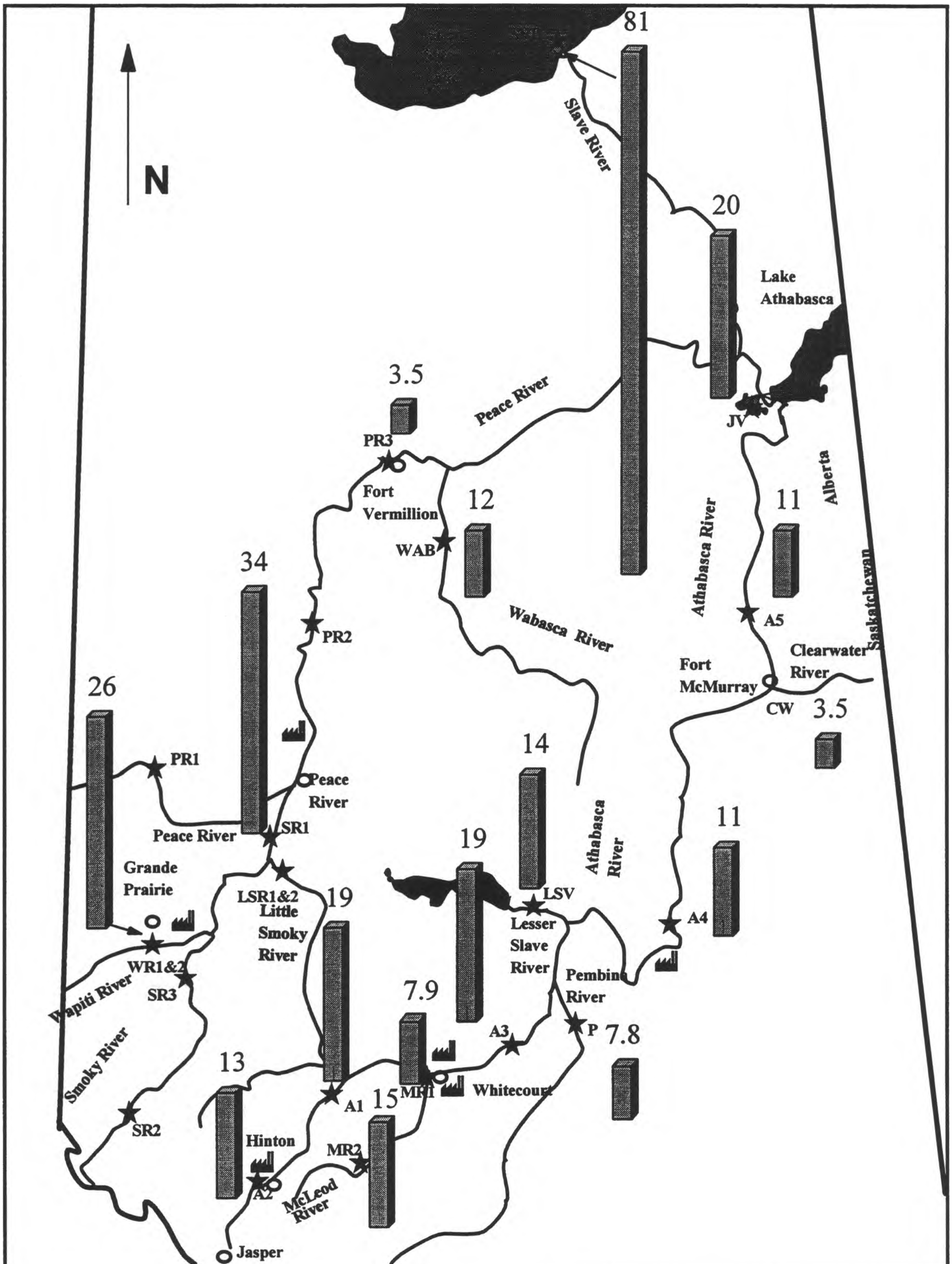


Figure 11. Levels of $\sum$CHLOR (ng·g^{-1} wet wt) in Burbot Livers, September to December 1994.

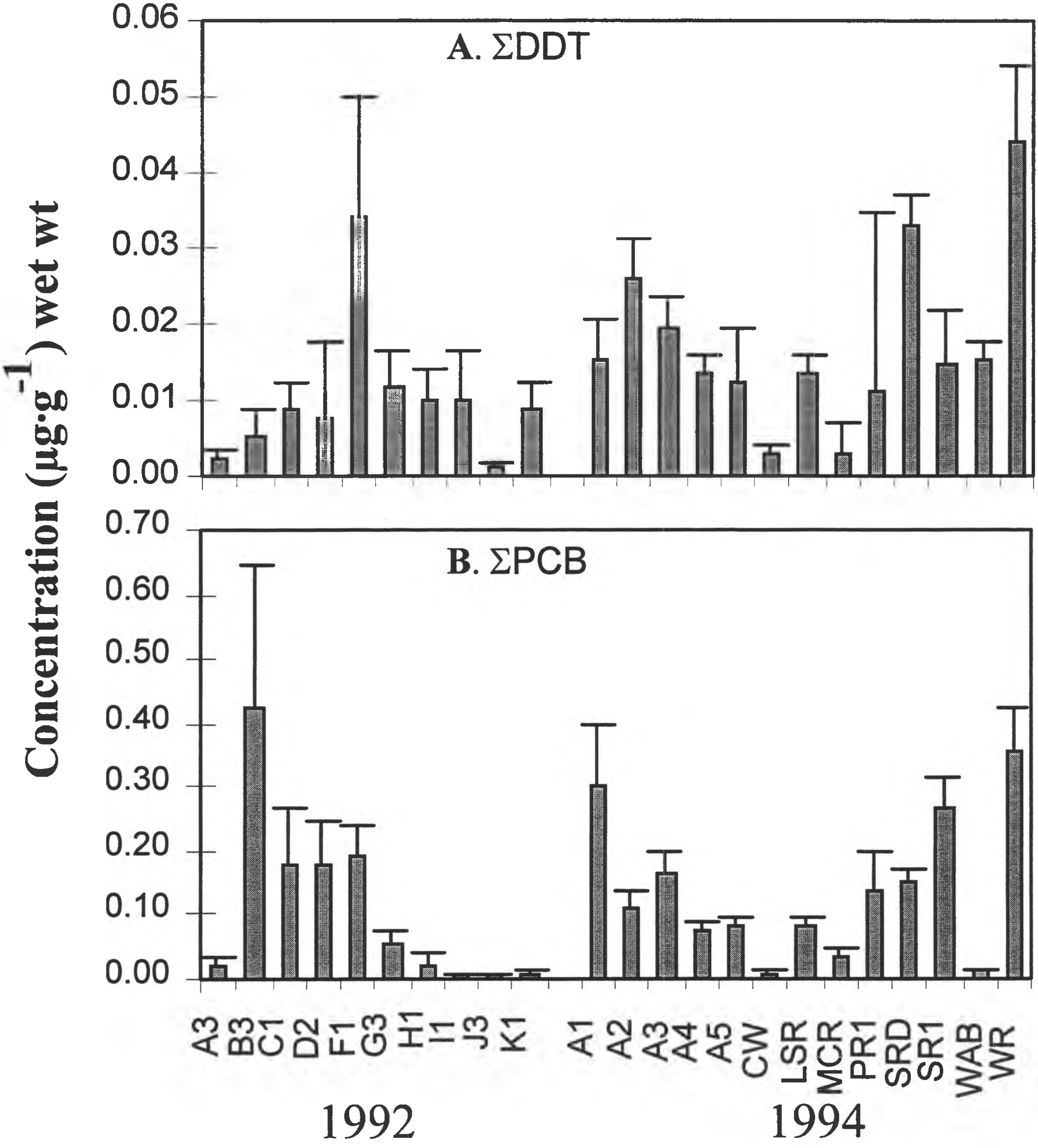


Detailed statistical analysis of the data for OC pesticides in burbot liver was confined to the DDT group (as p,p'-DDE and ΣDDT) because of it was consistently detected in all samples. Log transformed ΣDDT concentrations in 1992 burbot liver data, was more strongly correlated with %lipid, ΣPCB and CB153 than untransformed data (Appendix C6). Log transformation generally reduced the skewness, which is a measure of deviation from a normal distribution. Log ΣDDT in 1992 samples was weakly, but significantly, correlated with % lipid ($p=0.018$) and with ΣPCB. ANCOVA of ΣDDT in 1992 burbot liver samples was conducted to examine effects of sampling site and lipid using results from 64 samples from 7 sites for which % lipid and ΣDDT were available. There were no significant effects of lipid ($p=0.50$) or lipid-site interaction ($p=0.42$), therefore the ANCOVA was rerun with (wet wt) data from all 10 sites ($N=95$) to test the effect of site alone and multi mean comparisons were made with Tukey's test (at $p=0.05$) using the mean square error from the ANCOVA (SAS 1991). Although geometric mean ΣDDT concentrations were highest at F1 (Figure 12a) there were no significant differences between F1 and other near field sites (F1, D2 and C1) on the Wapiti/Smoky/upper Peace system. Burbot from Site F1 had significantly higher (geometric mean) ΣDDT levels than far-field sites on the lower Peace River (J3) and on the upper Smoky (A3) (Figure 12a).

The log p,p'-DDE and ΣDDT concentrations in 1994 burbot liver samples were weakly correlated with % lipid, age, weight and length ($p<0.0007$) as well as with ΣPCB (Appendix C7). Therefore ANCOVA was used to test the effect of % lipid and weight (which covaried with age and length) and sampling site. Results for lipid, weight and ΣDDT ($N>2$ per site) were available for 134 samples from 13 sites. Results of the ANCOVA showed that lipid ($p\leq0.04$) and lipid-site interaction ($p\leq0.005$) were significant covariates for p,p'-DDE and ΣDDT. Thus comparison between sites was confounded by lipid effects. Thus effects of location were tested with a one-way ANOVA using log transformed lipid normalized data ($\Sigma DDT_{L)}$. Concentrations of ΣDDT in burbot collected immediately upstream of both Hinton (A2) and Grande Prairie effluents (WR) were significantly higher than at the far-field sites of Clearwater River (CW), the lower Athabasca downstream of ALPAC (A4) as well as at the Lesser Slave River. Concentrations of ΣDDT_L in burbot from the Slave River Delta site were significantly higher than at CW but did not differ from the levels observed at the Wapiti/Smoky or upper Athabasca River sites. Geometric mean (wet weight) concentrations of ΣDDT showed similar trends (Figure 12a).

The temporal trend of ΣDDT in burbot liver was examined using data from site C1 (1992) and SR1 (1994) located on the Smoky River at the Hwy 49 bridge crossing. No significant differences in (log transformed) mean ΣDDT concentrations (t-test assuming unequal variance; $p=0.146$; $N=26$) were observed between the two sampling times (Table 27). Burbot samples were collected upstream of the municipal and pulp mill effluents at Grande Prairie, in 1994 (WR1 and 2) and downstream in 1992 (D2) therefore comparisons of possible temporal trends was problematic. On a wet weight basis geometric mean concentrations of ΣDDT in 1994 samples from WR (44 ng g^{-1}) were significantly higher ($p=0.07$) than those from D2 (10 ng g^{-1}). However, % lipid was higher in the 1994 samples. On a lipid normalized basis, differences were not significant (assuming equal variances; $p=0.27$)(Table 27). Although burbot samples were collected from two sites, near the mouth of the Notikewin River (PR2 and G3), and at the Near Beaver Ranch Indian Reserve (PR3 and I3) in both

Figure 12. Geometric mean concentrations (ng g^{-1} wet wt) of ΣDDT and ΣPCB in burbot liver - 1992 and 1994. Vertical bars represent SE of back transformed log 10 means.



1992 and 1994 statistical comparion could not be made because of limited sample numbers analysed for OC pesticides (N =1 or 2) in 1994.

Table 27. Temporal trends of ΣPCB and ΣDDT (geometric means ± SE) in Burbot Livers from the Wapiti/Smoky system, Fall 1992 and 1994[a]

		Fall 1992			Fall 1994[b]		
Location	Lipid or wet wt basis	N	ΣPCB ng g^{-1}	ΣDDT ng g^{-1}	N	ΣPCB ng g^{-1}	ΣDDT ng g^{-1}
Wapiti R near Grande Prairie[c]	wet	10	177 ± 67	10 ± 12	14	360 ± 65	44 ± 10
	lipid	10	698 ± 362	38 ± 38	14	718 ± 132	87 ± 21
Smoky R. at Hwy 49 crossing	wet	10	177 ± 90	9 ± 4	16	270 ± 48	15 ± 7.0
	lipid	-	-	-	16	466 ± 78	25 ± 12

[a] Comparison performed with log transformed wet weight or lipid normalized data, except for site C1 (Smoky R. 1992) for which no lipid was available.

[b] Significant differences (t-test of log transformed data at p=0.05 assuming unequal variances) were not observed for ΣPCB at either site for either wet or lipid wt results (p>0.05). ΣDDT in 1994 was significantly higher at the Wapiti sites on a wet wt basis (p=0.03) but not on a lipid wt basis(p=0.20).

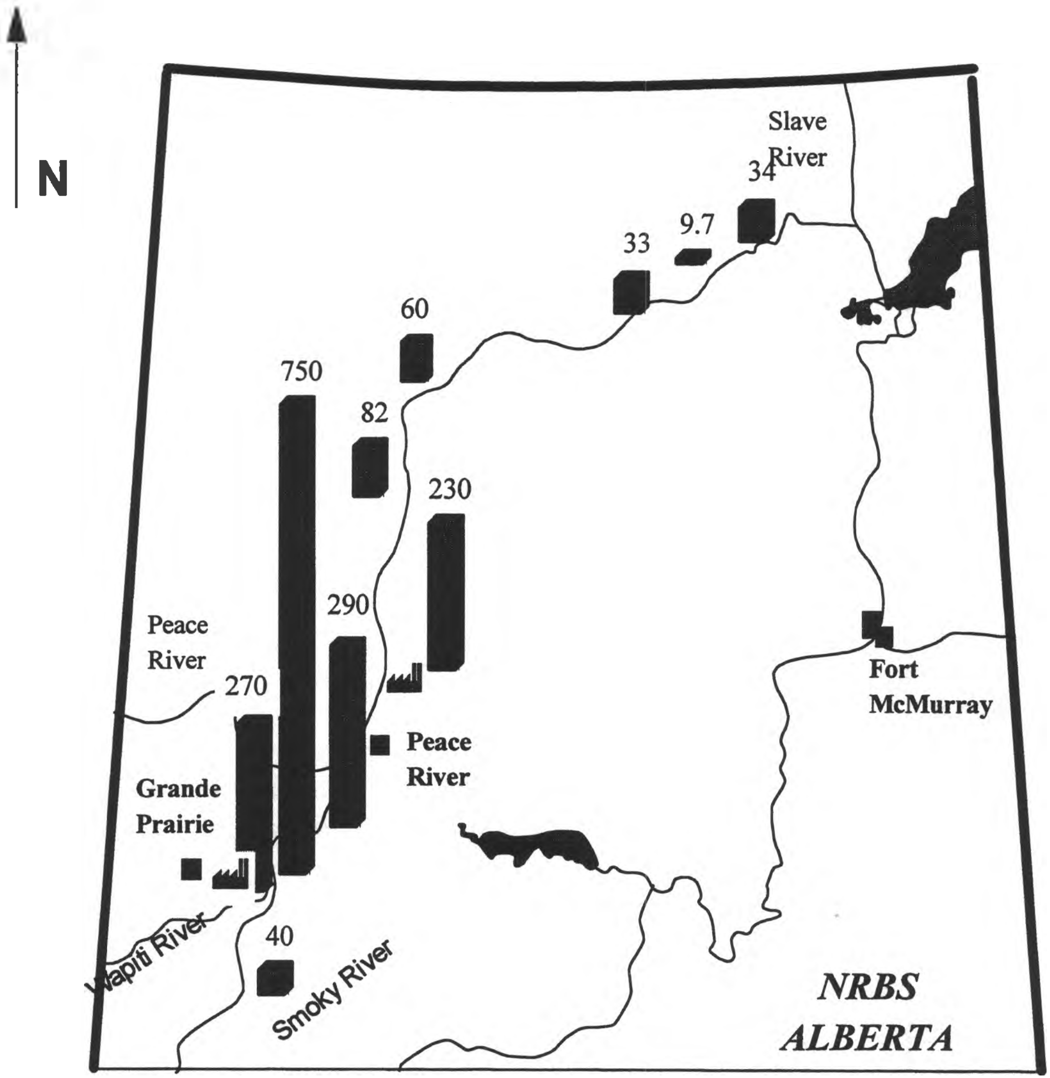
[c] Collection sites in 1994 were upstream of Grande Prairie (WR1 &2) and downstream in 1992.

6.3 PCBs INCLUDING NON-ORTHO CONGENERS

For the 1992 burbot livers, spatial trends of ΣPCBs were similar to those obtained for OC pesticides (Figure 12b and 13). High levels of ΣPCBs were found in burbot livers from the site D2 on the Wapiti River near Grande Prairie (arithmetic means; 270 ± 220 ng g^{-1}), from the site F1 near Peace River (230 ± 170 ng g^{-1}), and at site B3 (750 ± 600 ng g^{1}) and site D2 (290 ± 220 ng g^{1}) on the Smoky River. Past industrial and domestic use and disposal of PCBs in transformer oils and fluorescent light fixtures are a potential source of PCBs in municipal and industrial effluents entering the rivers near these sampling locations. The lowest levels of ΣPCBs were seen at the sample sites furthest downstream on the Peace River, nearer to Lake Athabasca. One of these sample sites, near John d'Or Prairie Indian Reserve (J3) had the lowest ΣPCBs levels of the 1992 burbot of 9.7 ± 9.2 ng g^{-1}. In addition, the sample site A3 on the Smoky River had low levels of 40 ±50 ng g^{-1}.

In 1994, high levels of ΣPCBs were seen in burbot livers obtained from sites just upstream of Grande Prairie - WR (arithmetic means; 420 ± 210 ng g^{-1}) and on the Smoky River (SR1; 390 ± 340

Figure 13. Levels of $\sum$PCB (ng $\cdot g^{-1}$ wet wt) in Burbot Liver from Peace River Basin, Fall 1992.



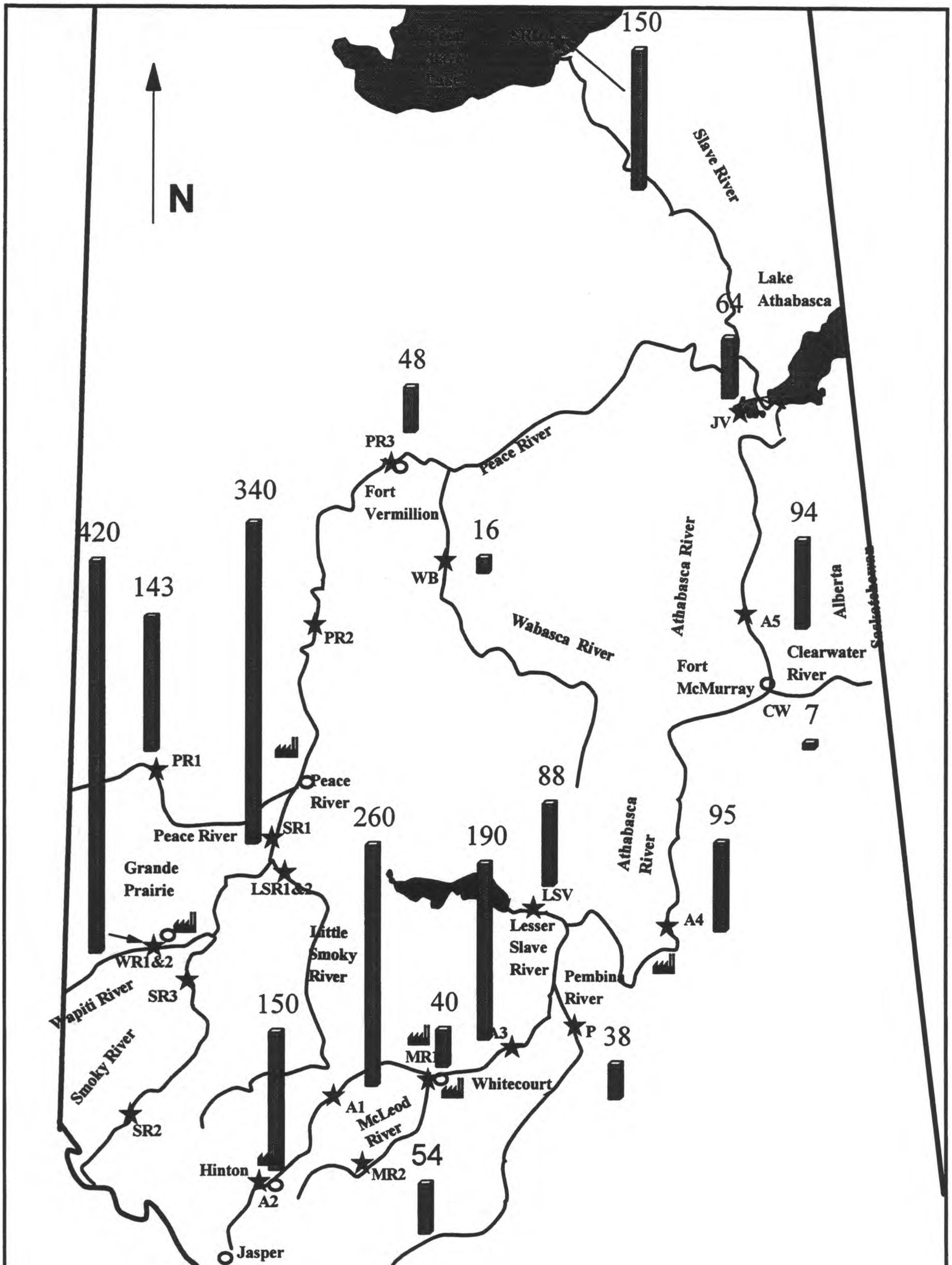
ng g^{-1}). Relatively high ΣPCB levels in burbot liver were also found downstream of Hinton (A1; 260 ± 190 ng g^{-1}) and near Whitecourt (A3; 190 ± 84 ng g^{1}) (Figure 14). A single sample from PR2, downstream from Diashowa, had similar levels to those found at PR1 (160 ± 64 ng g^{-1}) and in the upper Athabasca sites. In addition, relatively high levels of ΣPCBs (150 ± 52 ng g^{-1}) were also seen in the livers of burbot from the Slave River delta (SRD). Lowest levels of ΣPCBs (≤ 54 ng g^{-1}) were seen in burbot from the far-field sites on the Pembina (P), Clearwater (CW), McLeod (MR) and Wabasca Rivers (WAB).

ANCOVA was used to examine effects of sampling site and lipid on ΣPCB in 1992 burbot liver samples. Results were available for 64 samples from 8 sites for which % lipid and ΣPCB had been determined. There were no significant effects of lipid (p=0.68) and only a weak lipid-site interaction (p=0.05) was osbserved, therefore one way ANOVA was used with (log transformed ΣPCB) data f rom all 10 sites (N=95) to test the effect of site alone and multi mean comparisons were made with Tukey's test using the mean square error from the ANOVA (SAS 1991). The results of Tukey's test showed that burbot from B3, downstream of Grande Prairie, had significantly higher (geometric mean) concentrations of ΣPCB than far field sites on the Peace River (H1, K1, J3 and I1) as well as the upstream Smoky River site (A3)(Figure 12b). There were no significant differences in ΣPCB between B3 and D2 (near Grande Prairie) or sites immediately downstream (F1,C1, G3).

The log ΣPCB concentrations in 1994 burbot liver samples were weakly correlated with % lipid (p=0.0001) but not with age, weight or length (p>0.06) (Appendix C7). The major PCB congener, CB153 was also strongly correlated with lipid and weight. ANCOVA was used to test the effect of % lipid (p=0.0001) and age (p=0.03) but not with weight or length of burbot. ANCOVA was conducted with results for lipid and ΣPCB from 13 sites (N=146). Results of the ANCOVA showed that lipid was not a significant covariate (p=0.06) and that there was no lipid-site interaction (p=0.134). Therefore differences between wet weight (geometric means) concentrations of ΣPCB were compared with Tukey's Test at p=0.05 (SAS 1991). ΣPCB were significantly higher in burbot collected immediately upstream of Grande Prairie (WR) than at all other sites (WAB, SR1, SRD) in the Wapiti/Smoky/Peace/Slave system except PR1 (Figure 12b). The number of samples from PR1 was small (N=3) so that the power of the comparions was limited at that site. ΣPCB levels in burbot from the upper Athabasca (upstream and downstream of Hinton (A2 and A1) were significantly higher than at other sites on the Athabasca system; Clearwater River (CW), McLeod River (MCR), Lesser Slave River, A4 and A5. Results for ΣPCB in burbot from the Slave River delta were significantly higher than in samples from Athabasca and Peace tributaries (CW, WAB and MCR) but did not differ significantly from other sites (Figure 12b).

The temporal trend of ΣPCB in burbot liver was examined using data from site C1 (1992) and SR1 (1994) located on the Smoky River at the Hwy 49 bridge crossing. No significant differences (t-test assuming equal variances; p=0.25 to 0.50; N=26) in (log transformed) mean ΣPCB, CB153 or CB52 concentrations were observed between the two sampling times. Burbot samples were collected upstream of the municipal and pulp mill effluents at Grande Prairie, in 1994 (WR1 and 2) and downstream in 1992 (D2) therefore comparisons of possible temporal trends was problematic. On a wet weight basis geometric mean concentrations of ΣPCBs in 1994 samples from WR (362 ng g^{-1})

Figure 14. Levels of ΣPCB ($ng \cdot g^{-1}$ wet wt) in Burbot Livers, September to December 1994.



were higher than those from D2 (177 ng g^{-1}). However, % lipid was higher in the 1994 samples. On a lipid normalized basis, there were no significant differences ($p>0.05$) in ΣPCB_L between D2 (698 ng g^{-1}) and WR (717 ng g^{-1}). Although burbot samples were collected from two sites, near the mouth of the Notikewin River (PR2 and G3), and at the Near Beaver Ranch Indian Reserve (PR3 and I3) in both 1992 and 1994 statistical comparion could not be made because of limited sample numbers analysed for PCBs (N =1 or 2 in 1994).

A similar pattern of PCB homologs occurred for burbot livers collected in 1992 and 1994. Generally hexachlorobiphenyls were the most common homolog group found in burbot livers, followed by hepta- and penta-chlorobiphenyls. In the 1992 burbot, penta-, hexa- and heptachlorobiphenyls accounted for 84 ± 17% of the ΣPCB levels, while tri- and tetrachloro- congeners accounted for 15 ± 17% of the ΣPCB level. Di-, nona-, and decachlorobiphenyls were rarely detected in the burbot livers. A similar distribution was seen for the 1994 burbot: penta-, hexa and heptachloro- congeners accounted for 88 ± 10% of ΣPCB. Tri- and tetrachlorobiphenyls accounted for 9.5 ± 10.9% of the ΣPCB.

Major PCB congeners found in the burbot livers were PCB 52, 101, 138, 151, and 180. Three non-ortho substituted (or coplanar) PCBs included in the burbot liver analysis were CB 77, 126, and 169. Concentrations of these congeners in burbot liver were very low relative to the ortho-substituted PCBs. These three congeners were below their detection limit of 0.005 ng g^{-1} for all burbot livers in 1992. A small number of burbot livers (8.2% or 1 in 11) from 1994 contained detectable levels of PCB 77 ranging from 0.021 to 0.17 ng g^{-1} (Appendix C5). At the site immediately below Grande Prairie, four out of the eight burbot livers contained PCB 77 with levels ranging from 0.079 to 0.16 ng g^{-1}. In addition, at this sample site, one fish contained PCB 126 at a concentration of 0.28 ng g^{-1}. Two fish also contained PCB 169, one fish out of two at Pembina River (0.014 ng g^{-1}) and one fish out 17 at Slave River Delta (0.032 ng g^{-1}).

6.4 OC PESTICIDES AND PCBS IN NORTHERN PIKE AND LONGNOSE SUCKER LIVER (1992 and 1994)

A set of 22 liver samples from longnose suckers collected in spring 1992, from the Athabasca River downstream of Hinton, were analysed for PCB congeners (including non-ortho PCBs) and OC pesticides. Longnose sucker livers from the Wapiti/Smoky/Peace system collected in 1994 were also analysed. Results are summarized briefly in Table 28 and in detail in Appendix D1 to D6. PCBs were the most prominent organochlorine contaminants in longnose sucker liver. In 1994, highest ΣPCB concentrations were found in samples from SR1 and WR1 (arithmetic means 66 and 28 ng g^{-1}, respectively), in the Wapiti/Smoky rivers (Figure 15; Table 28). Non-ortho PCBs (CB77, 126 and 169) were not detectable (<0.005 ng g^{-1}) in longnose sucker livers from the Hinton area. OC pesticides were present at low levels in sucker livers at all sites. Levels of p,p'-DDE were higher at SR1 and WR (arithmetic means 3.7 and 2.7 ng g^{-1}, respectively) than at other sites.

A small number of liver samples from Northern pike were analyzed for OC pesticides and PCBs

Table 28. Concentrations of OC pesticides and PCB Homologs (ng g^{-1} wet wt) in Longnose Sucker liver from the Wapiti/Smoky and Peace Rivers, 1994 and from the upper Athabasca River, Spring 1992

Compound/location	Hinton area 1992	PR1 1994	PR2 1994	SR1 1994	WR1 1994
OC Pesticides:					
ΣCHLOR	0.8 ± 0.9	<1	<1	<1	<1
ΣHCH	<0.2	<0.2	<0.2	<0.2	<0.2
HCB	0.3 ± 0.2	0.7 ± 0.1	0.3 ± 0.2	0.7 ± 0.6	0.8 ± 0.7
o,p'- and p,p'-DDT	0.5 ± 1.3	<1	<1	<1	<1
p,p'-DDE	1.1 ± 1.1	0.6 ± 0.6	0.4 ± 0.4	3.7 ± 6.4	2.7 ± 4.7
p,p'-DDD	0.2 ± 0.5	<1	<1	<1	<1
toxaphene	<10	<10	<10	<10	38.0 ± 85.0
PCBs					
ΣPCBs	18.6 ± 12.4	5.8 ± 4.0	1.7 ± 1.6	66.0 ± 99.0	28.0 ± 51.0
di/tri	0.9 ± 0.3	<0.05	<0.05	0.9 ± 1.6	<0.05
tetra	1.2 ± 1.2	0.3 ± 0.6	<0.02	2.9 ± 5.0	1.4 ± 3.2
penta	3.9 ± 2.1	0.7 ± 1.1	0.2 ± 0.3	21.0 ± 32.0	11.0 ± 19.0
hexa	6.2 ± 4.1	3.7 ± 2.2	1.7 ± 1.6	27.0 ± 37.0	14.0 ± 21.0
hepta	4.95 ± 4.3	0.9 ± 1.5	<0.02	8.5 ± 14.0	3.4 ± 6.3
octa	1.9 ± 1.8	<0.02	<0.02	5.2 ± 8.3	<0.02
nona	<0.02	<0.02	<0.02	<0.02	<0.02
deca	<0.02	<0.02	<0.02	<0.02	<0.02

Table 29. Concentrations of OC pesticides and PCB homologs (ng g^{-1}) in Northern pike liver from the Wapiti/Smoky and Peace Rivers, Sept to Dec 1994

Compound/location	PR1	PR2	SR1	WR1
OC Pesticides:	(n=2)	(n=1)	(n=2)	(n=4)
ΣCHLOR	<1	<1	<1	0.3 ± 0.5
ΣHCH	1.0	<0.2	<0.2	<0.2
HCB	0.6	0.5	0.6	0.5 ± 0.3
o,p'- and p,p'-DDT	<1	<1	<1	<1
p,p'-DDE	4.0	1.1	2.0	4.4 ± 2.4
p,p'-DDD	<1	<1	<1	<1
toxaphene	<10	<10	<10	<10
PCBs				
ΣPCB	23.0	2.0	160.0	36.0 ± 24.0
di	<0.03	<0.3	<0.3	<0.3
tri	<0.05	<0.03	<0.05	<0.05
tetra	0.7	<0.02	8.1	2.4 ± 2.3
penta	4.3	<0.03	70.0	12.0 ± 8.8
hexa	13.0	1.9	68.0	14.0 ± 8.6
hepta	4.5	0.4	13.0	6.9 ± 4.7
octa	0.3	<0.02	1.1	<0.02
nona	<0.02	<0.02	<0.02	<0.02
deca	<0.02	<0.02	<0.02	<0.02

Figure 15. Levels of ΣPCBs (ng g^{-1} wet wt) in Burbot, Longnose Sucker and Northern Pike Livers from the Peace River Basin, Fall 1994

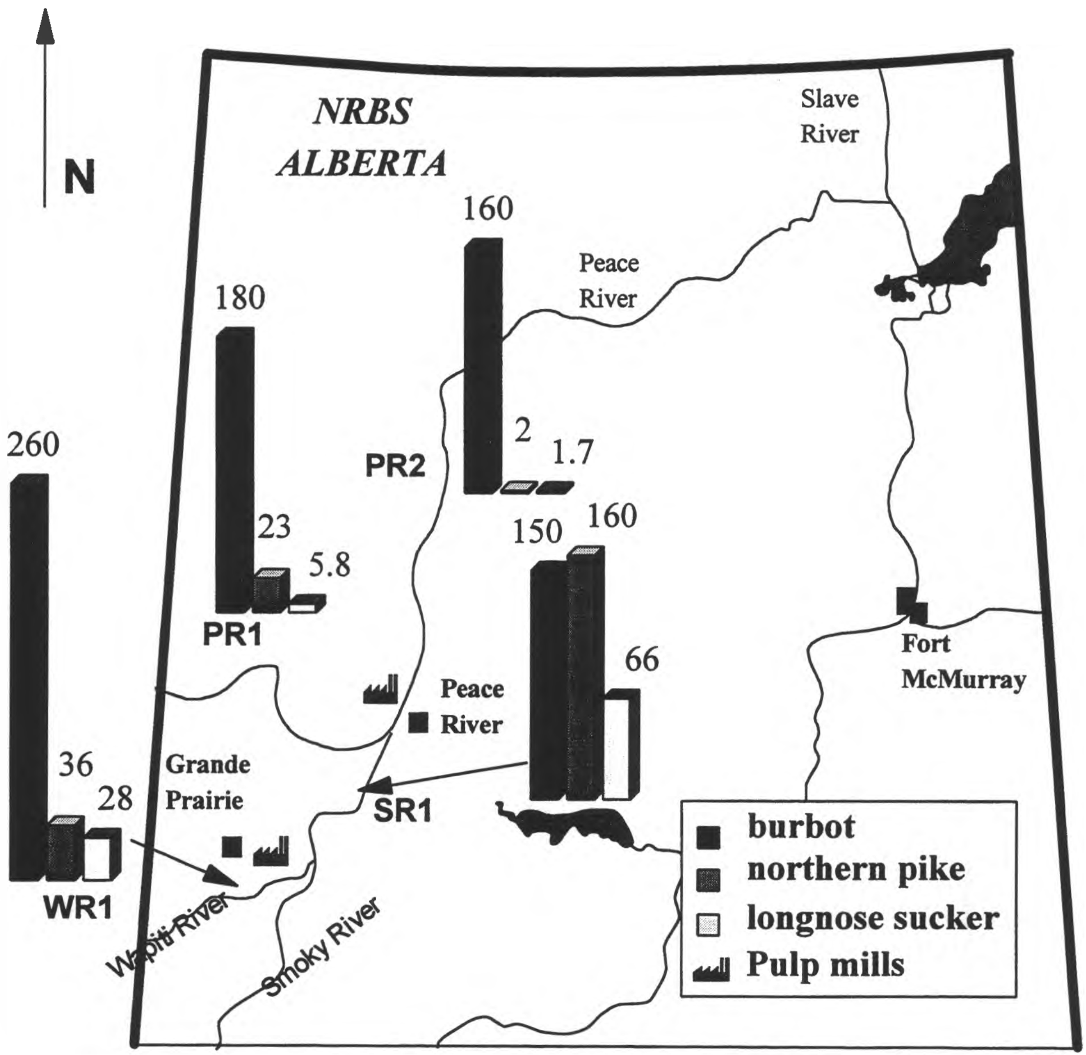


Table 30. Concentrations of PCBs and OC pesticides (ng g $^{-1}$ wet wt) in burbot, northern pike, lake whitefish, walleye and goldeye tissues from the Ft. Chipewyan Domestic Fishery Study (1994)[a]

Compounds	LA Burbot Muscle n=1	LA Burbot Liver n=1	LA N. Pike Muscle n=1	LA Goldeye Muscle n=1	LA Walleye Muscle n=1	LA . Whitefis Muscle n=1	QF burbot Muscle n=1	QF burbot liver n=2	QF N. Pike Muscle n=1	QF Goldeye Muscle n=1	QF Walleye Muscle n=1	QF . Whitefis Muscle n=1	JV Burbot Muscle n=1	JV Burbot liver n=1	JV . Whitefis Muscle n=2
OC pesticides															
ΣCHLOR	2.2	20.9	2.2	2.6	2.2	2.2	2.2	8.7	2.2	2.2	2.2	2.2	2.2	25.3	2.2
ΣHCH	0.2	4.4	0.2	0.3	0.2	0.2	0.2	2.1	0.2	0.2	0.2	0.2	0.2	1.4	0.2
HCB	0.1	4.9	0.1	0.2	0.1	0.2	0.1	1.6	0.1	0.3	0.1	0.1	0.2	3.0	0.1
o,p' & p,p'-DDT	1.0	2.5	1.0	1.0	1.0	1.0	1.0	1.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0
p,p'-DDE	0.3	15.0	1.1	0.7	0.3	0.3	0.3	2.0	0.3	1.1	0.3	0.3	0.3	20.0	0.3
p,p'-DDD	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0	0.5
ΣDDT	1.8	18.0	2.6	2.2	1.8	1.8	1.8	4.3	1.8	2.6	1.8	1.8	1.8	22.0	1.8
Toxaphene	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
ΣPCB	1.4	45.2	4.5	4.5	2.9	1.3	0.9	9.9	1.1	4.6	1.6	1.1	2.0	64.8	1.5
di/tri	0.5	1.8	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.8	0.5
tetra	0.1	2.6	0.1	0.2	0.2	0.3	0.1	0.1	0.1	0.2	0.1	0.1	0.1	3.1	0.1
penta	0.1	5.5	0.4	0.4	0.3	0.1	0.1	0.6	0.1	0.4	0.1	0.1	0.1	4.6	0.1
hexa	0.5	23.3	2.0	1.4	1.4	0.3	0.1	5.9	0.3	2.3	0.7	0.2	1.0	36.6	0.5
hepta	0.2	8.8	1.2	1.1	0.5	0.1	0.1	2.7	0.1	1.2	0.2	0.1	0.2	13.6	0.2
Octa	0.1	2.1	0.1	0.8	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5.0	0.1
Nona	<0.1	1.1	0.3	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.9	<0.1

[a] To calculate sum of chlordane, HCH and DDT-related compounds as well as PCB homologs 1/2 the detection limit was used rather than zero.

from four sites PR1, SR1, WR1, and WR2 (Figure 15;Table 29; Appendix D3, D4 and D5). A wide range of concentrations of ΣPCB was found in pike liver with highest mean concentrations (160 ng g^{-1} wet wt) observed in two samples from the Smoky River (SR1). These levels were comparable to those in burbot livers from the same location and about 2.5-times higher than in longnose sucker liver. Compared to PCBs, OC pesticide levels were low in northern pike liver samples and elevated levels were not found at SR1. The most prominent OC contaminant was p,p'-DDE which ranged in man concentration from 2 ng g^{-1} at SR1 to 4.4 ng g^{-1} at WR1.

6.5. PCBs AND OC PESTICIDES IN SAMPLES FROM THE FORT CHIPEWYAN DOMESTIC FISHERY (FALL 1994)

Single or duplicate pooled samples of burbot liver and muscle, and northern pike, lake whitefish, goldeye, and walleye muscle from three sites in the Peace-Athabasca delta region were analysed for PCBs (including non-ortho PCBs) and OC pesticides (Table 30). The three sites were Quatre Fourches, Jackfish Lake Fishing Village, and Potato Island (Lake Athabasca). Low concentrations of ΣPCBs (1.1 - 9.9 ng g^{-1} wet wt) and OC pesticides (0.1 - 2.2 ng g^{1} wet wt) were found in fish muscle samples. In general, levels were similar to those found in muscle of other species further upstream such as longnose suckers. Higher concentrations of ΣPCBs and OC pesticides (mainly ΣDDT andΣCHLOR) were found in burbot liver. Concentrations of these organochlorines in burbot liver from the Peace-Athabasca delta region were similar to those in other far-field tributary sites in the Peace/Athabasca system such as Clearwater River, Wabasca River, and McLeod River. Non-ortho PCBs were below detection limits (<0.005 ng g^{-1} wet wt) in all samples including burbot liver (Appendix D7).

7.0 DISCUSSION

7.1 ASSESSING RISK OF EXPOSURE TO OCS

Concentrations of PCBs in fish muscle or liver, under the five projects described in this study, are well below the limits set by Health Canada for commercial fish sale and export of 2000 ng g^{-1}. However, the data for PCBs, chlordane and toxaphene needs to be evaluated for human health risk assessment for subsistence use of fishes taking into account the traditional heavy use of fish by First Nations peoples in the Peace-Athabasca Region.

Health Canada's Tolerable daily intakes (TDIs) for major organochlorines are listed in Table 31. These TDIs are based on No Observable Adverse Effect Levels (NOAEL), or in the case of PCBs, Lowest Observable Adverse Effect Levels (LOAEL), established for these organochlorines via animal toxicology testing or epidemiological studies. The TDIs are derived for a 60 kg person and assuming life-time exposure, by dividing NOAELs with a safety factor which takes into account species differences, the range variation in sensitivity of individuals in the population and also uncertainties in the toxicological data (for e.g., less is known about toxaphene and chlordane than about PCBs so larger safety factors are used). Health Canada has recently used these TDIs to develop Recommended Maximum Weekly Intakes for consumption of certain tissues from subsistence fish and marine mammals in the Canadian Arctic (Health Canada 1995).

Table 31. Safety standards for major organochlorines used for human health risk assessment of subsistence foods by Health Canada

Organochlorine	NOAEL ($\mu g \cdot kg$ body $wt^{-1} \cdot day^{-1}$)	Safety Factor	TDI ($\mu g \cdot kg$ body $wt^{-1} \cdot day^{-1}$)
PCBs[a]	100	100	1.0
Chlordane	50	1000	0.05
Toxaphene	200	1000	0.2
DDT	200	10	20
HCH	300	1000	0.3

[a] Results for PCBs based on a LOAEL rather than a NOAEL.

For illustrative purposes only it is possible to do a preliminary assessment of the concentrations of organochlorines observed in the 1992 and 1994 studies. Comparison of the TDIs with mean concentrations in fish (mountain whitefish, pike, long-nosed sucker, goldeye or walleye) muscle indicates that PCB levels were found in mountain whitefish downstream of Hinton (means of 9.4 to 30 ng g^{-1}). Results for the two other species were much lower (means of 1 to 10 ng g^{-1}). It is clear that a 60 kg individual would have to consume 2 kg of mountain whitefish muscle per day to exceed the TDI for PCBs and 400 g to exceed it for toxaphene assuming similar levels of toxaphene to those of PCBs. Although chlordane has the lowest TDI, concentrations in mountain whitefish and pike muscle are about 10-fold lower than PCBs, thus the amount of fish required to exceed the chlordane TDI would be between that for toxaphene and PCBs. Much larger quantities (3 to 10 times) of other species (e.g., goldeye) would be needed because of lower levels. Given that large safety factors are built into the TDI a reasonable preliminary conclusion is that the organochlorine levels in fish muscle do not represent a human health hazard.

The concentrations of PCBs and other OCs observed in burbot liver, and in a limited nubmer of northern pike livers, are much higher than in muscle of burbot, pike, mountain whitefish and other species. This reflects the high lipid content of the burbot liver (30-50%) and their trophic position. Adult burbot are generally piscivorous. Mean concentrations of ΣPCBs in burbot liver ranged from 19 to 82 ng g^{-1} on the Athabasca River (and tributaries) and from 16 to 420 ng g^{-1} on the Peace and Wapiti/Smoky River and Slave River systems. Assuming the worst case of 400 ng g^{-1} a 60 kg individual would have to consume 150g burbot liver per day to exceed the TDI for PCBs. ΣCHLOR levels are about 1/10th of ΣPCB in burbot liver therefore the amount consumed to reach a TDI would be 75 g per day. The situation is more complex for toxaphene. Concentrations of toxaphene in burbot collected by the Special Burbot study, are not in accord with those reported for burbot by the Slave River (Peddle et al. 1995) and Great Slave Lakes studies (Evans 1994). This is discussed in more detail below. Assuming that the toxaphene levels in burbot liver in the Peace and Athabasca Rivers are indeed 8 to 10-times lower than ΣPCB then about 75 g per day of burbot liver could be consumed without exceeding the TDI for toxaphene. However further evaluation taking into account all fish tissues that may be consumed as part of the traditional diet (e.g., fish eggs, liver, fat) is needed.

The concentrations in fish muscle should also be evaluated for possible risks to fish-eating wildlife. The draft Canadian Environmental Quality Guidelines for protection of animals (freshwater wildlife) that consume aquatic biota is 7.6 $ng \cdot g^{-1}$ for total PCB congeners and 6.3 $ng \cdot g^{-1}$ for DDE. Mountain whitefish muscle samples from the upper Athabasca River exceed the criteria for ΣPCBs by 2 to10-times but they do not exceed the criteria for p,p'-DDE. Northern pike muscle from the RSS also had ΣPCB levels similar to the Canadian EQG while other species in the lower Athabasca had lower levels. The US EPA has established guideline values of 160 $ng\ g^{-1}$ for PCBs and 39 $ng\ g^{-1}$ for ΣDDT in fish flesh for assessment of hazards to wildlife (US EPA 1995b). The low value for DDT is related to the high persistence of the metabolite DDE which is associated with eggshell thinning in fish-eating birds. Concentrations in muscle of all fish sampled are well below these levels by a factor of at least 5 to greater than 10-fold. The US EPA wildlife criteria for 2,3,7,8-TCDD of 0.5 $ng\ kg^{-1}$ are exceeded in mountain whitefish flesh from the same locations analysed for PCBs. Levels of PCBs and ΣDDT in burbot liver also exceed these criteria.

Burbot liver can also be assessed by calculating 2,3,7,8-TCDD/F TEQs for non-ortho and mono-ortho PCBs. TCDD TEQs calculated using the limited data for non-ortho congeners were low and influenced mainly by levels of PCBs 105 and 118 (Appendix B). But 2,3,7,8-TCDD/F congeners were detected in burbot liver (Pastershank and Muir 1996) and accounted for more TCDD TEQs than the PCBs.

7.2. REGIONAL VARIATIONS OF PCB AND OC PESTICIDES IN FISHES

Although production of PCBs, and persistent OC pesticides such as DDT and toxaphene, was halted in the 1970s and early 1980's, these contaminants were still detected in all fish from the NRBS 1992 and 1994 fish collections. In part, this can be explained by their environmental persistence and their redistribution into aquatic ecosystems. Elevated levels of PCBs and OC pesticides were seen in burbot liver, and to a lesser extent in mountain whitefish and northern pike muscle, immediately downstream of municipal/industrial sources (including BKMs) relative to samples from tributaries or long distances from effluents. The highest PCB and OC pesticide levels in burbot liver and northern pike liver were seen in the Wapiti/Smoky River system. The elevated PCBs, first observed burbot collected from in the Wapiti/Smoky in 1992 were confirmed with the 1994 samples.

The regional variation of ΣPCBs and toxaphene in burbot liver is illustrated in Figure 16. The relatively high levels of PCBs and chlordane were found in burbot liver from the Slave River delta

Figure 16. Regional levels of ∑PCB and toxaphene (ng g^{-1}wet wt) in Burbot Liver from recent studies. including Special Burbot collection - 1992. Other samples are from 1992-3. (Peddle et al. 1995; Evans 1994; Muir and Lockhart 1994).

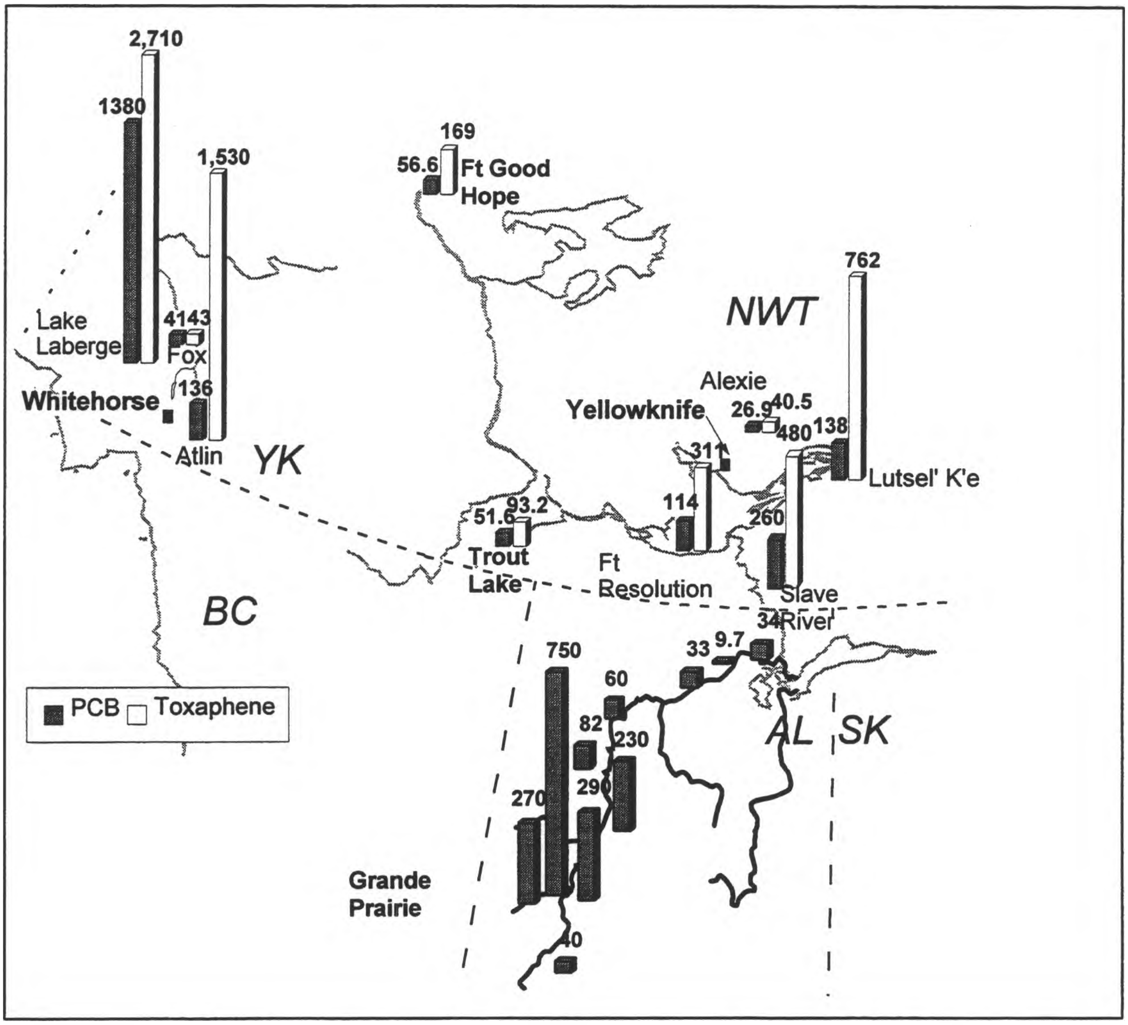
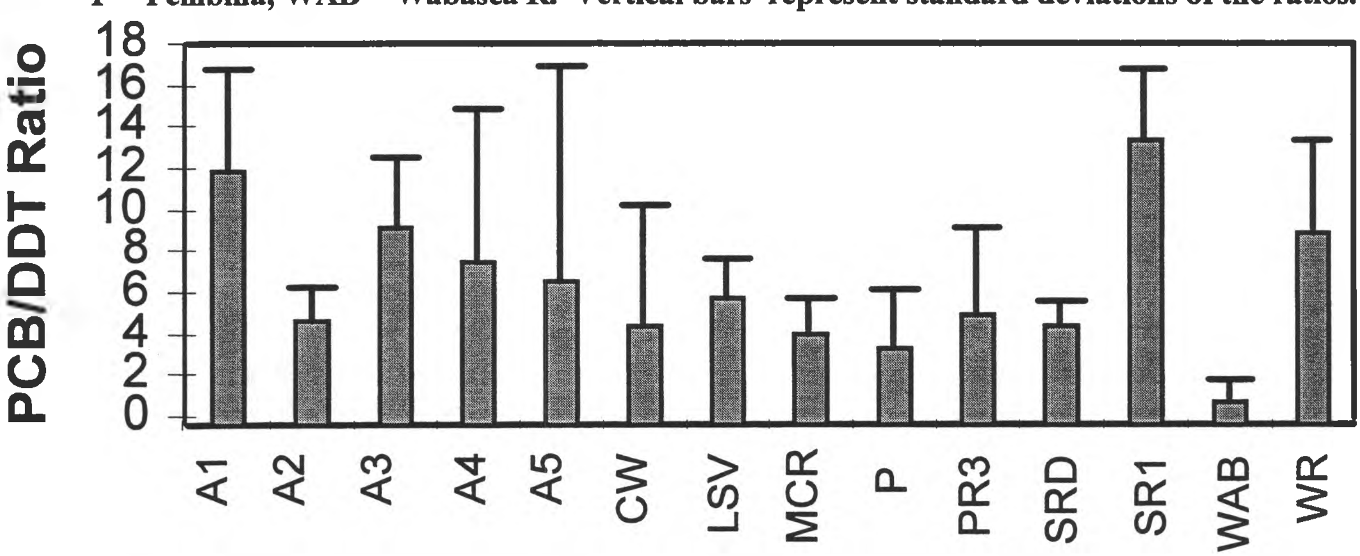


Figure 17. PCB/DDT ratios in burbot liver from 1994 collection sites. A = Athabasca R., PR = Peace River, SLR = Slave River, MR = MacLoed R., CW = Clearwater, SR = Smoky R.; P = Pembina, WAB = Wabasca R. Vertical bars represent standard deviations of the ratios.



in 1994 agree well with those reported by the Slave River study (Peddle et al. 1995) and in Great Slave Lake (Muir and Lockhart 1994; Evans 1994). Concentrations of ΣPCB and OC pesticides are higher in burbot from Great Slave Lake than in small lakes draining into the Mackenzie system (e.g. Alexie and Trout Lakes) or in burbot from the Athabasca delta and lower Peace River. One possible explanation for higher levels in Slave River delta burbot, relative to other far-field locations is that the burbot are feeding at a higher trophic level in these locations. In Great Slave lake and in the Slave River, burbot are generally top predators based on stable isotope (^{15}N) analysis (Evans 1994), and on stomach contents analysis (Tallman 1996). Burbot feed upon a variety of benthic and pelagic fish such as cisco, white suckers and lake whitefish. Burbot from smaller NWT lakes and in the upper Peace and lower Slave River may be feeding primarily on benthic invertebrates rather than fishes (Tallman 1996). This would result in one less biomagnification step for organochlorines in the food chain. Analysis of ^{15}N in burbot from all of the sites would help confirm this "trophic level" hypothesis. In the Yukon, burbot from Lake Laberge have much higher toxaphene concentrations that those in nearby lakes, although inputs to all of the lakes are quite similar based on levels in sediments. This has been explained by the higher trophic position of burbot in Laberge (Kidd et al. 1995).

The higher PCBs in burbot and northern pike liver from sites in the vicinity of pulp mill and municipal effluents (Sites WR, SR1, A1 and A2 in 1994) could also be due, at least in part to food chain effects. Greater emissions of nutrients in the effluents may give rise to greater autochthonous organic carbon production in these reaches and ultimately in amounts of benthic forage fish, which are the usual diet of burbot. Actual spills or direct inputs of PCBs and other OC pesticides are another possible explanation for elevated levels in the immediate vicinity of municipal/industrial effluents. The higher levels of PCBs in long nose sucker liver samples from the Smoky River suggest a contamination source, rather than biomagnification through the food web, because suckers feed at a lower trophic level than burbot or pike. There may have been past uses of DDT for biting fly control, while γ-HCH is still registered for use as a seed treatment on cereal crops and was used in the past as a cattle treatment in the region (Somers et al. 1987). If direct contamination from past spills of PCBs or use of DDT had occurred, we would expect to see wide variation in PCB/DDE ratios in burbot liver among sampling sites. This is not the case. Although there is quite a large variation of PCB/DDE (Figure 17), the ratio is not higher at sites immediately downstream of effluents (e.g., SR1, A2, A3, PR2). The two highest PCB/DDE ratios are for burbot from upstream of Hinton and in the Slave River delta, areas that are much less impacted by human activity than immediately downstream of industrial areas. The relatively similar PCB/DDE ratios for sites on the mainstem Athabasca, Peace and Wapiti/Smoky, imply common sources rather than direct inputs of PCBs.

Further analysis of the data is needed to examine patterns of PCB congeners at these locations using multivariate techniques. Higher proportions of hepta-, octa- and nonachloro- congeners were evident in mountain whitefish at Weldwood and Obed Coal sites, immediately downstream of Hinton. This suggests a different source of PCBs, possibly from past PCB use in the town of Hinton or in the pulp mill (the effluent is combined municipal/pulp mill), compared to those upstream or to northern pike. On the other hand, the greater autochthonous organic carbon production downstream could give rise to a longer food web which would favor biomagnification of higher chlorinated congeners.

Another explanation of the higher PCBs and OC pesticides in the immediate vicinity of municipal/industrial effluents may be desorption from the large volume of surfaces of timber used by the BKM. Organochlorines are present primarily in the gas phase in the atmospheric and are known to absorb to plant leaves and tree bark. Pine needles and tree bark has been used to monitor airborne PCBs and DDT (Kylin et al. 1994). Therefore, tree debarking and wood processing operations could result in higher levels of organochlorines as byproducts. This is highly speculative because we are aware of no reports confirming this. But release of the PCBs and OC pesticides in the effluent on dissolved phases and on particles (they would not be biodegraded in treatment ponds) would be expected to give rise to slightly elevated levels downstream of the effluents similar to what is observed for PCDD/Fs and chlorophenolics. Analysis of effluents for these persistent OCs would be needed to confirm this hypothesis.

Levels of toxaphene were below the detection for most fish in the RSS, RAP, and Special Burbot collection studies of 1992 and 1994. The low toxaphene levels in burbot liver are unusual as can be seen in Figure 16. Studies on the Slave River (Peddle et al. 1995, Great Slave Lake (Evans 1994), Yukon lakes (Kidd et al. 1995) and Mackenzie River (Muir and Lockhart 1994) have shown toxaphene to be present at levels equal to or greater than ΣPCBs. The interlab study (Appendix E1) showed that results obtained for toxaphene by two other laboratories where higher than those for Zenon, the analytical lab responsible for all organochlorine analysis. There is therfore great uncertainty about levels of toxaphene in fish in the Peace/Athabasca area.

Unlike the PCBs and OC pesticides, the CPs detected in fish muscle and liver were clearly indicative of a BKM source with highest levels observed in fish caught immediately downstream of BKMs. The veratroles (TCV), anisoles (PCA) and PCP were the most common chlorophenolics. An exception to this trend was the PCP levels in mountain whitefish muscle on the Athabasca which were present at similar levels in upstream and downstream of the BKM. The same fishes showed much lower PCDD/Fs at the upstream site. The spatial trend of PCP in burbot liver sampled in 1992 in the Wapiti/Smoky/Peace also did not follow that of PCDD/Fs (Pastershank and Muir 1996) and was highest at sites along the Smoky River further downstream from the BKM. Therefore, there must be multiple sources of PCP in the region probably due to its past widespread use as a wood preservative.

Owens et al. (1994), in their study of the Wapiti/Smoky river, showed that CPs was rarely detected in fillets of mountain whitefish but were prominent in bile (as glucuronide conjugates). Analysis of bile would have been useful in this study to detect direct exposure to BKM effluent because biotransformation and excretion of most chlorophenolics are so rapid and complete that only a small amount is stored in muscle or liver tissues. The presence of veratroles and anisoles in fish muscle is clearly also indicative of BKM exposure and could be used as an indicator for future environmental effects monitoring of BKMs. However there are other possible sources to the aquatic environment because of the volatility of veratroles and anisoles which might make interpretation difficult.

7.3 RECOMMENDATIONS

1. Continued monitoring of organochlorines such as PCBs, toxaphene and chlorinated veratrole/anisole at 2 to 3 year intervals i.e in 1996, 1998 etc at selected sites on the Wapiti/Smoky/Peace and on the Athabasca in burbot liver and in mountain whitefish flesh. Now that baseline concentrations have been established temporal trends can be assessed to confirm declining chlorophenolics in fish tissues. The relatively high levels of PCBs and other OC pesticides near confluence of the Wapiti/Smoky and downstream of Hinton, while nowhere near actionable levels for sale commercial fish (2000 ng g^{-1}), need to be monitored and the elevated levels explained.

2. Following from #1 is the need to have dietary intake information by subsistence fishers for certain areas. Perhaps this is already being carried out by other programs.

3. Identify the source of elevated PCBs and other OCs in fish near pulp mills with some small, site-specific studies. The first and most likely possibility is that the food webs near the mills are more diverse allowing greater biomagnication of PCBs because burbot and other piscivorous fishes would consume more forage fish than invertebrates. But industrial activity in the past nearby or on these sites could have led to contamination which continues to emit very low levels (but well above "background" atmospheric inputs). This seems to be the case for PCP.

4. All chemical monitoring recommended above assumes use of methods as good as or better than those used by NRBS. For example, analysis of individual fish and congener specific PCB analysis. Toxaphene analysis should be continued because of its prominence as a contaminant in Great Slave Lake fishes. This will allow proper comparison with work on the Slave River and along the Mackenzie.

5. Analysis of PAH and chlorophenolic metabolites in fish bile. One major gap in the contaminants information is the lack of data on the more readily metabolizable compounds in fish. The SPMD work by Parrott et al (1995) illustrates the need for further work to characterize what fish are exposed to. We currently are only monitoring the non-metabolizable, persistent organics. But there are techniques for determining selected CPs and PAH metabolites in bile. Combined with SPMD work this would help identify chemical exposures of fish and may be useful in interpreting biomarker data such as sex steroid and thyroid hormone levels. Future contaminant issues for fish in the Peace and Athabasca basins are going to be related to "nonpersistent" contaminants.

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APPENDICES

Table A1. Levels of CPs (ng g^{-1} wet wt) in Mountain Whitefish and Northern Pike muscle samples from the Athabasca River, Spring, 1992

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ng g^{-1} ± SD
u/s of Hinton	mountain whitefish	Pentachlorophenol	0.2	0	to	1.3	(4/10)	0.3 ± 0.4
		Tetrachlorocatechol	0.4	0	to	2.0	(6/10)	0.8 ± 0.8
		3,4,5-TriCl-catechol	0.4	0	to	1.8	(5/10)	0.5 ± 0.6
Weldwood Haul Br.	mountain whitefish	Pentachlorophenol	0.2	0	to	0.4	(7/11)	0.2 ± 0.2
		Tetrachloroveratrole	0.4	0	to	9.5	(9/11)	4.1 ± 2.7
		Pentachloroanisole	0.2	0	to	2.2	(9/11)	0.9 ± 0.7
		2346+2356-TeCl-Anisole	0.4	0	to	1.8	(2/11)	0.3 ± 0.7
Obed Coal Br.	mountain whitefish	Pentachlorophenol	0.2	0	to	0.5	(2/10)	0.1 ± 0.2
		345-TriCl-Guaiacol	0.4	0	to	0.5	(2/10)	0.1 ± 0.2
		Tetrachlorocatechol	0.4	0	to	5.0	(4/10)	0.9 ± 1.5
		3,4,5-TriCl-Catechol	0.4	0	to	1.2	(1/10)	0.1 ± 0.4
		Tetrachloroveratrole	0.4	0	to	6.9	(8/10)	3.6 ± 2.7
		Pentachloroanisole	0.2	0	to	1.2	(7/10)	0.7 ± 0.5
Emerson L. Br.	mountain whitefish	Pentachlorophenol	0.2	0	to	0.5	(1/8)	0.1 ± 0.2
		Tetrachloroveratrole	0.4	0.4	to	11.0	(8/8)	6.7 ± 2.9
		Pentachloroanisole	0.2	0.2	to	1.4	(8/8)	0.8 ± 0.4
Knight Br.	mountain whitefish	Pentachlorophenol	0.2	0	to	0.5	(7/9)	0.3 ± 0.2
		Tetrachloroveratrole	0.4	0.4	to	3.9	(9/9)	1.6 ± 1.0
		Pentachloroanisole	0.2	0	to	0.5	(6/9)	0.2 ± 0.2
Windfall Br.	mountain whitefish	Pentachlorophenol	0.2	0	to	0.6	(4/10)	0.2 ± 0.3
		Tetrachloroveratrole	0.4	0	to	3.1	(9/10)	2 ± 0.9
		3,4,5-TriCl-Catechol	0.4	0	to	3.1	(5/10)	1 ± 1.2
		Pentachloroanisole	0.2	0	to	0.4	(4/10)	0.1 ± 0.2
u/s of Hinton	northern pike	Pentachlorophenol	0.2	0	to	1.0	(2/6)	0.2 ± 0.4
		Tetrachlorocatechol	0.4	0	to	7.7	(2/6)	2.0 ± 3.3
		3,4,5-TriCl-Catechol	0.4	0	to	7.2	(2/6)	1.7 ± 2.9
		35-Di-chloro-catechol	0.4	0	to	2.4	(1/6)	0.4 ± 1.0
		45-Di-chloro-catechol	0.4	0	to	3.5	(1/6)	0.6 ± 1.4
		Tetrachloroveratrole	0.4	0	to	5.1	(2/6)	0.9 ± 2.1
		Pentachloroanisole	0.2	0	to	0.7	(1/6)	0.1 ± 0.3
Emerson L. Br.	northern pike	Pentachlorophenol	0.2	0	to	0.4	(1/2)	0.2 ± 0.3
		Tetrachloroveratrole	0.4	0	to	0.7	(2/2)	0.7 ± 0.0
		Pentachloroanisole	0.2	0	to	0.2	(1/2)	0.1 ± 0.1
Knight Br.	northern pike	Pentachlorophenol	0.2	0	to	0.5	(5/10)	0.2 ± 0.2
		Tetrachloroveratrole	0.4	0	to	0.6	(3/10)	0.1 ± 0.2
Windfall Br.	northern pike	Pentachlorophenol	0.2	0	to	1.7	(6/10)	0.5 ± 0.5
		Tetrachlorocatechol	0.4	0	to	1.0	(2/10)	0.1 ± 0.3
		Tetrachloroveratrole	0.4	0	to	0.5	(2/10)	0.1 ± 0.2

[1] Only chlorophenolics detectable in at least one sample from each site are reported

Table A2. Levels of OC Pesticides (ng g^{-1} wet wt) in Mountain Whitefish and Northern Pike muscle samples from the Athabasca River, Spring 1992.

Location	Fish Species	Compound[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
upstream/control	mountain whitefish	alpha-HCH	0.2	0	to	3.3	(7/10)	1.0 ± 1.2
		gamma-HCH	0.2	0	to	0.7	(6/10)	0.3 ± 0.3
		trans-Nonachlor	1	0	to	4	(6/10)	1.9 ± 1.9
		Oxychlordane	1	0	to	2	(4/10)	0.7 ± 0.9
		alpha-Chlordane	1	0	to	4	(6/10)	1.7 ± 1.7
		p,p'-DDE	0.5	0	to	12	(6/10)	1.8 ± 3.7
		p,p'-DDD	1	0	to	5	(5/10)	1.8 ± 2.0
		p,p'-DDT	2	0	to	8	(6/10)	2.8 ± 3.0
		Toxaphene	50	50	to	100	(3/10)	21.0 ± 36.0
Weldwood Haul Br.	mountain whitefish	alpha-HCH	0.2	0	to	0.4	(3/10)	0.1 ± 0.2
		trans-Nonachlor	1	0	to	1	(1/10)	0.1 ± 0.3
		p,p'-DDE	0.5	0	to	1.7	(3/10)	0.6 ± 0.5
		p,p'-DDT	2	0	to	4	(2/10)	0.6 ± 1.3
		Hexachlorobenzene	0.1	0.1	to	1.2	(10/10)	0.8 ± 0.3
Obed Coal Bridge	mountain whitefish	alpha-HCH	0.2	0	to	2.5	(9/10)	1.3 ± 0.9
		beta-HCH	0.2	0	to	1.8	(6/10)	0.8 ± 0.8
		gamma-HCH	0.2	0.2	to	1	(9/10)	0.5 ± 0.3
		trans-Nonachlor	1	0	to	3	(5/10)	0.8 ± 1.0
		Oxychlordane	1	0	to	2	(4/10)	0.6 ± 0.9
		alpha-Chlordane	1	0	to	3	(5/10)	1.1 ± 1.3
		gamma-Chlordane	1	0	to	3	(3/10)	0.6 ± 1.1
		p,p'-DDE	0.5	0	to	1.6	(7/10)	0.8 ± 0.6
		p,p'-DDD	1	0	to	9	(7/10)	2.6 ± 3.0
		p,p'-DDT	2	0	to	6	(4/10)	3.0 ± 3.7
		Hexachlorobenzene	0.1	4.8	to	63	(10/10)	33.6 ± 25.4
		Heptachlor epoxide	0.4	0	to	0.4	(1/10)	0.0
Emerson Lake Br.	mountain whitefish	alpha-HCH	0.2	0	to	0.4	(5/8)	0.1 ± 0.2
		beta-HCH	0.2	0	to	0.3	(1/8)	0.0 ± 0.1
		trans-Nonachlor	1	0	to	1	(2/8)	0.2 ± 0.4
		p,p'-DDE	0.5	0	to	2.8	(4/8)	0.8 ± 0.9
		p,p'-DDT	2	0	to	2	(2/8)	0.3 ± 0.7
			0.1	0.6	to	1.9	(8/8)	1.2 ± 0.5
Knight Bridge	mountain whitefish	alpha-HCH	0.2	0	to	0.2	(2/10)	0.0 ± 0.1
		p,p'-DDE	0	0	to	0.9	(1/10)	0.1 ± 0.3
		Hexachlorobenzene	0.5	0.2	to	1	(10/10)	0.5 ± 0.3
					to			
Windfall Bridge	mountain whitefish	alpha-HCH	0.2	0	to	0.2	(1/4)	0.1 ± 0.1
		trans-Nonachlor	1	0	to	1	(2/4)	0.5 ± 0.6
		p,p'-DDE	0.5	0	to	1.3	(1/4)	0.3 ± 0.7
		Hexachlorobenzene	0.1	0.5	to	1	(4/4)	0.8 ± 0.2
upstream/control	northern pike	Aldrin	0.2	0	to	0.2	(2/6)	0.1 ± 0.1
		beta-HCH	0.2	0	to	0.2	(1/6)	0.0 ± 0.1
		gamma-HCH	0.2	0	to	1	(3/6)	0.3 ± 0.4
		gamma-Chlordane	1	0	to	1	(1/6)	0.2 ± 0.4

Location	Fish Species	Compound[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
		p,p'-DDE	0.5	0	to	0.6	(2/6)	0.2 ± 0.3
		p,p'-DDD	1	0	to	1	(2/6)	0.3 ± 0.5
		p,p'-DDT	2	0	to	2	(1/6)	0.3 ± 0.8
		Hexachlorobenzene	0.1	0	to	1	(2/6)	0.3 ± 0.4
		Methoxychlor	2	0	to	2	(2/6)	0.7 ± 1.0
		Toxaphene	50	0	to	50	(1/6)	8.3 ± 20.4
Weldwood Haul Br.	northern pike	p,p'-DDE	0.5	0.5	to	0.5	(1/1)	0.1
		Hexachlorobenzene	0.1	0.1	to	0.1	(1/1)	0.1
Emerson Lake	northern pike	alpha-HCH	0.2	0.2	to	0.3	(1/1) Dup	0.2 ± 0.2
		p,p'-DDE	0.5	0.5	to	0.7	(1/1) Dup	0.4 ± 0.5
		Hexachlorobenzene	0.1	0.2	to	0.6	(1/1) Dup	0.4 ± 0.3
Knight Bridge	northern pike	alpha-HCH	0.2	0	to	0.4	(3/10)	0.1 ± 0.1
		p,p'-DDE	0.5	0	to	1.6	(1/10)	0.1 ± 0.5
		p,p'-DDD	1	0	to	1	(1/10)	0.1 ± 0.3
		Hexachlorobenzene	0.1	0.2	to	0.7	(10/10)	0.5 ± 0.2

[1] - Only organochlorines detected in at least one sample from each site are reported.

Table A3. Levels of PCBs (ng g^{-1} wet wt) in Mountain Whitefish and Northern Pike muscle, Athabasca River, Spring 1992.

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean	±	SD ng g^{-1}
Upstream/control	mountain whitefish	PCB 18	0.05	0	to	3	(5/10)	0.56	±	0.92
		PCB 33	0.05	0	to	0.3	(3/10)	0.08	±	0.13
		PCB 22	0.05	0	to	0.6	(1/10)	0.06	±	0.19
		PCB 52	0.05	0	to	0.5	(3/10)	0.12	±	0.20
		PCB 49	0.03	0	to	0.3	(3/10)	0.07	±	0.12
		PCB 44	0.03	0	to	0.3	(2/10)	0.05	±	0.11
		PCB 70/76	0.03	0	to	0.5	(3/10)	0.11	±	0.19
		PCB 65/95	0.03	0	to	0.8	(5/10)	0.25	±	0.31
		PCB 56/60	0.02	0	to	0.1	(3/10)	0.03	±	0.05
		PCB 84	0.02	0	to	0.3	(4/10)	0.07	±	0.11
		PCB 89	0.02	0	to	0.2	(3/10)	0.04	±	0.07
		PCB 101	0.03	0	to	1.3	(7/10)	0.52	±	0.49
		PCB 87	0.02	0	to	0.6	(5/10)	0.24	±	0.26
		PCB 110	0.02	0	to	1.2	(6/10)	0.52	±	0.48
		PCB 151	0.02	0	to	0.7	(7/10)	0.33	±	0.29
		PCB 149	0.02	0	to	3.1	(10/10)	0.76	±	0.88
		PCB 118	0.03	0	to	1.2	(6/10)	0.39	±	0.40
		PCB 146	0.02	0	to	0.5	(3/10)	0.10	±	0.18
		PCB 153	0.02	0.84	to	3.5	(10/10)	1.6	±	0.85
		PCB 105	0.02	0	to	0.7	(6/10)	0.24	±	0.26
		PCB 141	0.02	0	to	0.4	(4/10)	0.11	±	0.17
		PCB 137	0.02	0	to	0.21	(4/10)	0.07	±	0.10
		PCB 138	0.02	0.55	to	2.1	(10/10)	1.2	±	0.63
		PCB 129	0.02	0	to	0.25	(2/10)	0.04	±	0.08
		PCB 182/187	0.02	0	to	0.7	(8/10)	0.29	±	0.24
		PCB 183	0.02	0	to	0.6	(8/10)	0.28	±	0.24
		PCB 128	0.02	0	to	0.6	(7/10)	0.28	±	0.24
		PCB 185	0.02	0	to	0.3	(2/10)	0.05	±	0.11
		PCB 174	0.02	0	to	0.4	(5/10)	0.14	±	0.17
		PCB 177	0.02	0	to	0.4	(5/10)	0.16	±	0.18
		PCB 171/202	0.02	0	to	0.5	(7/10)	0.22	±	0.18
		PCB 180	0.02	0.19	to	1.8	(10/10)	0.77	±	0.48
		PCB 191	0.02	0.02	to	0.14	(10/10)	0.01	±	0.04
		PCB 170	0.02	0	to	0.57	(7/10)	0.25	±	0.20
		PCB 201	0.02	0	to	0.6	(7/10)	0.24	±	0.21
		PCB 196/203	0.02	0	to	0.54	(6/10)	0.13	±	0.17
		PCB 194	0.02	0	to	0.27	(6/10)	0.08	±	0.08
		PCB 205	0.02	0	to	0.1	(4/10)	0.04	±	0.05
		PCB 209	0.02	0	to	0.33	(1/10)	0.03	±	0.10
		PCB - Total	2	2	to	21	(10/10)	11	±	7.3
Weldwood Haul Br.	mountain whitefish	PCB 22	0.05	0	to	3	(5/9)	0.75	±	1.1
		PCB 52	0.05	0	to	6.8	(5/9)	1.1	±	2.1
		PCB 70/76	0.03	0	to	0.93	(1/9)	0.09	±	0.29

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean	±	SD ng g^{-1}
		PCB 65/95	0.03	0	to	0.35	(2/9)	0.06	±	0.13
		PCB 84	0.02	0	to	0.33	(1/9)	0.03	±	0.10
		PCB 89	0.02	0	to	0.44	(1/9)	0.04	±	0.14
		PCB 101	0.03	0.2	to	1.9	(9/9)	0.75	±	0.44
		PCB 87	0.02	0	to	0.9	(6/9)	0.25	±	0.28
		PCB 110	0.02	0	to	7.6	(8/9)	1.7	±	2.1
		PCB 151	0.02	0	to	1	(7/9)	0.43	±	0.34
		PCB 149	0.02	0	to	4.8	(5/9)	1.6	±	1.8
		PCB 118	0.03	0	to	1.9	(6/9)	1.0	±	0.75
		PCB 153	0.02	0.02	to	4.2	(9/9)	2.4	±	1.1
		PCB 105	0.02	0	to	0.62	(3/9)	0.16	±	0.26
		PCB 141	0.02	0	to	3.8	(7/9)	0.62	±	1.1
		PCB 137	0.02	0	to	0.31	(2/9)	0.06	±	0.12
		PCB 138	0.02	0.65	to	3.6	(9/9)	2.0	±	0.87
		PCB 129	0.02	0	to	0.46	(1/9)	0.05	±	0.15
		PCB 182/187	0.02	0	to	0.4	(2/9)	0.09	±	0.15
		PCB 183	0.02	0	to	1.4	(4/9)	0.28	±	0.43
		PCB 128	0.02	0	to	1.3	(7/9)	0.53	±	0.38
		PCB 174	0.02	0	to	0.61	(6/9)	0.23	±	0.21
		PCB 177	0.02	0	to	0.76	(5/9)	0.19	±	0.25
		PCB 171/202	0.02	0	to	0.47	(3/9)	0.10	±	0.16
		PCB 180	0.02	0.56	to	3.1	(9/9)	1.4	±	0.70
		PCB 191	0.02	0	to	0.21	(1/9)	0.02	±	0.07
		PCB 170	0.02	0	to	0.91	(8/9)	0.45	±	0.24
		PCB 201	0.02	0	to	0.27	(1/9)	0.03	±	0.09
		PCB 196/203	0.02	0	to	0.81	(7/9)	0.26	±	0.22
		PCB 189	0.02	0	to	0.33	(1/9)	0.03	±	0.10
		PCB 207	0.02	0	to	0.74	(3/9)	0.14	±	0.27
		PCB 194	0.02	0	to	0.68	(7/9)	0.24	±	0.20
		PCB 209	0.02	0	to	0.33	(1/9)	0.03	±	0.10
		PCB - Total	2	4	to	39	(9/9)	17	±	9.8
Obed Coal Bridge	mountain whitefish	PCB 18	0.05	0	to	0.05	(6/10)	0.58	±	0.56
		PCB 31	0.05	0	to	0.05	(3/10)	0.06	±	0.10
		PCB 28	0.05	0	to	0.05	(2/10)	0.18	±	0.47
		PCB 33	0.05	0	to	0.05	(3/10)	0.36	±	0.82
		PCB 22	0.05	0	to	0.05	(8/10)	0.89	±	1.3
		PCB 52	0.05	0	to	0.05	(7/10)	0.60	±	0.68
		PCB 49	0.03	0	to	0.03	(3/10)	0.16	±	0.28
		PCB 44	0.03	0	to	0.03	(5/10)	0.24	±	0.38
		PCB 70/76	0.03	0	to	0.03	(8/10)	0.57	±	0.42
		PCB 65/95	0.03	0	to	0.03	(5/10)	0.25	±	0.31
		PCB 56/60	0.02	0	to	0.02	(2/10)	0.10	±	0.25
		PCB 84	0.02	0	to	0.02	(6/10)	0.23	±	0.26
		PCB 89	0.02	0	to	0.02	(5/10)	0.15	±	0.20
		PCB 101	0.03	0.2	to	0.03	(10/10)	1.5	±	0.96
		PCB 87	0.02	0	to	0.02	(9/10)	0.73	±	0.52
		PCB 110	0.02	0.3	to	0.02	(10/10)	1.2	±	0.53

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean	±	SD ng g^{-1}
		PCB 151	0.02	0	to	0.02	(9/10)	0.77	±	0.50
		PCB 149	0.02	0.2	to	0.02	(10/10)	2.8	±	2.5
		PCB 118	0.03	0	to	0.03	(6/10)	0.90	±	0.95
		PCB 146	0.02	0	to	0.02	(9/10)	0.31	±	0.23
		PCB 153	0.02	0.5	to	0.02	(10/10)	2.2	±	1.0
		PCB 105	0.02	0	to	0.02	(9/10)	0.52	±	0.31
		PCB 141	0.02	0	to	0.02	(8/10)	0.42	±	0.31
		PCB 137	0.02	0	to	0.02	(6/10)	0.11	±	0.13
		PCB 138	0.02	1	to	0.02	(10/10)	2.3	±	0.88
		PCB 129	0.02	0	to	0.02	(4/10)	0.08	±	0.15
		PCB 182/187	0.02	0.2	to	0.02	(10/10)	0.57	±	0.28
		PCB 183	0.02	0.2	to	0.02	(10/10)	0.40	±	0.17
		PCB 128	0.02	0.2	to	0.02	(10/10)	0.52	±	0.20
		PCB 185	0.02	0	to	0.02	(1/10)	0.01	±	0.019
		PCB 174	0.02	0.1	to	0.02	(10/10)	0.28	±	0.13
		PCB 177	0.02	0	to	0.02	(8/10)	0.20	±	0.15
		PCB 171/202	0.02	0	to	0.02	(5/10)	0.19	±	0.22
		PCB 180	0.02	0	to	0.02	(9/10)	1.1	±	0.55
		PCB 191	0.02	0	to	0.02	(1/10)	0.10	±	0.32
		PCB 170	0.02	0	to	0.02	(9/10)	0.47	±	0.24
		PCB 201	0.02	0	to	0.02	(3/10)	0.08	±	0.15
		PCB 196/203	0.02	0	to	0.02	(9/10)	0.20	±	0.11
		PCB 195/208	0.02	0	to	0.02	(3/10)	0.06	±	0.10
		PCB 207	0.02	0	to	0.02	(1/10)	0.01	±	0.03
		PCB 194	0.02	0	to	0.02	(6/10)	0.13	±	0.13
		PCB - Total	2	2	to	2	(10/10)	24	±	11
Emerson Lake Br.	mountain whitefish	PCB 18	0.05	0	to	1.1	(1/8)	0.12	±	0.37
		PCB 52	0.05	0	to	1.4	(4/8)	0.43	±	0.57
		PCB 49	0.03	0	to	0.34	(1/8)	0.038	±	0.11
		PCB 44	0.03	0	to	0.99	(3/8)	0.23	±	0.40
		PCB 70/76	0.03	0	to	2.1	(6/8)	0.73	±	0.72
		PCB 84	0.02	0	to	0.75	(6/8)	0.33	±	0.30
		PCB 89	0.02	0	to	1.4	(6/8)	0.38	±	0.42
		PCB 101	0.03	0.03	to	3.2	(8/8)	2.0	±	0.69
		PCB 87	0.02	0	to	1.3	(7/8)	0.77	±	0.41
		PCB 110	0.02	0	to	4.5	(7/8)	1.8	±	1.2
		PCB 151	0.02	0	to	1.9	(7/8)	0.92	±	0.53
		PCB 149	0.02	1.8	to	14	(8/8)	4.3	±	4.0
		PCB 118	0.03	0	to	2.7	(5/8)	1.4	±	1.1
		PCB 146	0.02	0	to	1.1	(5/8)	0.36	±	0.35
		PCB 153	0.02	2.4	to	8.4	(8/8)	4.3	±	1.8
		PCB 105	0.02	0	to	2.2	(3/8)	0.60	±	0.84
		PCB 141	0.02	0.39	to	1.4	(8/8)	0.67	±	0.30
		PCB 137	0.02	0	to	0.46	(5/8)	0.18	±	0.16
		PCB 138	0.02	2	to	7.7	(8/8)	3.6	±	1.8
		PCB 182/187	0.02	0	to	1.7	(4/8)	0.45	±	0.62
		PCB 183	0.02	0	to	1.1	(6/8)	0.43	±	0.33

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean	±	SD ng g^{-1}
		PCB 128	0.02	0.48	to	1.8	(8/8)	0.95	±	0.43
		PCB 174	0.02	0.27	to	1.2	(8/8)	0.59	±	0.29
		PCB 177	0.02	0.17	to	1.1	(8/8)	0.46	±	0.29
		PCB 171/202	0.02	0	to	0.47	(5/8)	0.18	±	0.17
		PCB 180	0.02	1.2	to	4	(8/8)	2.4	±	1.0
		PCB 170	0.02	0.39	to	1.5	(8/8)	0.79	±	0.33
		PCB 196/203	0.02	0	to	0.74	(6/8)	0.34	±	0.26
		PCB 207	0.02	0	to	0.51	(2/8)	0.13	±	0.20
		PCB 194	0.02	0	to	0.57	(7/8)	0.33	±	0.17
		PCB - Total	2	2	to	65	(8/8)	30	±	14
Knight Bridge	mountain whitefish	PCB 22	0.05	0	to	0.54	(3/9)	0.14	±	0.22
		PCB 52	0.05	0	to	0.69	(1/9)	0.08	±	0.23
		PCB 56/60	0.02	0	to	0.5	(1/9)	0.06	±	0.17
		PCB 101	0.03	0	to	1.8	(6/9)	0.51	±	0.57
		PCB 87	0.02	0	to	0.65	(4/9)	0.17	±	0.23
		PCB 110	0.02	0	to	4.2	(6/9)	1.39	±	1.4
		PCB 151	0.02	0	to	0.74	(6/9)	0.30	±	0.26
		PCB 118	0.03	0	to	1.8	(3/9)	0.38	±	0.65
		PCB 153	0.02	0.84	to	4.7	(9/9)	2.1	±	1.2
		PCB 141	0.02	0	to	0.59	(5/9)	0.18	±	0.20
		PCB 138	0.02	0.55	to	3.1	(9/9)	1.4	±	0.77
		PCB 182/187	0.02	0	to	1.1	(3/9)	0.19	±	0.37
		PCB 183	0.02	0	to	1.8	(4/9)	0.53	±	0.68
		PCB 128	0.02	0	to	0.56	(6/9)	0.22	±	0.19
		PCB 174	0.02	0	to	0.34	(5/9)	0.12	±	0.12
		PCB 177	0.02	0	to	0.25	(4/9)	0.07	±	0.09
		PCB 180	0.02	0.28	to	2.2	(9/9)	0.97	±	0.57
		PCB 170	0.02	0	to	0.84	(7/9)	0.33	±	0.26
		PCB 196/203	0.02	0	to	0.3	(3/9)	0.08	±	0.12
		PCB 194	0.02	0	to	0.45	(2/9)	0.08	±	0.17
		PCB - Total	2	2	to	27	(9/9)	9.4	±	7.5
Windfall Bridge	mountain whitefish	PCB 18	0.05	0	to	10	(1/4)	2.5	±	5.0
		PCB 28	0.05	0	to	0.36	(2/4)	0.18	±	0.20
		PCB 33	0.05	0	to	0.5	(1/4)	0.13	±	0.25
		PCB 22	0.05	0	to	1.2	(2/4)	0.47	±	0.58
		PCB 52	0.05	0	to	4.5	(2/4)	1.3	±	2.2
		PCB 44	0.03	0	to	0.93	(1/4)	0.23	±	0.47
		PCB 65/95	0.03	0	to	0.59	(1/4)	0.15	±	0.30
		PCB 84	0.02	0	to	0.4	(2/4)	0.16	±	0.20
		PCB 89	0.02	0	to	0.2	(2/4)	0.10	±	0.11
		PCB 101	0.03	0	to	2	(3/4)	1.0	±	0.99
		PCB 87	0.02	0	to	0.78	(2/4)	0.30	±	0.38
		PCB 110	0.02	0	to	4.8	(2/4)	1.6	±	2.3
		PCB 151	0.02	0	to	1.2	(3/4)	0.61	±	0.53
		PCB 149	0.02	0	to	4.5	(2/4)	1.2	±	2.2
		PCB 118	0.03	0	to	0.83	(1/4)	0.21	±	0.42

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean	±	SD ng g^{-1}
		PCB 146	0.02	0	to	0.32	(1/4)	0.08	±	0.16
		PCB 153	0.02	0.91	to	6.2	(4/4)	3.1	±	2.3
		PCB 141	0.02	0	to	0.75	(3/4)	0.34	±	0.32
		PCB 137	0.02	0	to	0.27	(1/4)	0.07	±	0.14
		PCB 138	0.02	0.77	to	4.1	(4/4)	2.1	±	1.5
		PCB 129	0.02	0	to	0.2	(1/4)	0.05	±	0.10
		PCB 182/187	0.02	0	to	0.94	(1/4)	0.24	±	0.47
		PCB 183	0.02	0	to	2.9	(2/4)	0.80	±	1.4
		PCB 128	0.02	0	to	0.89	(2/4)	0.29	±	0.42
		PCB 185	0.02	0	to	0.2	(1/4)	0.05	±	0.10
		PCB 174	0.02	0	to	0.33	(3/4)	0.19	±	0.15
		PCB 177	0.02	0	to	0.28	(2/4)	0.12	±	0.14
		PCB 171/202	0.02	0	to	0.28	(1/4)	0.07	±	0.14
		PCB 180	0.02	0.52	to	2.8	(4/4)	1.3	±	1.0
		PCB 191	0.42	0	to	0.17	(1/4)	0.04	±	0.09
		PCB 170	0.43	0	to	1.1	(3/4)	0.43	±	0.47
		PCB 196/203	0.02	0	to	0.6	(2/4)	0.19	±	0.28
		PCB 195/208	0.02	0	to	0.49	(1/4)	0.12	±	0.25
		PCB 207	0.02	0	to	0.21	(1/4)	0.05	±	0.11
		PCB 194	0.02	0	to	0.45	(2/4)	0.15	±	0.21
		PCB - Total	2	8	to	40	(4/4)	20	±	14
Upstream/control	northern pike	PCB 18	0.05	0	to	0.4	(1/6)	0.07	±	0.16
		PCB 28	0.05	0	to	0.2	(1/6)	0.03	±	0.08
		PCB 33	0.05	0	to	0.4	(1/6)	0.07	±	0.16
		PCB 22	0.05	0	to	0.4	(1/6)	0.07	±	0.16
		PCB 49	0.03	0	to	0.3	(1/6)	0.05	±	0.12
		PCB 70/76	0.03	0	to	0.2	(1/6)	0.03	±	0.08
		PCB 65/95	0.03	0	to	0.2	(1/6)	0.03	±	0.08
		PCB 101	0.03	0	to	0.4	(3/6)	0.20	±	0.22
		PCB 87	0.02	0	to	0.2	(1/6)	0.03	±	0.08
		PCB 110	0.02	0	to	0.6	(4/6)	0.18	±	0.23
		PCB 151	0.02	0	to	0.3	(1/6)	0.05	±	0.12
		PCB 149	0.02	0	to	0.3	(3/6)	0.12	±	0.15
		PCB 118	0.03	0	to	0.6	(3/6)	0.18	±	0.24
		PCB 153	0.02	0	to	1.5	(5/6)	0.72	±	0.52
		PCB 105	0.02	0	to	0.3	(2/6)	0.10	±	0.15
		PCB 141	0.02	0	to	0.8	(1/6)	0.13	±	0.33
		PCB 138	0.02	0	to	1.2	(5/6)	0.53	±	0.39
		PCB 182/187	0.02	0	to	0.4	(5/6)	0.23	±	0.16
		PCB 183	0.02	0	to	0.1	(1/6)	0.02	±	0.04
		PCB 128	0.02	0	to	0.2	(1/6)	0.03	±	0.08
		PCB 180	0.02	0	to	0.3	(4/6)	0.13	±	0.12
		PCB 170	0.02	0	to	0.1	(1/6)	0.02	±	0.04
		PCB 201	0.02	0	to	0.1	(1/6)	0.02	±	0.04
		PCB - Total	2	0	to	8	(5/6)	4.5	±	2.8
Weldwood Haul Br.	northern pike	PCB 153	0.02	0.19	to	0.19	(1/1)	0.19		

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean	±	SD ng g^{-1}
Emerson Lake Br.	northern pike	PCB 28	0.05	0.05	to	0.45	(1/1)	0.23	±	0.32
		PCB 22	0.05	0.05	to	0.48	(1/1)	0.24	±	0.34
		PCB 52	0.05	0.05	to	0.59	(1/1)	0.30	±	0.42
		PCB 49	0.03	0.03	to	0.32	(1/1)	0.16	±	0.23
		PCB 44	0.03	0.03	to	0.33	(1/1)	0.17	±	0.23
		PCB 84	0.02	0.02	to	0.18	(1/1)	0.09	±	0.13
		PCB 101	0.03	0.03	to	0.99	(1/1)	0.68	±	0.45
		PCB 87	0.02	0.02	to	0.24	(1/1)	0.20	±	0.06
		PCB 110	0.02	0.02	to	0.71	(1/1)	0.52	±	0.28
		PCB 151	0.02	0.02	to	0.44	(1/1)	0.32	±	0.17
		PCB 149	0.02	0.82	to	1.8	(1/1)	1.3	±	0.69
		PCB 146	0.02	0.02	to	0.14	(1/1)	0.07	±	0.10
		PCB 153	0.02	0.85	to	1.7	(1/1)	1.3	±	0.60
		PCB 141	0.02	0.02	to	0.24	(1/1)	0.18	±	0.09
		PCB 138	0.02	0.45	to	0.98	(1/1)	0.72	±	0.37
		PCB 182/187	0.02	0.02	to	0.23	(1/1)	0.21	±	0.03
		PCB 183	0.02	0.02	to	0.15	(1/1)	0.08	±	0.11
		PCB 174	0.02	0.02	to	0.13	(1/1)	0.07	±	0.09
		PCB 177	0.02	0.02	to	0.08	(1/1)	0.04	±	0.06
		PCB 180	0.02	0.29	to	0.33	(1/1)	0.31	±	0.03
		PCB 170	0.02	0.02	to	0.11	(1/1)	0.11	±	0.00
		PCB - Total	2	4	to	11	(1/1)	7.5	±	4.9
Knight Bridge	northern pike	PCB 22	0.05	0	to	0.67	(1/10)	0.06	±	0.20
		PCB 101	0.03	0	to	0.89	(8/10)	0.27	±	0.26
		PCB 87	0.02	0	to	0.24	(2/10)	0.04	±	0.08
		PCB 110	0.02	0	to	0.69	(5/10)	0.15	±	0.22
		PCB 151	0.02	0	to	0.4	(3/10)	0.07	±	0.13
		PCB 149	0.02	0	to	2.2	(8/10)	0.50	±	0.61
		PCB 118	0.03	0	to	0.88	(4/10)	0.23	±	0.34
		PCB 146	0.02	0	to	0.27	(1/10)	0.02	±	0.08
		PCB 153	0.02	0.29	to	2.7	(10/10)	0.94	±	0.66
		PCB 141	0.02	0	to	0.23	(3/10)	0.05	±	0.09
		PCB 138	0.02	0	to	1.6	(9/10)	0.54	±	0.42
		PCB 182/187	0.02	0	to	0.48	(6/10)	0.13	±	0.15
		PCB 183	0.02	0	to	0.26	(3/10)	0.05	±	0.09
		PCB 128	0.02	0	to	0.25	(2/10)	0.04	±	0.08
		PCB 174	0.02	0	to	0.14	(3/10)	0.03	±	0.05
		PCB 177	0.02	0	to	0.09	(1/10)	0.01	±	0.03
		PCB 171/202	0.02	0	to	0.1	(1/10)	0.01	±	0.03
		PCB 180	0.02	0	to	0.83	(9/10)	0.29	±	0.23
		PCB 170	0.02	0	to	0.24	(3/10)	0.05	±	0.09
		PCB 196/203	0.02	0	to	0.15	(2/10)	0.02	±	0.05
		PCB 194	0.02	0	to	0.14	(2/10)	0.02	±	0.05
		PCB - Total	2	0	to	12	(8/10)	3.5	±	3.4

[1] - Only PCB congeners detected in at least one sample from each site are reported.

Table A4. Levels of OC Pesticides (ng g^{-1} wet wt) in Mountain Whitefish and Northern Pike muscle, Athabasca River, Spring 1992

Location	Fish Species	Compound[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
Upstream/control	mountain whitefish	alpha-HCH	0.2	0.3	to	0.9	(4/4)	0.60 ± 0.26
		beta-HCH	0.2	0.5	to	0.7	(4/4)	0.58 ± 0.10
		p,p'-DDE	0.5	0.5	to	0.9	(4/4)	0.68 ± 0.17
		Hexachlorobenzene	0.1	0.3	to	1.1	(4/4)	0.55 ± 0.38
		gamma-HCH	0.2	0	to	0.7	(2/4)	0.25 ± 0.33
		Toxaphene	10	0	to	10	(2/4)	5.0 ± 5.8
Weldwood	mountain whitefish	alpha-HCH	0.2	0	to	1.1	(3/4)	0.65 ± 0.48
		beta-HCH	0.2	0	to	0.6	(3/4)	0.25 ± 0.25
		p,p'-DDE	0.5	0.6	to	2.3	(4/4)	1.5 ± 0.79
		o,p'-DDT	1	0	to	1	(1/4)	0.25 ± 0.50
		p,p'-DDD	1	0	to	1	(3/4)	0.25 ± 0.50
		p,p'-DDT	1	0	to	2	(2/4)	0.75 ± 0.96
		Heptachlor	0.2	0	to	1.3	(2/4)	0.43 ± 0.61
		Hexachlorobenzene	0.1	0.5	to	2.3	(4/4)	1.3 ± 0.77
		gamma-HCH	0.2	0	to	0.2	(1/4)	0.05 ± 0.10
		trans-nonachlor	1	0	to	7	(3/4)	2.8 ± 3.0
		Toxaphene	10	20	to	50	(4/4)	28 ± 15
Obed Coal	mountain whitefish	alpha-HCH	0.2	0.2	to	0.8	(5/5)	0.50 ± 0.22
		beta-HCH	0.2	0	to	0.6	(1/5)	0.12 ± 0.27
		delta-HCH	0.2	0	to	0.2	(1/5)	0.04 ± 0.09
		p,p'-DDE	0.5	0.7	to	1.9	(5/5)	1.3 ± 0.55
		p,p'-DDT	1	0	to	2	(1/5)	0.4 ± 0.89
		Heptachlor	0.2	0	to	0.4	(2/5)	0.14 ± 0.19
		Hexachlorobenzene	0.1	0.3	to	0.7	(5/5)	0.44 ± 0.17
		Toxaphene	10	10	to	30	(5/5)	16 ± 8.9
Emerson Lake	mountain whitefish	alpha-HCH	0.2	0.5	to	1	(4/4)	0.75 ± 0.21
		beta-HCH	0.2	0	to	0.3	(1/4)	0.08 ± 0.15
		p,p'-DDE	0.5	1.1	to	2.6	(4/4)	1.8 ± 0.67
		o,p'-DDT	1	0	to	1	(1/4)	0.25 ± 0.50
		p,p'-DDT	1	0	to	2	(2/4)	0.75 ± 0.96
		Heptachlor	0.2	0	to	0.9	(2/4)	0.35 ± 0.44
		Hexachlorobenzene	0.1	0.5	to	1.7	(4/4)	1.1 ± 0.49
		trans-nonachlor	1	0	to	14	(3/4)	6.0 ± 6.7
		Toxaphene	10	0	to	20	(3/4)	12.5 ± 9.6
Knight Bridge	mountain whitefish	alpha-HCH	0.2	0.2	to	2.2	(3/3)	1.3 ± 1.0
		beta-HCH	0.2	0	to	0.2	(1/3)	0.07 ± 0.12
		p,p'-DDE	0.5	0.6	to	1.4	(3/3)	0.93 ± 0.42
		Hexachlorobenzene	0.1	0.6	to	5.7	(3/3)	2.3 ± 2.9
		Toxaphene	10	0	to	20	(2/3)	10 ± 10
Weldwood	northern pike	alpha-HCH	0.2				(1/1)	0.70
		p,p'-DDE	0.5				(1/1)	0.80
		Hexachlorobenzene	0.1				(1/1)	1.1
		Toxaphene	10				(1/1)	20

Location	Fish Species	Compound[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
Emerson Lake	northern pike	alpha-HCH	0.2	0	to	1	(2/3)	0.43 ± 0.51
		beta-HCH	0.2	0	to	1.3	(1/3)	0.43 ± 0.75
		p,p'-DDE	0.5	0	to	3.4	(2/3)	1.4 ± 1.8
		Hexachlorobenzene	0.1	0.1	to	1.3	(3/3)	0.67 ± 0.60
		trans-nonachlor	1	0	to	2	(1/3)	0.67 ± 1.2
Knight Bridge	northern pike	alpha-HCH	0.2	0	to	0.4	(1/3)	0.08 ± 0.18
		p,p'-DDE	0.5	0	to	0.8	(2/3)	0.16 ± 0.36
		Hexachlorobenzene	0.1	0	to	0.2	(2/3)	0.10 ± 0.10
Windfall Br.	northern pike	p,p'-DDE	0.5	0	to	4	(4/6)	0.90 ± 1.4
		Hexachlorobenzene	0.1	0	to	0.2	(5/6)	0.12 ± 0.07

[1] - Only organochlorines detected in at least one sample from each site are reported.

Table A5. Levels of PCBs (ng g^{-1} wet wt) in Mountain Whitefish and Northern Pike muscle, Athabasca River, Fall 1992.

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
Upstream/control	mountain whitefish	PCB 28	0.05	0	to	0.57	(3/4)	0.31 ± 0.24
		PCB 33	0.05	0	to	1.1	(2/4)	0.44 ± 0.54
		PCB 52	0.05	0	to	0.47	(2/4)	0.15 ± 0.22
		PCB 49	0.03	0	to	0.22	(2/4)	0.08 ± 0.10
		PCB 70/76	0.03	0	to	0.38	(1/4)	0.10 ± 0.19
		PCB 66/95	0.03	0.95	to	4.3	(4/4)	1.8 ± 1.6
		PCB 56/60	0.02	0	to	0.38	(1/4)	0.10 ± 0.19
		PCB 84	0.02	0	to	0.33	(1/4)	0.08 ± 0.17
		PCB 89	0.02	0	to	0.44	(2/4)	0.16 ± 0.21
		PCB 101	0.03	0.32	to	0.68	(4/4)	0.49 ± 0.15
		PCB 87	0.02	0	to	0.38	(1/4)	0.10 ± 0.19
		PCB 110	0.02	0.3	to	0.74	(4/4)	0.45 ± 0.20
		PCB 151	0.02	0	to	0.29	(2/4)	0.12 ± 0.14
		PCB 149	0.02	0.51	to	0.92	(4/4)	0.64 ± 0.19
		PCB 118	0.03	0.43	to	1.1	(4/4)	0.80 ± 0.29
		PCB 146	0.02	0	to	0.42	(1/4)	0.11 ± 0.21
		PCB 153	0.02	0.7	to	3.2	(4/4)	1.7 ± 1.1
		PCB 105	0.02	0	to	0.51	(3/4)	0.28 ± 0.22
		PCB 141	0.02	0	to	0.28	(1/4)	0.07 ± 0.14
		PCB 137	0.02	0	to	0.19	(2/4)	0.09 ± 0.10
		PCB 138	0.02	0.48	to	2.4	(4/4)	1.3 ± 0.81
		PCB 129	0.02	0	to	0.12	(1/4)	0.03 ± 0.06
		PCB 182/18	0.02	0.66	to	3.4	(4/4)	1.5 ± 1.3
		PCB 183	0.02	0.19	to	0.93	(4/4)	0.47 ± 0.32
		PCB 128	0.02	0	to	0.56	(3/4)	0.36 ± 0.25
		PCB 174	0.02	0	to	0.11	(1/4)	0.03 ± 0.06
		PCB 171/20	0.02	0	to	0.22	(3/4)	0.11 ± 0.09
		PCB 180	0.02	0.17	to	2.2	(4/4)	0.84 ± 0.93
		PCB 170	0.02	0.12	to	0.86	(4/4)	0.39 ± 0.33
		PCB 201	0.02	0	to	0.38	(3/4)	0.21 ± 0.18
		PCB 196/20	0.02	0	to	0.29	(1/4)	0.07 ± 0.15
		PCB 195/20	0.02	0	to	0.09	(1/4)	0.02 ± 0.05
		PCB 194	0.02	0	to	0.22	(1/4)	0.06 ± 0.11
		PCB - Total	1	6	to	20	(4/4)	14 ± 6.2
Weldwood	mountain whitefish	PCB5/8	0.3	0	to	2.3	(3/4)	1.4 ± 1.1
		PCB 31	0.05	0	to	0.24	(1/4)	0.06 ± 0.12
		PCB 28	0.05	0.17	to	1.1	(4/4)	0.66 ± 0.41
		PCB 33	0.05	0.29	to	2.9	(4/4)	1.4 ± 1.2
		PCB 22	0.05	0	to	1.9	(3/4)	0.76 ± 0.87
		PCB 52	0.05	0.13	to	0.75	(4/4)	0.52 ± 0.28
		PCB 49	0.03	0.08	to	0.83	(4/4)	0.47 ± 0.31
		PCB 44	0.03	0	to	0.92	(3/4)	0.40 ± 0.41
		PCB 70/76	0.03	0	to	1	(4/4)	0.38 ± 0.44

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
		PCB 66/95	0.03	4	to	54	(4/4)	21 ± 23
		PCB 56/60	0.02	0.13	to	1.1	(4/4)	0.61 ± 0.43
		PCB 84	0.02	0.13	to	1.2	(4/4)	0.62 ± 0.46
		PCB 89	0.02	0.12	to	0.65	(4/4)	0.44 ± 0.23
		PCB 101	0.03	0.47	to	3.1	(4/4)	2.3 ± 1.2
		PCB 87	0.02	0.24	to	3.8	(4/4)	1.7 ± 1.5
		PCB 110	0.02	0.61	to	4.1	(4/4)	2.0 ± 1.5
		PCB 151	0.02	0.2	to	1.1	(4/4)	0.71 ± 0.38
		PCB 149	0.02	1.2	to	8.8	(4/4)	3.7 ± 3.5
		PCB 118	0.03	1.2	to	8	(4/4)	3.2 ± 3.2
		PCB 146	0.02	0.31	to	1.7	(4/4)	1.1 ± 0.59
		PCB 153	0.02	1.1	to	6	(4/4)	3.4 ± 2.0
		PCB 105	0.02	0.34	to	1.7	(4/4)	0.85 ± 0.60
		PCB 141	0.02	0.27	to	1.7	(4/4)	0.96 ± 0.59
		PCB 137	0.02	0	to	0.43	(3/4)	0.21 ± 0.20
		PCB 138	0.02	1.2	to	6.8	(4/4)	3.4 ± 2.4
		PCB 129	0.02	0.06	to	0.51	(4/4)	0.36 ± 0.21
		PCB 182/18	0.02	1.3	to	6.9	(4/4)	4.2 ± 2.5
		PCB 183	0.02	0.77	to	2.3	(4/4)	1.3 ± 0.67
		PCB 128	0.02	0.36	to	1.8	(4/4)	1.0 ± 0.63
		PCB 174	0.02	0.21	to	1.2	(4/4)	0.62 ± 0.42
		PCB 177	0.02	0	to	0.54	(3/4)	0.22 ± 0.23
		PCB 171/20	0.02	0	to	0.37	(3/4)	0.18 ± 0.17
		PCB 180	0.02	0.99	to	3.5	(4/4)	1.7 ± 1.2
		PCB 170	0.02	0.29	to	1.5	(4/4)	0.73 ± 0.53
		PCB 201	0.02	0.18	to	2.1	(4/4)	0.83 ± 0.89
		PCB 196/20	0.02	0	to	0.56	(2/4)	0.17 ± 0.27
		PCB 195/20	0.02	0	to	0.53	(2/4)	0.16 ± 0.25
		PCB 207	0.02	0	to	0.64	(2/4)	0.18 ± 0.31
		PCB 194	0.02	0	to	0.42	(3/4)	0.18 ± 0.18
		PCB 205	0.02	0	to	0.12	(2/4)	0.04 ± 0.06
		PCB - Total	1	21	to	130	(4/4)	65 ± 47
Obed Coal	mountain whitefish	PCB5/8	0.3	0	to	0.7	(2/5)	0.24 ± 0.34
		PCB 18	0.05	0	to	0.56	(1/5)	0.11 ± 0.25
		PCB 31	0.05	0	to	0.18	(1/5)	0.04 ± 0.08
		PCB 28	0.05	0	to	0.44	(3/5)	0.22 ± 0.21
		PCB 33	0.05	0	to	1.6	(4/5)	0.68 ± 0.66
		PCB 22	0.05	0	to	0.96	(3/5)	0.43 ± 0.42
		PCB 52	0.05	0	to	0.83	(3/5)	0.41 ± 0.39
		PCB 49	0.03	0	to	0.48	(3/5)	0.25 ± 0.23
		PCB 44	0.03	0	to	0.71	(2/5)	0.24 ± 0.34
		PCB 70/76	0.03	0	to	0.92	(2/5)	0.25 ± 0.40
		PCB 66/95	0.03	2.1	to	40	(5/5)	17 ± 16
		PCB 56/60	0.02	0.12	to	1.4	(5/5)	0.47 ± 0.54
		PCB 84	0.02	0	to	1.4	(3/5)	0.43 ± 0.58
		PCB 89	0.02	0	to	0.62	(3/5)	0.28 ± 0.29
		PCB 101	0.03	0.2	to	3.5	(5/5)	1.1 ± 1.4

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
		PCB 87	0.02	0	to	1.9	(2/5)	0.6 ± 0.87
		PCB 110	0.02	0.63	to	3.7	(5/5)	1.9 ± 1.3
		PCB 151	0.02	0	to	1.1	(3/5)	0.45 ± 0.46
		PCB 149	0.02	1.1	to	11	(5/5)	4.4 ± 4.0
		PCB 118	0.03	0	to	3	(4/5)	1.5 ± 1.2
		PCB 146	0.02	0	to	1.6	(3/5)	0.67 ± 0.72
		PCB 153	0.02	1.8	to	3.8	(5/5)	2.8 ± 0.85
		PCB 105	0.02	0	to	1.5	(3/5)	0.62 ± 0.67
		PCB 141	0.02	0.16	to	1	(5/5)	0.54 ± 0.36
		PCB 137	0.02	0	to	1.6	(4/5)	0.43 ± 0.66
		PCB 138	0.02	1.6	to	5.1	(5/5)	3.4 ± 1.6
		PCB 129	0.02	0.11	to	0.72	(5/5)	0.33 ± 0.25
		PCB 182/18	0.02	0.55	to	3.4	(5/5)	1.7 ± 1.2
		PCB 183	0.02	0.43	to	1.4	(5/5)	0.97 ± 0.47
		PCB 128	0.02	0.21	to	1.8	(5/5)	0.79 ± 0.65
		PCB 185	0.02	0	to	0.75	(2/5)	0.18 ± 0.33
		PCB 174	0.02	0.16	to	0.84	(5/5)	0.50 ± 0.31
		PCB 177	0.02	0.1	to	0.4	(5/5)	0.27 ± 0.15
		PCB 171/20	0.02	0.08	to	0.28	(5/5)	0.18 ± 0.09
		PCB 180	0.02	0.66	to	3.2	(5/5)	1.7 ± 1.1
		PCB 191	0.02	0	to	0.11	(1/5)	0.02 ± 0.05
		PCB 170	0.02	0.3	to	0.99	(5/5)	0.69 ± 0.35
		PCB 201	0.02	0	to	0.82	(3/5)	0.47 ± 0.43
		PCB 196/20	0.02	0	to	0.33	(4/5)	0.20 ± 0.14
		PCB 189	0.02	0	to	0.07	(1/5)	0.01 ± 0.03
		PCB 195/20	0.02	0	to	0.26	(3/5)	0.11 ± 0.11
		PCB 207	0.02	0	to	0.22	(3/5)	0.10 ± 0.11
		PCB 194	0.02	0.07	to	0.28	(5/5)	0.18 ± 0.10
		PCB 205	0.02	0	to	0.1	(1/5)	0.02 ± 0.04
		PCB 206	0.02	0	to	0.07	(1/5)	0.01 ± 0.03
		PCB - Total	1	12	to	81	(5/5)	47 ± 34
Emerson Lake	mountain whitefish	PCB 16/32	0.05	0	to	1.1	(1/4)	0.28 ± 0.55
		PCB 31	0.05	0	to	0.5	(1/4)	0.13 ± 0.25
		PCB 28	0.05	0	to	1.9	(2/4)	0.64 ± 0.90
		PCB 33	0.05	0	to	2.4	(2/4)	1.1 ± 1.3
		PCB 22	0.05	0	to	1.8	(2/4)	0.73 ± 0.88
		PCB 52	0.05	0	to	1.5	(2/4)	0.56 ± 0.72
		PCB 49	0.03	0	to	1	(2/4)	0.46 ± 0.54
		PCB 44	0.03	0	to	1.2	(2/4)	0.48 ± 0.59
		PCB 40	0.03	0	to	0.39	(2/4)	0.18 ± 0.21
		PCB 70/76	0.03	0	to	3.4	(1/4)	0.85 ± 1.7
		PCB 66/95	0.03	0.69	to	76	(4/4)	36 ± 40
		PCB 56/60	0.02	0	to	1.2	(3/4)	0.57 ± 0.53
		PCB 84	0.02	0	to	2	(2/4)	0.88 ± 1.0
		PCB 89	0.02	0	to	0.65	(1/4)	0.16 ± 0.33
		PCB 101	0.03	0.36	to	7.4	(4/4)	3.5 ± 3.5

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
		PCB 87	0.02	0	to	2.8	(2/4)	1.3 ± 1.5
		PCB 110	0.02	0.68	to	5.5	(4/4)	2.2 ± 2.3
		PCB 151	0.02	0	to	1.6	(2/4)	0.73 ± 0.85
		PCB 149	0.02	0.92	to	18	(4/4)	7.7 ± 8.3
		PCB 118	0.03	0	to	0.71	(2/4)	0.3 ± 0.37
		PCB 146	0.02	0	to	1.4	(3/4)	0.72 ± 0.73
		PCB 153	0.02	1.4	to	6.2	(4/4)	3.7 ± 2.5
		PCB 105	0.02	0	to	1.6	(3/4)	0.80 ± 0.77
		PCB 141	0.02	0.17	to	1.9	(4/4)	0.82 ± 0.79
		PCB 137	0.02	0	to	0.48	(2/4)	0.19 ± 0.24
		PCB 138	0.02	1.1	to	7	(4/4)	3.9 ± 3.1
		PCB 129	0.02	0	to	0.75	(3/4)	0.33 ± 0.35
		PCB 182/18	0.02	0.45	to	3.8	(4/4)	1.9 ± 1.7
		PCB 183	0.02	0.42	to	2.4	(4/4)	1.3 ± 0.97
		PCB 128	0.02	0.13	to	1.4	(4/4)	0.73 ± 0.66
		PCB 174	0.02	0.13	to	1.1	(4/4)	0.53 ± 0.48
		PCB 177	0.02	0	to	0.63	(2/4)	0.23 ± 0.30
		PCB 171/20	0.02	0	to	0.38	(2/4)	0.13 ± 0.18
		PCB 180	0.02	0.3	to	2.9	(4/4)	1.4 ± 1.3
		PCB 170	0.02	0.17	to	1.4	(4/4)	0.67 ± 0.58
		PCB 201	0.02	0	to	1.1	(2/4)	0.44 ± 0.54
		PCB 196/20	0.02	0	to	0.47	(2/4)	0.18 ± 0.23
		PCB 207	0.02	0	to	0.26	(2/4)	0.10 ± 0.13
		PCB 194	0.02	0	to	0.4	(2/4)	0.15 ± 0.19
		PCB 205	0.02	0	to	0.26	(1/4)	0.07 ± 0.13
		PCB - Total	1	9	to	160	(4/4)	77 ± 79
		PCB 77	0.005	0	to	130	(1/4)	33 ± 65
		PCB 126	0.005	0	to	69	(1/4)	17 ± 35
		PCB 169	0.005	0	to	98	(1/4)	25 ± 49
Knight Bridge	mountain whitefish	PCB 28	0.05	0	to	0.17	(1/3)	0.06 ± 0.10
		PCB 33	0.05	0	to	0.38	(2/3)	0.15 ± 0.20
		PCB 52	0.05	0	to	0.15	(1/3)	0.05 ± 0.09
		PCB 49	0.03	0	to	0.11	(1/3)	0.04 ± 0.06
		PCB 44	0.03	0	to	0.14	(1/3)	0.05 ± 0.08
		PCB 70/76	0.03	0	to	0.15	(1/3)	0.05 ± 0.09
		PCB 66/95	0.03	1.2	to	8.9	(3/3)	4.3 ± 4.1
		PCB 56/60	0.02	0	to	0.23	(2/3)	0.15 ± 0.13
		PCB 84	0.02	0	to	0.11	(1/3)	0.04 ± 0.06
		PCB 89	0.02	0	to	0.39	(1/3)	0.13 ± 0.23
		PCB 101	0.03	0.2	to	0.88	(3/3)	0.44 ± 0.38
		PCB 87	0.02	0	to	0.2	(1/3)	0.07 ± 0.12
		PCB 85	0.02	0	to	0.14	(1/3)	0.05 ± 0.08
		PCB 110	0.02	0	to	0.83	(2/3)	0.41 ± 0.42
		PCB 151	0.02	0	to	1.2	(2/3)	0.45 ± 0.65
		PCB 149	0.02	0.67	to	1.1	(3/3)	0.84 ± 0.23
		PCB 146	0.02	0	to	0.17	(1/3)	0.06 ± 0.10
		PCB 153	0.02	0.49	to	1.7	(3/3)	1.1 ± 0.61

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
		PCB 105	0.02	0	to	0.47	(2/3)	0.19 ± 0.25
		PCB 141	0.02	0	to	0.22	(2/3)	0.10 ± 0.11
		PCB 137	0.02	0	to	0.05	(1/3)	0.02 ± 0.03
		PCB 138	0.02	0.56	to	1.3	(3/3)	0.95 ± 0.37
		PCB 129	0.02	0	to	0.06	(1/3)	0.02 ± 0.03
		PCB 182/18	0.02	0.28	to	1.5	(3/3)	0.87 ± 0.61
		PCB 183	0.02	0.41	to	0.74	(3/3)	0.56 ± 0.17
		PCB 128	0.02	0	to	0.08	(1/3)	0.03 ± 0.05
		PCB 174	0.02	0	to	0.08	(1/3)	0.03 ± 0.05
		PCB 177	0.02	0	to	0.04	(1/3)	0.01 ± 0.02
		PCB 171/20	0.02	0	to	0.02	(1/3)	0.01 ± 0.01
		PCB 180	0.02	0.28	to	0.59	(3/3)	0.41 ± 0.16
		PCB 170	0.02	0	to	0.1	(1/3)	0.03 ± 0.06
		PCB 201	0.02	0.07	to	0.66	(3/3)	0.35 ± 0.30
		PCB 196/20	0.02	0	to	0.03	(1/3)	0.01 ± 0.02
		PCB 195/20	0.02	0	to	0.02	(1/3)	0.01 ± 0.01
		PCB 207	0.02	0	to	0.02	(1/3)	0.01 ± 0.01
		PCB 194	0.02	0	to	0.02	(1/3)	0.01 ± 0.01
		PCB 205	0.02	0	to	0.02	(1/3)	0.01 ± 0.01
		PCB - Total	1	8	to	18	(3/3)	12 ± 5.3
Weldwood	northern pike	PCB 28	0.05		to		(1/1)	0.10
		PCB 52	0.05		to		(1/1)	0.34
		PCB 49	0.03		to		(1/1)	0.21
		PCB 44	0.03		to		(1/1)	0.12
		PCB 66/95	0.03		to		(1/1)	7.9
		PCB 56/60	0.02		to		(1/1)	0.46
		PCB 84	0.02		to		(1/1)	0.36
		PCB 89	0.02		to		(1/1)	0.53
		PCB 101	0.03		to		(1/1)	2.0
		PCB 87	0.02		to		(1/1)	0.65
		PCB 110	0.02		to		(1/1)	0.63
		PCB 151	0.02		to		(1/1)	0.48
		PCB 149	0.02		to		(1/1)	1.8
		PCB 118	0.03		to		(1/1)	0.89
		PCB 146	0.02		to		(1/1)	0.32
		PCB 153	0.02		to		(1/1)	2.0
		PCB 105	0.02		to		(1/1)	0.08
		PCB 141	0.02		to		(1/1)	0.41
		PCB 138	0.02		to		(1/1)	1.6
		PCB 129	0.02		to		(1/1)	0.13
		PCB 182/18	0.02		to		(1/1)	2.3
		PCB 183	0.02		to		(1/1)	0.70
		PCB 128	0.02		to		(1/1)	0.41
		PCB 174	0.02		to		(1/1)	0.21
		PCB 180	0.02		to		(1/1)	0.50
		PCB 170	0.02		to		(1/1)	0.25
		PCB 201	0.02		to		(1/1)	0.34

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
		PCB - Total	1		to		(1/1)	26
Emerson Lake	northern pike	PCB 28	0.05	0	to	0.31	(1/3)	0.10 ± 0.18
		PCB 52	0.05	0	to	0.48	(1/3)	0.16 ± 0.28
		PCB 49	0.03	0	to	0.19	(1/3)	0.06 ± 0.11
		PCB 44	0.03	0	to	0.14	(1/3)	0.05 ± 0.08
		PCB 66/95	0.03	0.5	to	2.7	(3/3)	1.6 ± 1.1
		PCB 56/60	0.02	0	to	0.84	(2/3)	0.37 ± 0.43
		PCB 84	0.02	0	to	8.3	(1/3)	2.8 ± 4.8
		PCB 101	0.03	0.12	to	1.7	(3/3)	0.68 ± 0.88
		PCB 87	0.02	0	to	0.28	(0/3)	0.11 ± 0.15
		PCB 110	0.02	0.11	to	0.78	(3/3)	0.40 ± 0.35
		PCB 151	0.02	0	to	0.31	(1/3)	0.10 ± 0.18
		PCB 149	0.02	0.19	to	1.3	(3/3)	0.69 ± 0.56
		PCB 118	0.03	0	to	0.48	(2/3)	0.24 ± 0.24
		PCB 146	0.02	0	to	0.36	(1/3)	0.12 ± 0.21
		PCB 153	0.02	0.54	to	1.6	(3/3)	1.0 ± 0.53
		PCB 105	0.02	0	to	0.16	(2/3)	0.09 ± 0.08
		PCB 141	0.02	0	to	0.28	(2/3)	0.11 ± 0.15
		PCB 137	0.02	0	to	0.02	(1/3)	0.01 ± 0.01
		PCB 138	0.02	0.52	to	1.2	(3/3)	0.97 ± 0.39
		PCB 129	0.02	0	to	0.12	(2/3)	0.05 ± 0.06
		PCB 182/18	0.02	0.29	to	1.2	(3/3)	0.71 ± 0.46
		PCB 183	0.02	0.17	to	0.5	(3/3)	0.39 ± 0.19
		PCB 128	0.02	0.07	to	0.66	(3/3)	0.30 ± 0.32
		PCB 185	0.02	0	to	0.05	(1/3)	0.02 ± 0.03
		PCB 174	0.02	0	to	0.17	(2/3)	0.07 ± 0.09
		PCB 171/20	0.02	0	to	0.02	(1/3)	0.01 ± 0.01
		PCB 180	0.02	0.24	to	0.81	(3/3)	0.50 ± 0.29
		PCB 201	0.02	0	to	0.76	(2/3)	0.27 ± 0.43
		PCB 196/20	0.02	0	to	0.07	(2/3)	0.04 ± 0.04
		PCB 194	0.02	0	to	0.07	(1/3)	0.02 ± 0.04
		PCB 205	0.02	0	to	0.03	(1/3)	0.01 ± 0.02
		PCB - Total	1	4	to	22	(3/3)	12 ± 9.1
Knight Bridge	northern pike	PCB 49	0.03	0	to	0.03	(1/3)	0.01 ± 0.01
		PCB 70/76	0.03	0	to	0.03	(1/3)	0.01 ± 0.01
		PCB 66/95	0.03	0.29	to	1.3	(3/3)	0.73 ± 0.48
		PCB 56/60	0.02	0	to	0.04	(1/3)	0.01 ± 0.02
		PCB 84	0.02	0	to	0.07	(2/3)	0.02 ± 0.03
		PCB 89	0.02	0	to	0.02	(1/3)	0.00 ± 0.01
		PCB 101	0.03	0	to	0.44	(3/3)	0.26 ± 0.18
		PCB 87	0.02	0	to	0.12	(3/3)	0.08 ± 0.05
		PCB 85	0.02	0	to	0.03	(1/3)	0.01 ± 0.01
		PCB 110	0.02	0.12	to	0.28	(3/3)	0.22 ± 0.08
		PCB 151	0.02	0	to	0.15	(3/3)	0.09 ± 0.06
		PCB 149	0.02	0.22	to	0.48	(3/3)	0.37 ± 0.12
		PCB 118	0.03	0.18	to	0.87	(3/3)	0.37 ± 0.29

Location	Fish Species	Congener[1]	Detection Limit ng g⁻¹	Low		High	# of Detects	Mean ± SD ng g⁻¹
		PCB 146	0.02	0	to	0.14	(3/3)	0.08 ± 0.05
		PCB 153	0.02	0.27	to	1.9	(3/3)	0.86 ± 0.62
		PCB 105	0.02	0.05	to	0.25	(3/3)	0.13 ± 0.09
		PCB 141	0.02	0	to	0.15	(3/3)	0.09 ± 0.06
		PCB 138	0.02	0.26	to	1.6	(3/3)	0.74 ± 0.51
		PCB 129	0.02	0	to	0.06	(3/3)	0.04 ± 0.03
		PCB 182/18	0.02	0.25	to	0.88	(3/3)	0.43 ± 0.26
		PCB 183	0.02	0.09	to	0.46	(3/3)	0.21 ± 0.15
		PCB 128	0.02	0.05	to	0.24	(3/3)	0.10 ± 0.08
		PCB 185	0.02	0	to	0.05	(2/3)	0.01 ± 0.02
		PCB 174	0.02	0.05	to	0.18	(3/3)	0.11 ± 0.05
		PCB 177	0.02	0	to	0.08	(3/3)	0.04 ± 0.03
		PCB 171/20	0.02	0	to	0.07	(1/3)	0.02 ± 0.03
		PCB 180	0.02	0.15	to	0.82	(3/3)	0.43 ± 0.25
		PCB 170	0.02	0.08	to	0.38	(3/3)	0.20 ± 0.11
		PCB 201	0.02	0	to	0.12	(3/3)	0.06 ± 0.05
		PCB 196/20	0.02	0.02	to	0.13	(3/3)	0.07 ± 0.04
		PCB 195/20	0.02	0	to	0.03	(1/3)	0.01 ± 0.01
		PCB 194	0.02	0.04	to	0.11	(3/3)	0.06 ± 0.03
		PCB 205	0.02	0	to	0.03	(1/3)	0.01 ± 0.01
		PCB - Total	1	3	to	9	(3/3)	6.0 ± 2.4
Windfall Br.	northern pike	PCB 28	0.05	0	to	0.12	(1/6)	0.02 ± 0.05
		PCB 33	0.05	0	to	0.05	(1/6)	0.01 ± 0.02
		PCB 52	0.05	0	to	0.07	(3/6)	0.02 ± 0.04
		PCB 49	0.03	0	to	0.06	(3/6)	0.02 ± 0.03
		PCB 44	0.03	0	to	0.05	(2/6)	0.01 ± 0.02
		PCB 70/76	0.03	0	to	0.06	(1/6)	0.01 ± 0.02
		PCB 66/95	0.03	0.18	to	10	(6/6)	3.2 ± 4.4
		PCB 56/60	0.02	0	to	0.12	(5/6)	0.07 ± 0.04
		PCB 84	0.02	0	to	0.04	(2/6)	0.01 ± 0.02
		PCB 89	0.02	0	to	0.54	(4/6)	0.10 ± 0.26
		PCB 101	0.03	0.15	to	0.6	(6/6)	0.33 ± 0.20
		PCB 87	0.02	0	to	0.25	(5/6)	0.12 ± 0.10
		PCB 85	0.02	0	to	0.06	(2/6)	0.01 ± 0.03
		PCB 110	0.02	0.1	to	0.46	(6/6)	0.27 ± 0.17
		PCB 151	0.02	0.06	to	0.18	(6/6)	0.12 ± 0.05
		PCB 149	0.02	0.15	to	1.6	(6/6)	0.60 ± 0.64
		PCB 118	0.03	0.07	to	0.66	(6/6)	0.28 ± 0.23
		PCB 146	0.02	0	to	0.34	(5/6)	0.16 ± 0.14
		PCB 153	0.02	0.26	to	1.7	(6/6)	0.86 ± 0.55
		PCB 105	0.02	0	to	0.42	(5/6)	0.14 ± 0.18
		PCB 141	0.02	0.04	to	0.24	(6/6)	0.13 ± 0.094
		PCB 137	0.02	0	to	0.07	(4/6)	0.03 ± 0.03
		PCB 138	0.02	0.2	to	1.2	(6/6)	0.65 ± 0.44
		PCB 129	0.02	0	to	0.1	(4/6)	0.04 ± 0.05
		PCB 182/18	0.02	0.09	to	0.51	(6/6)	0.30 ± 0.17
		PCB 183	0.02	0.06	to	0.28	(6/6)	0.17 ± 0.10

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
		PCB 128	0.02	0	to	0.26	(5/6)	0.11 ± 0.11
		PCB 185	0.02	0	to	0.03	(2/6)	0.01 ± 0.01
		PCB 174	0.02	0	to	0.25	(5/6)	0.10 ± 0.10
		PCB 171/20	0.02	0	to	0.06	(4/6)	0.03 ± 0.03
		PCB 180	0.02	0.08	to	0.8	(6/6)	0.42 ± 0.33
		PCB 191	0.02	0	to	0.03	(2/6)	0.01 ± 0.01
		PCB 170	0.02	0	to	0.33	(5/6)	0.17 ± 0.13
		PCB 201	0.02	0	to	0.46	(5/6)	0.13 ± 0.20
		PCB 196/20	0.02	0	to	0.11	(4/6)	0.05 ± 0.05
		PCB 195/20	0.02	0	to	0.05	(4/6)	0.02 ± 0.02
		PCB 207	0.02	0	to	0.04	(3/6)	0.01 ± 0.02
		PCB 194	0.02	0	to	0.14	(4/6)	0.05 ± 0.06
		PCB 205	0.02	0	to	0.11	(3/6)	0.02 ± 0.04
		PCB - Total	1	2	to	20	(6/6)	8.7 ± 8.1

[1] - Only PCB congeners detected in at least one sample from each site are reported.

Table B1. Levels of chlorophenolic compounds (ng g^{-1} wet wt) in Mountain Whitefish, Long-nose Suckers, Goldeye, and Walleye from the Athabasca River, Spring 1992

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
Weldwood	long-nose suckers	Pentachlorophenol	0.2	0	to	0.8	(6/11)	0.2 ± 0.3
		3,4,5-TriClGuaiacol	0.4	0	to	1.7	(4/11)	0.4 ± 0.6
		4,5,6-TriClGuaiacol	0.4	0	to	0.4	(1/11)	0.0 ± 0.1
		Tetrachloroveratrole	0.4	0	to	3.1	(10/11)	1.6 ± 0.8
		Pentachloroanisole	0.2	0	to	0.4	(5/11)	0.1 ± 0.2
Whitecourt	long-nose suckers	Pentachlorophenol	0.2	0	to	0.9	(4/10)	0.2 ± 0.3
		3,4,5-TriClGuaiacol	0.4	0	to	1.3	(1/10)	0.1 ± 0.4
		4,5-Dichloroguaiacol	0.4	0	to	1.7	(1/10)	0.2 ± 0.5
		Tetrachloroveratrole	0.4	0	to	2.7	(7/10)	1.0 ± 1.0
		Pentachloroanisole	0.2	0	to	0.3	(2/10)	0.1 ± 0.1
Weldwood	mountain whitefish	Pentachlorophenol	0.2	0	to	0.5	(6/10)	0.2 ± 0.2
		3,4,5-TriClGuaiacol	0.4	0	to	2.3	(8/10)	1.0 ± 0.8
		4,5,6-TriClGuaiacol	0.4	0	to	0.9	(4/10)	0.3 ± 0.4
		Tetrachloroveratrole	0.4	1.8	to	7.5	(10/10)	4.6 ± 1.4
Whitecourt	mountain whitefish	Pentachlorophenol	0.2	0	to	1.1	(4/10)	0.2 ± 0.4
		Tetrachloroveratrole	0.4	0.5	to	4.9	(10/10)	2.0 ± 1.7
		Pentachloroanisole	0.2	0	to	0.5	(6/10)	0.2 ± 0.2
Km. 299.8	walleye	Pentachlorophenol	0.2	0	to	0.5	(1/10)	0.1 ± 0.2
		Tetrachloroveratrole	0.4	0	to	0.5	(1/10)	0.1 ± 0.2
Jackfish Lake	walleye	Pentachlorophenol	0.2	0	to	1.6	(7/9)	0.6 ± 0.5
		2346+2356-TeClPhenol	0.2	0	to	0.5	(1/9)	0.1 ± 0.2
		Tetrachloroveratrole	0.4	0	to	0.4	(2/9)	0.1 ± 0.2
Goose Island	walleye	Pentachlorophenol	0.2	0	to	0.6		0.3 ± 0.3
Km. 627 to 633.8	goldeye	2346+2356-TeClPhenol	0.2	0	to	0.4	(1/6)	0.1 ± 0.2
		2,4,6-TriClPhenol	0.2	0	to	1.5	(1/6)	0.4 ± 0.7
		3,4,5-TriClGuaiacol	0.4	0	to	3.2	(1/6)	0.7 ± 1.3
		4,5,6-TriClGuaiacol	0.4	0	to	0.6	(1/6)	0.1 ± 0.2
		4,5-Dichloroguaiacol	0.4	0	to	2.9	(2/6)	0.8 ± 1.2
		Tetrachloroveratrole	0.4	0	to	2.2	(2/5)	0.7 ± 0.9
Km. 299.8	goldeye	Pentachlorophenol	0.2	0	to	1.1	(2/6)	0.3 ± 0.5
		2346+2356-TeClPhenol	0.2	0	to	1.1	(1/6)	0.2 ± 0.4
		Tetrachloroveratrole	0.4	0	to	1.6	(5/6)	1.0 ± 0.6
		3,4,5-TriClVeratrole	0.4	0	to	0.5	(1/6)	0.1 ± 0.2
Km. 230.4	goldeye	Pentachlorophenol	0.2	0	to	0.8	(4/7)	0.3 ± 0.3
		2346+2356-TeClPhenol	0.2	0	to	0.4	(1/7)	0.1 ± 0.2
		Tetrachloroveratrole	0.4	0	to	0.9	(1/7)	0.1 ± 0.3
Jackfish Lake	goldeye	Pentachlorophenol	0.2	0	to	1.5	(4/13)	0.2 ± 0.4
		Tetrachloroveratrole	0.4	0	to	1.2	(6/13)	0.4 ± 0.5

[1] Only chlorophenolics detectable in at least one sample from each site are reported

Table B2. Levels of OC Pesticides (ng g^{-1} wet wt) in Mountain Whitefish, Long-nose Suckers, Goldeye, and Walleye from the Athabasca River, Spring 1992

Location	Fish Species	Compound[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
Weldwood	long-nose sucker	Endrin	1	0	to	1	(1/11)	0.1 ± 0.3
		Hexachlorobenzene	0.1	0.1	to	0.2	(11/11)	0.1 ± 0.1
		Methoxychlor	2	0	to	2	(2/10)	0.4 ± 0.8
Whitecourt	long-nose sucker	p p'-DDE	0.5	0	to	0.6	(1/10)	0.1 ± 0.2
		p p'-DDD	1	0	to	2	(1/10)	0.2 ± 0.6
		Hexachlorobenzene	0.1	0.1	to	0.4	(10/10)	0.3 ± 0.1
Weldwood	mountain whitefish	Aldrin	0.2	0	to	0.3	(3/10)	0.1 ± 0.1
		alpha-HCH	0.2	0	to	0.3	(2/10)	0.1 ± 0.1
		p p'-DDE	0.5	0	to	1.7	(9/10)	0.8 ± 0.5
		p p'-DDD	1	0	to	1	(2/10)	0.2 ± 0.4
		p p'-DDT	1	0	to	1	(1/10)	0.1 ± 0.3
		Hexachlorobenzene	0.1	0.2	to	0.6	(10/10)	0.4 ± 0.1
		Methoxychlor	2	0	to	6	(9/10)	4.4 ± 1.6
Whitecourt	mountain whitefish	alpha-HCH	0.2	0	to	0.4	(6/10)	0.2 ± 0.2
		gamma-HCH	0.2	0	to	0.2	(1/10)	0.0 ± 0.1
		p p'-DDE	0.5	0	to	1	(2/10)	0.2 ± 0.4
		Hexachlorobenzene	0.1	0.2	to	0.6	(10/10)	0.4 ± 0.2
		delta-HCH	0.2	0	to	0.2	(1/10)	0.0 ± 0.1
		Methoxychlor	2	0	to	2	(1/10)	0.2 ± 0.6
Km. 627 to 6	walleye	Hexachlorobenzene	0.1	0	to	0.1	(1/9)	0.0 ± 0.0
Km. 299.8	walleye	Hexachlorobenzene	0.1	0	to	0.2	(3/10)	0.1 ± 0.1
					to			
Jackfish Lake	walleye	alpha-HCH	0.2	0	to	0.5	(7/9)	0.3 ± 0.2
		p p'-DDE	0.5	0	to	4.4	(7/9)	1.6 ± 1.6
		Hexachlorobenzene	0.1	0	to	0.8	(8/9)	0.4 ± 0.2
		trans-Nonachlor	1	0	to	3	(4/9)	1.0 ± 1.2
Goose Island	walleye	alpha-HCH	0.2	0	to	0.3	(2/4)	0.1 ± 0.2
		p p'-DDE	0.5	0	to	0.7	(1/4)	0.2 ± 0.4
		Hexachlorobenzene	0.1	0	to	0.3	(3/4)	0.2 ± 0.1
Km. 627	goldeye	gamma-HCH	0.2	0	to	0.2	(1/6)	0.0 ± 0.1
		delta-HCH	0.2	0	to	0.7	(1/6)	0.1 ± 0.3
		Hexachlorobenzene	0.1	0	to	0.7	(4/6)	0.3 ± 0.3
		delta-HCH	0.2	0	to	0.2	(1/6)	0.0 ± 0.1
Km. 299.8	goldeye	Hexachlorobenzene	0.1	0	to	1	(5/7)	0.4 ± 0.3
Km. 230.4	goldeye	p p'-DDE	0.5	0	to	1.8	(1/7)	0.3 ± 0.7

Location	Fish Species	Compound[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean	±	SD ng g^{-1}
		Hexachlorobenzene	0.1	0	to	0.7	(4/7)	0.3	±	0.3
Jackfish Lake	goldeye	alpha-HCH	0.2	0	to	1	(8/13)	0.3	±	0.3
		gamma-HCH	0.2	0	to	0.2	(3/13)	0.0	±	0.1
		delta-HCH	0.2	0	to	0.2	(3/13)	0.0	±	0.1
		Hexachlorobenzene	0.1	0.1	to	0.8	(13/13)	0.5	±	0.2

[1] - Only organochlorines detected in at least one sample from each site are reported.

Table B3. Levels of PCBs (ng g^{-1} wet wt) in Mountain Whitefish, Long-nose Suckers, Goldeye, and Walleye from the Athabasca River, Spring 1992

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean	±	SD ng g^{-1}
Weldwood	long-nose sucker	PCB 52	0.05	0.05	to	0.73	(1/11)	0.07	±	0.22
		PCB 49	0.03	0.03	to	0.34	(5/11)	0.13	±	0.15
		PCB 44	0.03	0.03	to	0.23	(1/11)	0.02	±	0.07
		PCB 56/60	0.02	0.02	to	0.16	(1/11)	0.01	±	0.05
		PCB 101	0.03	0.03	to	0.50	(9/11)	0.27	±	0.16
		PCB 87	0.02	0.02	to	0.21	(6/11)	0.08	±	0.08
		PCB 110	0.02	0.02	to	0.31	(5/11)	0.10	±	0.12
		PCB 151	0.02	0.02	to	0.21	(3/11)	0.06	±	0.10
		PCB 149	0.02	0.02	to	0.46	(3/11)	0.12	±	0.21
		PCB 118	0.03	0.03	to	0.43	(6/11)	0.17	±	0.18
		PCB 153	0.02	0.39	to	0.87	(11/11)	0.61	±	0.13
		PCB 141	0.02	0.08	to	0.08	(1/11)	0.01	±	0.02
		PCB 138	0.02	0.25	to	0.65	(11/11)	0.46	±	0.11
		PCB 182/187	0.02	0.02	to	0.26	(10/11)	0.15	±	0.07
		PCB 128	0.02	0.02	to	0.18	(7/11)	0.09	±	0.07
		PCB 174	0.02	0.02	to	0.14	(1/11)	0.01	±	0.04
		PCB 177	0.02	0.02	to	0.13	(2/11)	0.02	±	0.05
		PCB 180	0.02	0.17	to	0.42	(11/11)	0.29	±	0.08
		PCB 170	0.02	0.02	to	0.16	(5/11)	0.06	±	0.07
		PCB 194	0.02	0.02	to	0.11	(1/11)	0.01	±	0.03
		PCB - Total	1	1	to	5.0	(10/11)	2.8	±	1.5
Whitecourt	long-nose sucker	PCB 44	0.03	0.03	to	0.18	(1/10)	0.02	±	0.06
		PCB 101	0.03	0.03	to	0.62	(8/10)	0.28	±	0.20
		PCB 87	0.02	0.02	to	0.14	(1/10)	0.01	±	0.04
		PCB 110	0.02	0.02	to	0.25	(2/10)	0.05	±	0.10
		PCB 151	0.02	0.02	to	0.31	(2/10)	0.05	±	0.11
		PCB 118	0.03	0.03	to	0.64	(3/10)	0.13	±	0.23
		PCB 153	0.02	0.02	to	1.0	(9/10)	0.46	±	0.27
		PCB 138	0.02	0.02	to	0.64	(9/10)	0.33	±	0.18
		PCB 182/187	0.02	0.02	to	0.22	(4/10)	0.05	±	0.08
		PCB 128	0.02	0.02	to	0.20	(3/10)	0.04	±	0.07
		PCB 174	0.02	0.02	to	0.14	(1/10)	0.01	±	0.04
		PCB 180	0.02	0.02	to	0.34	(8/10)	0.16	±	0.12
		PCB 170	0.02	0.02	to	0.14	(2/10)	0.03	±	0.06
		PCB 194	0.02	0.02	to	0.08	(1/10)	0.01	±	0.03
		PCB - Total	1	1	to	4.0	(6/10)	1.4	±	1.3
Weldwood	mountain whitefish	PCB 18	0.05	0.05	to	3.4	(1/10)	0.34	±	1.1
		PCB 31	0.05	0.05	to	0.42	(1/10)	0.04	±	0.13
		PCB 52	0.05	0.05	to	2.1	(8/10)	1.1	±	0.69
		PCB 49	0.03	0.03	to	1.0	(9/10)	0.53	±	0.25
		PCB 44	0.03	0.03	to	0.56	(5/10)	0.22	±	0.24
		PCB 70/76	0.03	0.03	to	0.75	(3/10)	0.17	±	0.29
		PCB 56/60	0.02	0.02	to	0.51	(6/10)	0.20	±	0.19

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
		PCB 84	0.02	0.02	to	0.21	(1/10)	0.02 ± 0.07
		PCB 101	0.03	0.66	to	1.6	(10/10)	1.2 ± 0.33
		PCB 87	0.02	0.25	to	0.70	(10/10)	0.48 ± 0.12
		PCB 110	0.02	0.02	to	1.9	(9/10)	1.2 ± 0.54
		PCB 151	0.02	0.41	to	0.91	(10/10)	0.70 ± 0.15
		PCB 118	0.03	0.03	to	1.1	(2/10)	0.22 ± 0.46
		PCB 153	0.02	1	to	4.5	(10/10)	2.5 ± 1.1
		PCB 105	0.02	0.02	to	1.3	(5/10)	0.41 ± 0.48
		PCB 141	0.02	0.23	to	0.72	(10/10)	0.46 ± 0.17
		PCB 137	0.02	0.02	to	0.27	(3/10)	0.06 ± 0.11
		PCB 138	0.02	0.34	to	3.4	(10/10)	1.9 ± 0.81
		PCB 182/187	0.02	0.02	to	2.9	(3/10)	0.37 ± 0.90
		PCB 183	0.02	0.02	to	0.61	(6/10)	0.25 ± 0.23
		PCB 128	0.02	0.4	to	1.3	(10/10)	0.64 ± 0.28
		PCB 185	0.02	0.02	to	0.22	(1/10)	0.02 ± 0.07
		PCB 174	0.02	0.21	to	0.70	(10/10)	0.45 ± 0.13
		PCB 177	0.02	0.02	to	0.91	(9/10)	0.37 ± 0.25
		PCB 171/202	0.02	0.02	to	0.42	(7/10)	0.20 ± 0.17
		PCB 180	0.02	0.7	to	2.5	(10/10)	1.5 ± 0.52
		PCB 170	0.02	0.21	to	0.91	(10/10)	0.55 ± 0.21
		PCB 196/203	0.02	0.02	to	0.53	(9/10)	0.27 ± 0.15
		PCB 207	0.02	0.02	to	0.66	(3/10)	0.12 ± 0.22
		PCB 194	0.02	0.02	to	0.53	(9/10)	0.28 ± 0.14
		PCB 205	0.02	0.02	to	0.35	(2/10)	0.06 ± 0.13
		PCB 206	0.02	0.02	to	0.28	(1/10)	0.03 ± 0.09
		PCB - Total	1	1	to	31	(10/10)	17 ± 5.9
Whitecourt	mountain whitefish	PCB 52	0.05	0.05	to	1.8	(2/10)	0.22 ± 0.56
		PCB 49	0.03	0.03	to	0.93	(1/10)	0.08 ± 0.28
		PCB 101	0.03	0.03	to	1.4	(8/10)	0.39 ± 0.44
		PCB 87	0.02	0.02	to	0.78	(3/10)	0.11 ± 0.24
		PCB 110	0.02	0.02	to	0.66	(1/10)	0.06 ± 0.20
		PCB 151	0.02	0.02	to	0.68	(1/10)	0.06 ± 0.21
		PCB 118	0.03	0.03	to	1.2	(5/10)	0.37 ± 0.48
		PCB 153	0.02	0.27	to	1.4	(10/10)	0.76 ± 0.48
		PCB 105	0.02	0.02	to	0.21	(1/10)	0.02 ± 0.06
		PCB 141	0.02	0.08	to	0.22	(1/10)	0.02 ± 0.07
		PCB 138	0.02	0.17	to	1.2	(10/10)	0.63 ± 0.39
		PCB 182/187	0.02	0.02	to	0.19	(2/10)	0.03 ± 0.06
		PCB 128	0.02	0.02	to	0.37	(4/10)	0.10 ± 0.15
		PCB 174	0.02	0.02	to	0.23	(3/10)	0.05 ± 0.09
		PCB 180	0.02	0.1	to	0.87	(10/10)	0.41 ± 0.29
		PCB 170	0.02	0.02	to	0.36	(6/10)	0.13 ± 0.13
		PCB 194	0.02	0.02	to	0.20	(1/10)	0.02 ± 0.06
		PCB - Total	1	1	to	10	(8/10)	3.2 ± 3.3
Km. 627 to 633.8	walleye	PCB 153	0.02	0	to	0.28	(3/9)	0.08 ± 0.13
		PCB 138	0.02	0	to	0.22	(2/9)	0.04 ± 0.08

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean	± SD ng g^{-1}
		PCB 180	0.02	0	to	0.22	(1/9)	0.02	± 0.07
Km. 299.9	walleye	PCB 18	0.05	0.05	to	0.86	(2/10)	0.14	± 0.31
		PCB 101	0.03	0.03	to	0.25	(1/10)	0.03	± 0.08
		PCB 153	0.02	0.02	to	0.55	(3/10)	0.14	± 0.20
		PCB 138	0.02	0.02	to	0.41	(2/10)	0.09	± 0.15
		PCB 182/187	0.02	0.02	to	0.13	(1/10)	0.01	± 0.04
		PCB 180	0.02	0.02	to	0.33	(1/10)	0.05	± 0.11
		PCB - Total	1	1	to	2.0	(1/10)	0.30	± 0.67
Jackfish Lake	walleye	PCB 101	0.03	0.03	to	1.5	(5/9)	0.39	± 0.54
		PCB 87	0.02	0.02	to	0.61	(2/9)	0.09	± 0.21
		PCB 153	0.02	0.02	to	2.7	(8/9)	1.2	± 0.87
		PCB 141	0.02	0.02	to	0.42	(3/90	0.10	± 0.17
		PCB 138	0.02	0.02	to	2.0	(8/9)	0.88	± 0.67
		PCB 182/187	0.02	0.02	to	0.94	(8/9)	0.43	± 0.30
		PCB 174	0.02	0.02	to	0.17	(2/9)	0.03	± 0.07
		PCB 177	0.02	0.02	to	0.21	(2/9)	0.04	± 0.09
		PCB 171/202	0.02	0.02	to	0.26	(2/9)	0.05	± 0.11
		PCB 180	0.02	0.02	to	0.86	(7/9)	0.36	± 0.32
		PCB 196/203	0.02	0.02	to	0.19	(2/9)	0.04	± 0.08
		PCB 194	0.02	0.02	to	0.50	(3/9)	0.09	± 0.17
		PCB - Total	1	1	to	10	(8/9)	3.7	± 3.3
Goose Island	walleye	PCB 101	0.03	0.03	to	0.29	(1/4)	0.07	± 0.15
		PCB 153	0.02	0.02	to	0.73	(3/4)	0.32	± 0.30
		PCB 138	0.02	0.02	to	0.47	(3/4)	0.23	± 0.19
		PCB 182/187	0.02	0.02	to	0.24	(1/4)	0.06	± 0.12
		PCB 180	0.02	0.02	to	0.18	(1/4)	0.05	± 0.09
Km. 627 to 633.8	goldeye	PCB 153	0.02	0.02	to	0.33	(3/6)	0.09	± 0.13
		PCB 138	0.02	0.02	to	0.23	(1/6)	0.03	± 0.09
Km. 299.8	goldeye	PCB 153	0.02	0.02	to	0.29	(1/7)	0.04	± 0.11
Km. 230.4	goldeye	PCB 153	0.02	0.02	to	1.4	(2/7)	0.26	± 0.53
		PCB 138	0.02	0.02	to	1.1	(1/7)	0.16	± 0.42
		PCB - Total	1	1	to	4.0	(1/7)	0.57	± 1.5
Jackfish Lake	goldeye	PCB 101	0.03	0.03	to	0.17	(1/13)	0.01	± 0.05
		PCB 151	0.02	0.02	to	0.33	(1/13)	0.05	± 0.12
		PCB 153	0.02	0.02	to	0.44	(8/13)	0.21	± 0.18
		PCB 138	0.02	0.02	to	0.30	(8/13)	0.14	± 0.12
		PCB 182/187	0.02	0.02	to	0.36	(3/13)	0.07	± 0.12
		PCB 180	0.02	0.02	to	0.28	(3/13)	0.05	± 0.10
		PCB 170	0.02	0.02	to	0.1	(1/13)	0.01	± 0.02
		PCB - Total	1	1	to	2.0	(2/13)	0.29	± 0.61

[1] - Only PCB congeners detected in at least one sample from each site are reported.

Table C1. Levels of CPs (ng g^{-1} wet wt) in Burbot Livers, Peace/Wapiti/Smoky Rivers, Fall 1992.

Location	Congener[1]	Detection Limit ng g^{-1}	Low	High	# of Detects	Mean ± SD ng g^{-1}
Smoky River - B3 - Highway 34 Bridge Crossing	pentachlorophenol	0.2	0	to 120	(5/10)	13.1 ± 37.6
	2346+2356-TeClphenol	0.2	0	to 1.7	(2/10)	0.3 ± 0.7
	4,5,6-trichloroguaiacol	0.4	0	to 0.9	(1/10)	0.1 ± 0.3
	tetrachloroveratole	0.4	0	to 12.0	(9/10)	3.3 ± 3.4
	pentachlorophenol	0.2	0	to 1.3	(3/10)	0.2 ± 0.4
Wapiti - D2 - Below Proctor and Gamble Cellulose Mill	pentachlorophenol	0.2	0	to 13.0	(7/9)	3.4 ± 3.9
	2346+2356-TeClphenol	0.2	0	to 12.0	(2/9)	1.4 ± 4.0
	tetrachloroveratole	0.4	0	to 65.0	(6/9)	13.2 ± 20.7
	pentachlorophenol	0.2	0	to 3.7	(5/9)	1.0 ± 1.2
Smoky - A1 - Canfor main haul road bridge crossing	pentachlorophenol	0.2	0	to 2.3	(4/11)	0.6 ± 0.9
	2346+2356-TeClphenol	0.2	0	to 0.8	(1/11)	0.1 ± 0.2
	4,5-Dichlorocatechol	0.4	0	to 0.4	(1/11)	0.0 ± 0.1
Smoky - C1 - Near Watino (Hwy 49 bridge crossing)	pentachlorophenol	0.2	0	to 120	(4/10)	12.5 ± 37.8
	tetrachloroguaiacol	0.4	0	to 3.2	(4/10)	0.8 ± 1.2
	3,4,5-trichloroguaiacol	0.4	0	to 0.7	(1/10)	0.1 ± 0.2
	tetrachloroveratole	0.4	0	to 2.2	(1/10)	0.2 ± 0.7
	pentachlorophenol	0.2	0	to 0.9	(2/10)	0.1 ± 0.3
Peace River - F2 - Below Diashowa Canada Co. Ltd.	pentachlorophenol	0.2	0	to 8.8	(7/8)	3.1 ± 2.9
	2346+2356-TeClphenol	0.2	0	to 1.0	(1/8)	0.1 ± 0.3
	4,5-Dichloroguaiacol	0.4	0	to 1.5	(1/8)	0.2 ± 0.5
	tetrachloroveratole	0.4	0	to 10.0	(6/8)	4.2 ± 3.2
	3,4,5-trichlorosyringol	0.4	0	to 0.6	(1/8)	0.1 ± 0.2
	pentachloroanisole	0.2	0	to 1.4	(5/8)	0.6 ± 0.6
Peace River - G3 - near mouth of Notikewin River	pentachlorophenol	0.2	1.5	to 9.8	(8/8)	4.8 ± 3.3
	3,4,5-trichloroguaiacol	0.4	0	to 0.5	(2/8)	0.1 ± 0.2
	4,5-Dichloroguaiacol	0.4	0	to 0.7	(2/8)	0.2 ± 0.3
	3,4,5-trichlorocatechol	0.4	0	to 4.8	(3/8)	1.2 ± 1.8
	tetrachloroveratole	0.4	0	to 3.8	(4/8)	1.1 ± 1.4
Peace River - K1 - near Fox Lake Indian Reserve	pentachlorophenol	0.2	0	to 4.5	(4/10)	1.2 ± 1.8
	2346+2356-TeClphenol	0.2	0	to 2.2	(2/10)	0.3 ± 0.7
	2,4,6-trichlorophenol	0.2	0	to 0.4	(1/10)	0.0 ± 0.1
	3,4,5-trichloroguaiacol	0.4	0	to 0.9	(1/10)	0.1 ± 0.3
	4,5,6-trichloroguaiacol	0.4	0	to 0.7	(1/10)	0.1 ± 0.2
	4,5-Dichloroguaiacol	0.4	0	to 1.8	(3/10)	0.3 ± 0.6
	Tetrachlorocatechol	0.4	0	to 9.0	(2/10)	1.0 ± 2.8
	3,4,5-trichlorocatechol	0.4	0	to 14.0	(1/10)	1.4 ± 4.4
	4,5-Dichlorocatechol	0.4	0	to 1.2	(1/10)	0.1 ± 0.4
	tetrachloroveratole	0.4	0	to 3.2	(7/10)	1.1 ± 1.0
	pentachloroanisole	0.2	0	to 0.9	(4/10)	0.3 ± 0.4
Peace River - I3 - near Beaver Ranch Indian Reserve	pentachlorophenol	0.2	0	to 2.6	(9/10)	1.1 ± 0.8
	2346+2356-TeClphenol	0.2	0	to 1.3	(1/10)	0.1 ± 0.4
	3,4,5-trichloroguaiacol	0.4	0	to 1.0	(6/10)	0.5 ± 0.5
	4,5-Dichloroguaiacol	0.4	0	to 1.1	(2/10)	0.2 ± 0.4
	3,4,5-trichlorocatechol	0.4	0	to 0.5	(1/10)	0.1 ± 0.2
	4,5-Dichlorocatechol	0.4	0	to 0.9	(1/10)	0.1 ± 0.3
	4-chlorocatechol	0.4	0	to 0.7	(1/10)	0.1 ± 0.2
	tetrachloroveratole	0.4	0	to 1.7	(7/10)	0.8 ± 0.6
	pentachloroanisole	0.2	0	to 0.4	(2/10)	0.1 ± 0.1

Location	Congener[1]	Detection Limit ng g^{-1}	Low	High	# of Detects	Mean ± SD ng g^{-1}
Peace River - J3 - near John d'Or Prairie Indian Reserve	pentachlorophenol	0.2	0 to	18.0	(4/9)	2.6 ± 5.5
	2346+2356-TeClphenol	0.2	0 to	5.8	(2/9)	0.6 ± 1.8
	3,4,5-trichloroguaiacol	0.4	0 to	0.8	(4/9)	0.3 ± 0.3
	4,5-Dichloroguaiacol	0.4	0 to	1.0	(1/9)	0.2 ± 0.3
	3,4,5-trichlorocatechol	0.4	0 to	2.1	(2/9)	0.3 ± 0.7
	tetrachloroveratole	0.4	0 to	4.4	(6/9)	1.8 ± 1.5
	pentachloroanisole	0.2	0 to	1.2	(3/9)	0.4 ± 0.5

[1] Only chlorophenolics detectable in at least one sample from each site are reported

Table C2. Levels of OC Pesticides (ng g^{-1} wet wt) in Burbot Livers, Fall 1992.

Location	Compound[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
Smoky River - B3 - Highway 34 Bridge Crossing	Aldrin	0.2	0	to	4.4	(3/10)	0.95 ± 1.6
	alpha-HCH	0.2	0.30	to	5.8	(10/10)	1.4 ± 1.7
	gamma-HCH	0.2	0	to	1.2	(4/10)	0.35 ± 0.51
	trans-Nonachlor	1	0	to	12	(9/10)	5.2 ± 3.7
	Oxychlordane	1	0	to	6.0	(9/10)	3.4 ± 2.2
	alpha-Chlordane	1	0	to	3.0	(3/10)	0.50 ± 0.97
	gamma-chlordane	1	0	to	15	(7/10)	5.2 ± 5.7
	p,p'-DDE	0.5	0	to	33	(3/10)	6.6 ± 11
	o,p'-DDT	1	0	to	9.0	(6/10)	3.4 ± 3.3
	Dieldrin	1	0	to	5.0	(7/10)	1.9 ± 1.7
	Endosulfan sulphate	2	0	to	6.0	(7/10)	3.4 ± 2.5
	Endrin	1	0	to	29	(1/10)	2.9 ± 9.2
	Hexachlorobenzene	0.1	2.8	to	7.5	(10/10)	5.3 ± 1.7
	Heptachlor epoxide	0.4	0	to	2.7	(7/10)	0.96 ± 0.99
Wapiti - D2 - Below Proctor and Gamble Cellulose Mill	Aldrin	0.2	0	to	10	(5/10)	1.9 ± 4.0
	alpha-HCH	0.2	0	to	4.1	(6/10)	2.5 ± 4.9
	beta-HCH	0.2	0	to	5.9	(3/10)	1.0 ± 2.0
	gamma-HCH	0.2	0	to	1.0	(4/10)	0.8 ± 1.3
	trans-Nonachlor	1	0	to	10	(4/10)	1.8 ± 3.2
	Oxychlordane	1	0	to	17	(2/10)	1.8 ± 5.3
	alpha-Chlordane	1	0	to	49	(5/10)	7.6 ± 15
	gamma-chlordane	1	0	to	67	(8/10)	15 ± 22
	p,p'-DDE	0.5	0	to	170	(5/10)	29 ± 53
	p,p'-DDD	1	0	to	53	(4/10)	7.5 ± 16
	p,p'-DDT	1	0	to	15	(1/10)	1.5 ± 4.7
	o,p'-DDT	1	0	to	23	(6/10)	3.9 ± 7.0
	Dieldrin	1	0	to	3.0	(4/10)	0.9 ± 1.3
	Endrin	1	0	to	4.0	(3/10)	0.9 ± 1.5
	Hexachlorobenzene	0.1	0	to	19.5	(7/10)	4.9 ± 5.8
	Methoxychlor	0.2	0	to	0.90	(1/10)	0.09 ± 0.28
	Heptachlor epoxide	0.4	0	to	0.90	(3/10)	0.23 ± 0.37
	chlor	2	0	to	4.0	(1/10)	0.4 ± 1.3
	Toxaphene	50	0	to	460	(1/10)	46 ± 150
Smoky - A3 - Canfor main haul road bridge crossing	alpha-HCH	0.2	0	to	0.90	(9/11)	0.46 ± 0.31
	delta-HCH	0.2	0	to	0.50	(1/11)	0.05 ± 0.15
	gamma-HCH	0.2	0	to	0.60	(6/11)	0.22 ± 0.23
	Oxychlordane	1	0	to	2.0	(8/11)	0.82 ± 0.60
	gamma-chlordane	1	0	to	1.0	(1/11)	0.09 ± 0.30
	p,p'-DDE	0.5	0.50	to	4.8	(11/11)	5.4 ± 11
	p,p'-DDD	1	0	to	3.0	(1/11)	0.27 ± 0.90
	Dieldrin	1	0	to	2.0	(3/11)	0.45 ± 0.82
	Endosulfan sulphate	2	0	to	2.0	(1/11)	0.18 ± 0.60

Location	Compound[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
	Hexachlorobenzene	0.1	0.10	to	2.4	(11/11)	1.7 ± 0.50
	Heptachlor epoxide	0.4	0	to	1.3	(7/11)	0.55 ± 0.52
Smoky - C1 - Near Watino (Hwy 49 bridge crossing)	Aldrin	0.2	0	to	1.6	(1/10)	0.16 ± 0.51
	alpha-HCH	0.2	0	to	1.3	(4/10)	1.4 ± 3.41
	delta-HCH	0.2	0	to	0.80	(2/10)	0.15 ± 0.32
	gamma-HCH	0.2	0	to	1.2	(4/10)	0.33 ± 0.45
	trans-Nonachlor	1	0	to	6.0	(5/10)	1.6 ± 2.07
	Oxychlordane	1	0	to	5.0	(7/10)	1.9 ± 1.73
	p,p'-DDE	0.5	3.4	to	43	(10/10)	14 ± 14
	p,p'-DDD	1	0	to	7.0	(1/10)	0.7 ± 2.2
	Dieldrin	1	0	to	2.0	(1/10)	0.2 ± 0.63
	Endosulfan sulphate	2	0	to	10	(2/10)	1.4 ± 3.3
	Hexachlorobenzene	0.1	0	to	4.4	(8/10)	2.0 ± 1.50
	Heptachlor epoxide	0.4	0	to	1.2	(2/10)	0.2 ± 0.43
Peace River - F1 - Below Diashowa Canada Co. Ltd.	alpha-HCH	0.2	0	to	5.9	(7/9)	2.3 ± 2.2
	gamma-HCH	0.2	0	to	1.0	(3/10)	0.22 ± 0.37
	gamma-HCH	0.2	0	to	1.9	(1/10)	0.24 ± 0.67
	trans-Nonachlor	1	2.0	to	13	(9/9)	6.4 ± 4.1
	Oxychlordane	1	0	to	9.0	(8/9)	4.4 ± 3.0
	alpha-Chlordane	1	0	to	4.0	(6/9)	1.3 ± 1.3
	gamma-Chlordane	1	0	to	18	(7/9)	3.2 ± 5.6
	p,p'-DDE	0.5	14	to	330	(9/9)	60 ± 100
	p,p'-DDD	1	0	to	66	(3/9)	9.0 ± 22
	o,p'-DDT	1	0	to	6.0	(5/9)	1.6 ± 2.1
	Dieldrin	1	0	to	4.0	(6/9)	1.6 ± 1.5
	Endosulfan sulphate	2	0	to	5.0	(3/9)	1.1 ± 1.8
	Hexachlorobenzene	0.1	0	to	15	(5/9)	4.1 ± 5.0
	Heptachlor epoxide	0.4	0	to	2.8	(7/9)	1.2 ± 1.0
Peace River - G3 - near mouth of Notikewin River	alpha-HCH	0.2	0	to	7.3	(7/8)	3.2 ± 2.2
	trans-Nonachlor	1	0	to	4.0	(5/8)	1.5 ± 1.7
	Oxychlordane	1	2.0	to	5.0	(8/8)	2.7 ± 1.2
	p,p'-DDE	0.5	3.0	to	71	(8/8)	16 ± 23
	p,p'-DDD	1	0	to	8.0	(7/8)	3.0 ± 2.6
	Dieldrin	1	0	to	1.0	(1/8)	0.13 ± 0.35
	Heptachlor epoxide	0.4	0	to	5.2	(4/8)	1.5 ± 1.9
Peace River - K1 - near Fox Lake Indian Reserve	alpha-HCH	0.2	0	to	3.3	(5/10)	1.0 ± 1.3
	gamma-HCH	0.2	0	to	0.30	(1/10)	0.03 ± 0.09
	trans-Nonachlor	1	0	to	49	(8/10)	7.4 ± 16
	Oxychlordane	1	0	to	5.2	(8/10)	2.2 ± 1.9
	gamma-chlordane	1	0	to	2.0	(1/10)	0.20 ± 0.63
	p,p'-DDE	0.5	2.2	to	26	(10/10)	14 ± 23
	p,p'-DDD	1	0	to	9.0	(5/10)	2.8 ± 3.6
	p,p'-DDT	1	0	to	3.0	(1/10)	0.30 ± 0.95
	o,p'-DDT	1	0	to	1.0	(1/10)	0.10 ± 0.32

Location	Compound[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
	Dieldrin	1	0	to	2.0	(3/10)	0.60 ± 0.97
	Endosulfan sulphate	2	0	to	6.0	(1/10)	0.60 ± 1.9
	Hexachlorobenzene	0.1	0	to	5.5	(7/10)	2.4 ± 2.2
	Heptachlor epoxide	0.4	0	to	2.4	(5/10)	0.73 ± 0.86
Peace River - I3 - near Beaver Ranch Indian Reserve	alpha-HCH	0.2	0	to	4.4	(8/10)	1.9 ± 1.6
	beta-HCH	0.2	0	to	0.90	(1/10)	0.09 ± 0.28
	gamma-HCH	0.2	0	to	0.40	(1/10)	0.04 ± 0.13
	trans-Nonachlor	1	0	to	4.0	(7/10)	1.5 ± 1.4
	Oxychlordane	1	0	to	2.2	(8/10)	1.3 ± 0.93
	p p-DDE	0.5	0	to	48	(9/10)	17 ± 13
	p p-DDD	1	0	to	3.6	(3/10)	0.75 ± 1.3
	Dieldrin	1	0	to	2.0	(4/10)	0.80 ± 1.0
	Endosulfan II	1	0	to	1.4	(2/10)	0.25 ± 0.53
	Endosulfan sulphate	2	0	to	1.9	(2/10)	0.37 ± 0.78
	Heptachlor epoxide	0.4	0	to	1.8	(6/10)	0.84 ± 0.76
Peace River - J3 - near John d'Or Prairie Indian Reserve	alpha-HCH	0.2	0	to	11	(5/10)	1.9 ± 3.4
	trans-Nonachlor	1	0	to	1.0	(2/10)	0.20 ± 0.42
	Oxychlordane	1	0	to	2.0	(2/10)	0.30 ± 0.67
	p p-DDE	0.5	0	to	7.5	(7/10)	2.3 ± 2.6
	Dieldrin	1	0	to	2.0	(2/10)	0.60 ± 1.1
	Endosulfan I	1	0	to	2.0	(1/10)	0.20 ± 0.63
	Heptachlor epoxide	0.4	0	to	2.0	(3/10)	0.42 ± 0.76
Peace River - H1 - Near Carcajou	alpha-HCH	0.2	0	to	7.5	(7/9)	3.1 ± 2.5
	gamma-HCH	0.2	0	to	0.25	(1/10)	0.03 ± 0.08
	trans-Nonachlor	1	1.0	to	39	(9/9)	5.5 ± 12
	Oxychlordane	1	1.0	to	5.5	(9/9)	2.5 ± 1.35
	alpha-Chlordane	1	0	to	0.70	(2/9)	0.13 ± 0.28
	gamma-chlordane	1	0	to	2.0	(2/10)	0.35 ± 0.67
	p,p'-DDE	0.5	0	to	39	(8/10)	11 ± 11
	p,p'-DDD	1	0	to	11	(7/10)	3.7 ± 3.6
	Heptachlor epoxide	0.4	0	to	1.7	(3/10)	0.27 ± 0.54

[1] - Only organochlorines detected in at least one sample from each site are reported.

Table C3. Levels of PCBs (ng g^{-1} wet wt) in Burbot Livers, Fall 1992.

Location	Congener[1]	Detection Limits ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
Smoky River - B3 - Highway 34 Bridge Crossing	PCB 33	0.05	0	to	2.2	(1/10)	0.2 ± 0.7
	PCB 22	0.05	0	to	2.7	(1/10)	0.3 ± 0.9
	PCB 52	0.05	0	to	69.0	(9/10)	29.0 ± 24.9
	PCB 49	0.03	0	to	13.0	(7/10)	4.9 ± 4.5
	PCB 44	0.03	0	to	23.0	(8/10)	9.4 ± 7.6
	PCB 101	0.03	5.3	to	210.0	(10/10)	88.4 ± 79.2
	PCB 87	0.02	0	to	91.0	(9/10)	37.5 ± 32.9
	PCB 151	0.02	2.2	to	28.0	(10/10)	12.2 ± 9.1
	PCB 149	0.02	0	to	4.8	(1/10)	0.5 ± 1.5
	PCB 118	0.03	0	to	370.0	(9/10)	150.0 ± 140.0
	PCB 153	0.02	8.1	to	300.0	(10/10)	120.0 ± 100.0
	PCB 105	0.02	0	to	130.0	(9/10)	54.0 ± 46.9
	PCB 141	0.02	1.1	to	33.0	(10/10)	13.5 ± 11.1
	PCB 137	0.02	0	to	29.0	(9/10)	11.5 ± 9.8
	PCB 138	0.02	3	to	330.0	(10/10)	130.1 ± 120.0
	PCB 129	0.02	0	to	12.0	(8/10)	4.9 ± 4.1
	PCB 182/187	0.02	0	to	4.8	(8/10)	2.2 ± 1.7
	PCB 128	0.02	0	to	82.0	(9/10)	34.2 ± 30.2
	PCB 174	0.02	0	to	0.7	(1/10)	0.1 ± 0.2
	PCB 177	0.02	0	to	1.7	(1/10)	0.2 ± 0.5
	PCB 180	0.02	2	to	54.0	(10/10)	23.6 ± 17.2
	PCB 191	0.02	0	to	2.8	(5/10)	1.0 ± 1.2
	PCB 170	0.02	0.87	to	36.0	(10/10)	14.6 ± 11.3
	PCB 196/203	0.02	0	to	5.2	(9/10)	2.5 ± 1.6
	PCB 189	0.02	0	to	4.1	(5/10)	0.8 ± 1.3
	PCB 194	0.02	0	to	4.7	(8/10)	1.9 ± 1.6
	PCB - Total	1	1	to	1800		750 ± 630
Wapiti - D2 - Below Proctor and Gamble Cellulose Mill	PCB 16/32	0.05	0	to	2.4	(1/10)	0.2 ± 0.8
	PCB 33	0.05	0	to	5.5	(4/10)	1.6 ± 2.3
	PCB 52	0.05	0	to	37.5	(6/10)	12.0 ± 13.2
	PCB 49	0.03	0	to	16.9	(6/10)	4.1 ± 5.3
	PCB 44	0.03	0	to	8.6	(5/10)	3.0 ± 3.5
	PCB 40	0.03	0	to	2.8	(1/10)	0.3 ± 0.9
	PCB 70/76	0.03	0.03	to	33.0	(10/10)	5.1 ± 11.0
	PCB 65/95	0.03	0.03	to	7.7	(10/10)	0.9 ± 2.4
	PCB 56/60	0.02	0	to	3.8	(2/10)	0.6 ± 1.4
	PCB 84	0.02	0.02	to	18.0	(10/10)	2.9 ± 6.3
	PCB 89	0.02	0.02	to	30.0	(10/10)	3.0 ± 9.5
	PCB 101	0.03	0.03	to	44.4	(10/10)	17.4 ± 18.1
	PCB 87	0.02	0	to	26.0	(8/10)	12.9 ± 10.3
	PCB 110	0.02	0.02	to	7.9	(10/10)	2.2 ± 3.2
	PCB 151	0.02	0.02	to	32.0	(10/10)	3.6 ± 10.0
	PCB 149	0.02	0	to	54.0	(3/10)	11.4 ± 21.3
	PCB 118	0.03	0	to	21.0	(2/10)	2.9 ± 6.8
	PCB 146	0.02	0.02	to	53.0	(10/10)	21.2 ± 17.1

Location	Congener[1]	Detection Limits ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
	PCB 153	0.02	0	to	215.0	(6/10)	43.7 ± 74.7
	PCB 105	0.02	0	to	61.9	(8/10)	10.0 ± 18.6
	PCB 141	0.02	0	to	25.0	(7/10)	4.7 ± 7.5
	PCB 137	0.02	0	to	55.0	(6/10)	16.9 ± 19.8
	PCB 138	0.02	0	to	226.0	(6/10)	39.2 ± 81.5
	PCB 129	0.02	0	to	12.9	(4/10)	1.9 ± 4.0
	PCB 182/187	0.02	0	to	9.7	(3/10)	2.6 ± 4.2
	PCB 183	0.02	0	to	46.0	(6/10)	8.0 ± 14.1
	PCB 128	0.02	0	to	38.9	(1/10)	3.9 ± 12.3
	PCB 185	0.02	0	to	2.5	(3/10)	0.5 ± 0.9
	PCB 177	0.02	0	to	1.0	(3/10)	0.3 ± 0.5
	PCB 171/202	0.02	0	to	2.1	(4/10)	0.5 ± 0.7
	PCB 180	0.02	0	to	108.0	(5/10)	16.4 ± 33.6
	PCB 191	0.02	0	to	75.0	(5/10)	10.4 ± 23.1
	PCB 170	0.02	0	to	13.1	(2/10)	1.4 ± 4.1
	PCB 201	0.02	0	to	2.8	(2/10)	0.4 ± 0.9
	PCB 196/203	0.02	0	to	4.8	(5/10)	0.9 ± 1.5
	PCB 194	0.02	0	to	1.2	(4/10)	0.3 ± 0.4
	PCB - Total	1	1	to	670		270 ± 240
Smoky - A3 - Canfor main haul road bridge crossing	PCB 5/8	0.3	0	to	9.4	(1/11)	0.9 ± 2.8
	PCB 18	0.05	0.05	to	12.0	(11/11)	5.0 ± 3.9
	PCB 52	0.05	0	to	8.0	(8/11)	2.3 ± 2.6
	PCB 49	0.03	0	to	2.2	(3/11)	0.5 ± 0.8
	PCB 44	0.03	0	to	2.1	(3/11)	0.4 ± 0.8
	PCB 65/95	0.03	0.03	to	95.0	(11/11)	8.7 ± 28.6
	PCB 101	0.03	0.96	to	12.0	(11/11)	4.0 ± 4.1
	PCB 87	0.02	0	to	5.1	(7/11)	1.2 ± 1.8
	PCB 149	0.02	0	to	5.5	(1/11)	0.5 ± 1.7
	PCB 118	0.03	0	to	6.2	(6/11)	2.0 ± 2.3
	PCB 153	0.02	1.4	to	20.0	(11/11)	5.8 ± 5.7
	PCB 105	0.02	0	to	7.0	(3/11)	0.9 ± 2.1
	PCB 141	0.02	0	to	2.4	(5/11)	0.5 ± 0.8
	PCB 137	0.02	0	to	2.2	(1/11)	0.2 ± 0.7
	PCB 138	0.02	0.93	to	10.0	(11/11)	3.2 ± 2.5
	PCB 129	0.02	0	to	1.3	(1/11)	0.1 ± 0.4
	PCB 182/187	0.02	0	to	0.8	(1/11)	0.1 ± 0.2
	PCB 128	0.02	0	to	7.8	(1/11)	0.7 ± 2.4
	PCB 180	0.02	0.64	to	7.8	(11/11)	2.3 ± 2.2
	PCB 170	0.02	0	to	3.5	(5/11)	0.7 ± 1.1
	PCB 196/203	0.02	0	to	1.3	(2/11)	0.1 ± 0.4
	PCB 194	0.02	0	to	1.0	(2/11)	0.1 ± 0.3
	PCB - Total	1	1	to	190		40.2 ± 52.7
Smoky - C1 - Near Watino (Hwy 49 bridge crossing)	PCB 5/8	0.3	0	to	14.0	(1/11)	1.4 ± 4.4
	PCB 33	0.05	0	to	1.9	(1/11)	0.2 ± 0.6
	PCB 52	0.05	0	to	29.0	(8/11)	9.9 ± 8.4
	PCB 49	0.03	0	to	6.9	(5/10)	1.8 ± 2.3
	PCB 44	0.03	0	to	4.9	(4/10)	1.2 ± 1.7

Location	Congener[1]	Detection Limits ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
	PCB 65/95	0.03	0.03	to	39.0	(10/10)	14.9 ± 17.7
	PCB 101	0.03	1.3	to	88.0	(10/10)	28.6 ± 25.5
	PCB 87	0.02	0	to	29.0	(9/10)	9.4 ± 9.0
	PCB 151	0.02	0.02	to	15.0	(10/10)	4.2 ± 4.9
	PCB 149	0.02	0	to	51.0	(2/10)	7.8 ± 17.4
	PCB 118	0.03	0	to	110.0	(8/10)	38.3 ± 35.6
	PCB 153	0.02	5.5	to	160.0	(10/10)	55.7 ± 48.4
	PCB 105	0.02	0.85	to	52.0	(10/10)	16.4 ± 15.5
	PCB 141	0.02	0	to	20.0	(9/10)	6.0 ± 5.9
	PCB 137	0.02	0	to	18.0	(8/10)	5.3 ± 5.5
	PCB 138	0.02	4.2	to	160.0	(10/10)	53.4 ± 48.5
	PCB 129	0.02	0	to	7.0	(6/10)	1.8 ± 2.2
	PCB 182/187	0.02	0	to	2.0	(3/10)	0.6 ± 0.9
	PCB 128	0.02	1.2	to	40.0	(10/10)	12.7 ± 11.9
	PCB 174	0.02	0	to	1.0	(2/10)	0.2 ± 0.3
	PCB 177	0.02	0	to	0.5	(1/10)	0.1 ± 0.2
	PCB 180	0.02	1.8	to	41.0	(10/10)	13.7 ± 12.0
	PCB 191	0.02	0	to	0.8	(1/10)	0.1 ± 0.2
	PCB 170	0.02	0.64	to	21.0	(10/10)	7.2 ± 6.3
	PCB 196/203	0.02	0	to	3.9	(4/10)	0.9 ± 1.4
	PCB 194	0.02	0	to	3.9	(5/10)	1.0 ± 1.4
	PCB - Total	1	1	to	700		292 ± 227
Peace River - F1 - Below Diashowa Canada Co. Ltd.	PCB 18	0.05	0.05	to	130.0	(9/9)	14.5 ± 43.3
	PCB 31	0.05	0	to	1.6	(1/9)	0.2 ± 0.5
	PCB 22	0.05	0	to	4.5	(2/9)	0.8 ± 1.7
	PCB 52	0.05	0	to	15.0	(7/9)	6.5 ± 5.6
	PCB 49	0.03	0	to	3.0	(5/9)	1.0 ± 1.1
	PCB 44	0.03	0	to	5.8	(7/9)	2.3 ± 1.8
	PCB 40	0.03	0	to	14.0	(2/9)	1.8 ± 4.9
	PCB 65/95	0.03	0.03	to	2.0	(9/9)	0.2 ± 0.7
	PCB 84	0.02	0	to	2.5	(1/9)	0.3 ± 0.8
	PCB 101	0.03	0.03	to	41.0	(9/9)	14.4 ± 14.3
	PCB 87	0.02	0	to	18.0	(7/9)	7.7 ± 6.3
	PCB 110	0.02	0.02	to	14.0	(9/9)	5.7 ± 6.0
	PCB 151	0.02	0.02	to	20.0	(9/9)	9.8 ± 5.7
	PCB 149	0.02	0	to	17.0	(4/9)	5.5 ± 7.1
	PCB 118	0.03	0	to	110.0	(6/9)	28.6 ± 35.8
	PCB 146	0.02	0.02	to	24.0	(9/9)	2.7 ± 8.0
	PCB 153	0.02	3	to	140.0	(9/9)	36.0 ± 40.3
	PCB 141	0.02	0	to	9.1	(8/9)	4.1 ± 2.8
	PCB 137	0.02	0	to	21.0	(8/9)	6.0 ± 6.9
	PCB 138	0.02	1.2	to	130.0	(9/9)	35.2 ± 37.3
	PCB 129	0.02	0	to	3.4	(5/9)	1.1 ± 1.3
	PCB 182/187	0.02	0	to	4.3	(7/9)	1.8 ± 1.4
	PCB 183	0.02	0	to	8.0	(6/9)	3.7 ± 3.1
	PCB 128	0.02	0	to	39.0	(6/9)	9.1 ± 12.1
	PCB 174	0.02	0	to	0.9	(2/9)	0.1 ± 0.3
	PCB 177	0.02	0	to	0.3	(1/9)	0.0 ± 0.1

Location	Congener[1]	Detection Limits ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
	PCB 171/202	0.02	0	to	3.7	(5/9)	0.8 ± 1.2
	PCB 180	0.02	5.3	to	48.0	(9/9)	11.6 ± 13.7
	PCB 191	0.02	0	to	12.0	(1/9)	1.3 ± 4.0
	PCB 170	0.02	0	to	24.0	(5/9)	4.6 ± 7.6
	PCB 201	0.02	0	to	3.0	(4/9)	0.8 ± 1.1
	PCB 196/203	0.02	0	to	8.0	(5/9)	1.7 ± 2.7
	PCB 189	0.02	0	to	1.1	(3/9)	0.3 ± 0.5
	PCB 195/208	0.02	0	to	0.9	(1/9)	0.1 ± 0.3
	PCB 194	0.02	0	to	6.0	(7/9)	1.6 ± 2.0
	PCB 205	0.02	0	to	1.3	(1/9)	0.1 ± 0.4
	PCB - Total	1	1	to	670		220 ± 180
Peace River - G3 - near mouth of Notikewin River	PCB 18	0.05	0.05	to	80.0	(8/8)	18.8 ± 34.8
	PCB 101	0.03	0.03	to	9.0	(8/8)	1.5 ± 3.1
	PCB 110	0.02	0.02	to	8.0	(8/8)	1.3 ± 2.8
	PCB 151	0.02	0.02	to	11.0	(8/8)	3.3 ± 4.2
	PCB 149	0.02	0	to	20.0	(1/8)	2.5 ± 7.1
	PCB 153	0.02	0	to	82.0	(7/8)	25.6 ± 26.0
	PCB 137	0.02	0	to	3.0	(1/8)	0.4 ± 1.1
	PCB 138	0.02	0	to	55.0	(7/8)	15.9 ± 18.0
	PCB 128	0.02	0	to	12.0	(3/8)	2.6 ± 4.5
	PCB 180	0.02	0	to	25.0	(7/8)	6.6 ± 8.2
	PCB 201	0.02	0	to	8.3	(3/8)	1.7 ± 3.0
	PCB 189	0.02	0	to	4.9	(1/8)	0.6 ± 1.7
	PCB 205	0.02	0	to	4.7	(1/8)	0.6 ± 1.7
	PCB - Total	1	1	to	200.0		79.4 ± 70.9
Peace River - K1 - near Fox Lake Indian Reserve	PCB 52	0.05	0	to	2.5	(2/10)	0.5 ± 1.0
	PCB 44	0.03	0	to	1.0	(1/10)	0.1 ± 0.3
	PCB 65/95	0.03	0	to	14.0	(4/10)	2.5 ± 4.5
	PCB 101	0.03	0.03	to	7.5	(10/10)	1.8 ± 2.4
	PCB 87	0.02	0	to	1.8	(2/10)	0.2 ± 0.6
	PCB 110	0.02	0.02	to	2.0	(10/10)	0.3 ± 0.7
	PCB 151	0.02	0.02	to	4.0	(10/10)	0.8 ± 1.4
	PCB 149	0.02	0	to	4.0	(3/10)	0.8 ± 1.4
	PCB 118	0.03	0	to	12.0	(2/10)	1.5 ± 3.8
	PCB 153	0.02	0	to	30.0	(9/10)	8.9 ± 9.5
	PCB 105	0.02	0	to	2.7	(3/10)	0.4 ± 0.9
	PCB 141	0.02	0	to	2.5	(3/10)	0.6 ± 1.0
	PCB 137	0.02	0	to	2.0	(2/10)	0.3 ± 0.7
	PCB 138	0.02	0	to	19.0	(8/10)	5.8 ± 6.3
	PCB 182/187	0.02	0	to	1.7	(4/10)	0.4 ± 0.6
	PCB 183	0.02	0	to	6.0	(3/10)	0.9 ± 1.9
	PCB 128	0.02	0	to	8.0	(3/10)	1.2 ± 2.5
	PCB 171/202	0.02	0	to	0.5	(1/10)	0.1 ± 0.2
	PCB 180	0.02	0	to	14.0	(7/10)	3.4 ± 4.3
	PCB 170	0.02	0	to	5.4	(5/10)	1.2 ± 1.8
	PCB 201	0.02	0	to	1.0	(1/10)	0.1 ± 0.3
	PCB 196/203	0.02	0	to	2.9	(3/10)	0.4 ± 0.9

Location	Congener[1]	Detection Limits ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
	PCB 195/208	0.02	0	to	1.0	(1/10)	0.1 ± 0.3
	PCB 194	0.02	0	to	1.9	(3/10)	0.4 ± 0.7
	PCB 205	0.02	0	to	4.5	(1/10)	0.5 ± 1.4
	PCB - Total	1	1	to	130.0		24.3 ± 39.9
Peace River - I3 - near Beaver Ranch Indian Reserve	PCB 22	0.05	0	to	5.2	(1/10)	0.5 ± 1.6
	PCB 101	0.03	0.03	to	1.8	(10/10)	0.2 ± 0.6
	PCB 110	0.02	0.02	to	4.0	(10/10)	0.8 ± 1.3
	PCB 151	0.02	0.02	to	4.4	(10/10)	1.9 ± 1.7
	PCB 149	0.02	0	to	5.0	(4/10)	1.0 ± 1.7
	PCB 153	0.02	0	to	36.0	(7/10)	10.8 ± 11.3
	PCB 141	0.02	0	to	3.6	(2/10)	0.4 ± 1.1
	PCB 137	0.02	0	to	25.0	(2/10)	2.6 ± 7.9
	PCB 138	0.02	0	to	25.0	(7/10)	7.2 ± 7.8
	PCB 182/187	0.02	0	to	2.1	(3/10)	0.3 ± 0.7
	PCB 183	0.02	0	to	4.0	(3/10)	0.6 ± 1.3
	PCB 128	0.02	0	to	1.5	(2/10)	0.2 ± 0.5
	PCB 171/202	0.02	0	to	0.7	(1/10)	0.1 ± 0.2
	PCB 180	0.02	0	to	12.0	(8/10)	4.4 ± 4.0
	PCB 170	0.02	0	to	3.8	(2/10)	0.6 ± 1.3
	PCB 196/203	0.02	0	to	2.6	(3/10)	0.4 ± 0.9
	PCB 194	0.02	0	to	2.3	(2/10)	0.3 ± 0.7
	PCB - Total	1	1	to	58.0		16.1 ± 21.6
Peace River - J3 - near John d'Or Prairie Indian Reserve	PCB 101	0.03	0.03	to	2.0	(10/10)	0.4 ± 0.8
	PCB 151	0.02	0.02	to	1.8	(10/10)	0.4 ± 0.7
	PCB 149	0.02	0	to	1.0	(2/10)	0.2 ± 0.3
	PCB 153	0.02	0	to	11.0	(5/10)	3.0 ± 3.9
	PCB 141	0.02	0	to	0.7	(1/10)	0.1 ± 0.2
	PCB 138	0.02	0	to	9.4	(7/10)	3.3 ± 3.1
	PCB 182/187	0.02	0	to	0.6	(1/10)	0.1 ± 0.2
	PCB 171/202	0.02	0	to	0.4	(1/10)	0.0 ± 0.1
	PCB 180	0.02	0	to	4.5	(6/10)	1.5 ± 1.7
	PCB 170	0.02	0	to	1.8	(2/10)	0.3 ± 0.6
	PCB 196/203	0.02	0	to	0.4	(1/10)	0.0 ± 0.1
	PCB 194	0.02	0	to	0.4	(1/10)	0.0 ± 0.1
	PCB - Total	1	1	to	31.0		9.7 ± 9.7
Peace River - H1 - Near Carcajou	PCB 44	0.03	0	to	44.0	(1/9)	4.4 ± 13.9
	PCB 40	0.03	0	to	42.0	(1/9)	6.2 ± 14.1
	PCB 101	0.03	0	to	2.0	(2/9)	0.3 ± 0.7
	PCB 87	0.02	0	to	3.0	(3/9)	0.7 ± 1.2
	PCB 110	0.02	0.02	to	4.8	(9/9)	2.5 ± 2.1
	PCB 151	0.02	0.02	to	7.7	(9/9)	3.7 ± 2.6
	PCB 149	0.02	0	to	21.0	(8/9)	10.2 ± 6.2
	PCB 153	0.02	0	to	42.0	(7/9)	16.6 ± 12.4
	PCB 141	0.02	0	to	2.0	(2/9)	0.3 ± 0.7
	PCB 137	0.02	0	to	2.0	(2/9)	0.3 ± 0.6
	PCB 138	0.02	0	to	26.0	(2/9)	10.4 ± 7.7
	PCB 182/187	0.02	0	to	3.0	(5/9)	1.1 ± 1.1

Location	Congener[1]	Detection Limits ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
	PCB 183	0.02	0.2	to	3.6	(9/9)	1.6 ± 1.3
	PCB 128	0.02	0	to	5.0	(2/9)	0.8 ± 1.7
	PCB 180	0.02	0	to	12.0	(7/9)	5.3 ± 4.2
	PCB 170	0.02	0	to	2.0	(1/9)	0.2 ± 0.6
	PCB 201	0.02	0.02	to	1.1	(9/9)	0.3 ± 0.3
	PCB 196/203	0.02	0	to	2.0	(2/9)	0.3 ± 0.6
	PCB 194	0.02	0	to	1.3	(3/9)	0.4 ± 0.6
	PCB 205	0.02	0	to	1.0	(1/9)	0.1 ± 0.3
	PCB 209	0.02	0	to	1.0	(1/9)	0.1 ± 0.3
	PCB - Total	1	1	to	120		60.9 ± 47.6

[1] - Only PCB congeners detected in at least one sample from each site are reported.

Table C4. Levels of Organochlorine Pesticides (ng g^{-1} wet wt) in Burbot Livers, Fall 1994.

Location	Compound[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
A1	alpha-HCH	0.2	0	to	4.0	(6/7)	1.9 ± 1.4
	Cis-chlordane	1	5	to	12.0	(7/7)	7.9 ± 2.7
	p,p'-DDE	0.5	4.1	to	49.0	(7/7)	20.8 ± 18.2
	p,p'-DDT	1	0	to	11.0	(4/7)	2.7 ± 3.9
	Dieldrin	1	5	to	14.0	(7/7)	8.4 ± 3.9
	Endosulfan II	1	0	to	2.0	(1/7)	0.3 ± 0.8
	Endosulfan Sulphate	2	0	to	17.0	(4/7)	7.1 ± 7.3
	Heptachlor epoxide	0.4	0	to	5.5	(5/7)	2.2 ± 2.0
	Hexachlorobenzene	0.1	4.2	to	6.8	(7/7)	5.4 ± 1.1
	gamma-HCH	0.2	0	to	3.4	(3/7)	0.8 ± 1.3
	trans-nonachlor	1	5	to	11.0	(7/7)	7.3 ± 2.1
	Oxychlordane	1	0	to	5.0	(6/7)	4.1 ± 1.9
	Toxaphene	10	0	to	70.0	(1/7)	10.0 ± 26.5
A2	alpha-HCH	0.2	1.6	to	11.0	(8/8)	3.4 ± 3.3
	beta-HCH	0.2	0	to	3.2	(1/8)	0.4 ± 1.1
	delta-HCH	0.2	0	to	4.0	(1/8)	0.5 ± 1.4
	Cis-chlordane	1	3	to	9.0	(8/8)	4.8 ± 2.3
	p,p'-DDE	0.5	4.8	to	24.0	(8/8)	15.7 ± 6.0
	o,p'-DDT	1	0	to	2.0	(3/8)	0.8 ± 1.0
	p,p'-DDD	1	0	to	3.0	(4/8)	0.9 ± 1.1
	p,p'-DDT	1	5	to	21.0	(8/8)	11.3 ± 6.3
	Dieldrin	1	1	to	11.0	(8/8)	4.9 ± 3.8
	Endosulfan II	1	0	to	5.0	(4/8)	2.0 ± 2.3
	Endosulfan Sulphate	2	0	to	11.0	(6/8)	5.4 ± 3.9
	Endrin	1	0	to	2.0	(2/8)	0.5 ± 0.9
	Heptachlor epoxide	0.4	0	to	5.7	(7/8)	2.1 ± 1.7
	Hexachlorobenzene	0.1	2.5	to	6.6	(8/8)	3.8 ± 1.4
	gamma-HCH	0.2	0	to	2.1	(7/8)	1.0 ± 0.8
	trans-nonachlor	1	2	to	6.0	(8/8)	4.0 ± 1.7
	Oxychlordane	1	2	to	9.0	(8/8)	3.8 ± 2.3
	Toxaphene	10	0	to	50.0	(3/8)	10.0 ± 17.7
A3	alpha-HCH	0.2	1.65	to	5.6	(9/9)	2.9 ± 1.4
	Cis-chlordane	1	3	to	14.0	(9/9)	7.6 ± 4.3
	p,p'-DDE	0.5	8.8	to	64.5	(9/9)	25.6 ± 19.8
	o,p'-DDT	1	0	to	6.0	(2/9)	0.9 ± 2.0
	p,p'-DDD	1	0	to	6.0	(3/9)	1.1 ± 2.1
	p,p'-DDT	1	0	to	18.0	(3/9)	3.7 ± 6.3
	Dieldrin	1	4	to	15.0	(9/9)	8.1 ± 3.6
	Endosulfan II	1	0	to	3.0	(1/9)	0.3 ± 1.0
	Endosulfan Sulphate	2	0	to	57.0	(4/9)	10.2 ± 18.1
	Heptachlor epoxide	0.4	0	to	12.0	(7/9)	3.9 ± 4.0
	Hexachlorobenzene	0.1	3.5	to	9.7	(9/9)	5.8 ± 2.0
	gamma-HCH	0.2	0	to	4.9	(6/9)	1.1 ± 1.8

Location	Compound[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
	Mirex	2	0	to	3.0	(1/9)	0.3 ± 1.0
	trans-nonachlor	1	3	to	15.0	(9/9)	7.7 ± 4.1
	Oxychlordane	1	0	to	9.0	(6/9)	3.9 ± 3.3
A4	alpha-HCH	0.2	1.1	to	3.7	(10/10)	2.3 ± 0.7
	Cis-chlordane	1	2	to	7.0	(10/10)	3.8 ± 1.6
	p,p'-DDE	0.5	5.8	to	33.0	(10/10)	16.2 ± 8.0
	o,p'-DDT	1	0	to	2.0	(3/10)	0.5 ± 0.8
	p,p'-DDT	1	0	to	4.0	(3/10)	0.8 ± 1.4
	Dieldrin	1	0	to	4.0	(8/10)	2.0 ± 1.3
	Heptachlor epoxide	0.4	1.3	to	7.6	(10/10)	3.4 ± 2.1
	Hexachlorobenzene	0.1	2.3	to	6.4	(10/10)	4.8 ± 1.2
	gamma-HCH	0.2	0	to	3.4	(10/10)	1.2 ± 0.9
	trans-nonachlor	1	2	to	7.0	(10/10)	4.1 ± 1.9
	Oxychlordane	1	1	to	6.0	(10/10)	3.6 ± 1.6
	Toxaphene	10	0	to	50.0	(1/10)	5.0 ± 15.8
A5	alpha-HCH	56.3	0	to	3.2	(8/9)	1.2 ± 0.9
	Cis-chlordane	59.3	1	to	9.0	(9/9)	3.9 ± 2.9
	p,p'-DDE	61.3	0	to	200.0	(8/9)	38.1 ± 63.0
	p,p'-DDD	63.3	0	to	4.0	(3/9)	0.9 ± 1.5
	p,p'-DDT	64.3	0	to	2.0	(2/9)	0.3 ± 0.7
	Dieldrin	65.3	0	to	2.0	(2/9)	0.4 ± 0.9
	Endosulfan II	67.3	0	to	1.0	(1/9)	0.1 ± 0.3
	Endosulfan Sulphate	68.3	0	to	7.0	(2/9)	1.0 ± 2.3
	Heptachlor epoxide	71.3	0	to	5.2	(8/9)	2.5 ± 1.9
	Hexachlorobenzene	72.3	0.7	to	5.7	(9/9)	2.9 ± 1.6
	gamma-HCH	73.3	0	to	0.6	(8/9)	0.4 ± 0.2
	Mirex	75.3	0	to	2.0	(1/9)	0.2 ± 0.7
	trans-nonachlor	76.3	1	to	6.0	(9/9)	2.6 ± 1.9
	Oxychlordane	77.3	0	to	3.0	(8/9)	1.8 ± 1.0
CW	alpha-HCH	0.2	0	to	1.1	(2/4)	0.4 ± 0.5
	Cis-chlordane	1	0	to	3.0	(1/4)	0.8 ± 1.5
	p,p'-DDE	0.5	1.8	to	6.2	(4/4)	4.0 ± 1.8
	Endosulfan Sulphate	2	0	to	9.0	(1/4)	2.3 ± 4.5
	Hexachlorobenzene	0.1	1.4	to	5.0	(4/4)	2.4 ± 1.8
	gamma-HCH	0.2	0	to	2.0	(3/4)	1.2 ± 1.0
	trans-nonachlor	1	0	to	3.0	(3/4)	1.5 ± 1.3
	Oxychlordane	1	0	to	4.0	(2/4)	1.3 ± 1.9
LSV	alpha-HCH	0.2	1.1	to	17.0	(18/18)	3.4 ± 3.6
	beta-HCH	0.2	0	to	1.4	(1/18)	0.1 ± 0.3
	Cis-chlordane	1	0	to	8.0	(12/18)	2.3 ± 2.4
	p,p'-DDE	0.5	5	to	32.0	(18/18)	14.3 ± 7.6
	p,p'-DDD	1	0	to	2.0	(6/18)	0.5 ± 0.8
	p,p'-DDT	1	0	to	6.0	(7/18)	1.2 ± 1.8
	Dieldrin	1	0	to	8.0	(16/18)	2.2 ± 1.8
	Endosulfan I	1	0	to	1.0	(1/18)	0.1 ± 0.2

Location	Compound[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
	Endosulfan II	1	0	to	2.0	(2/18)	0.2 ± 0.6
	Endosulfan Sulphate	2	0	to	28.0	(5/18)	2.2 ± 6.6
	Heptachlor epoxide	0.4	0	to	7.0	(17/18)	3.5 ± 1.8
	Hexachlorobenzene	0.1	4.2	to	13.0	(18/18)	7.5 ± 2.2
	gamma-HCH	0.2	0	to	5.0	(16/18)	2.6 ± 1.4
	Mirex	2	0	to	7.0	(1/18)	0.4 ± 1.6
	trans-nonachlor	1	3	to	10.0	(18/18)	5.9 ± 2.0
	Oxychlordane	1	3	to	9.0	(18/18)	5.6 ± 1.7
	Toxaphene	10	0	to	80.0	(3/18)	11.1 ± 25.9
MCR2	Cis-chlordane	1	0	to	4.0	(2/4)	1.8 ± 2.1
	p,p'-DDE	0.5	0	to	21.0	(3/4)	7.7 ± 9.5
	p,p'-DDT	1	0	to	8.0	(3/4)	4.5 ± 4.1
	Dieldrin	1	0	to	3.0	(2/4)	1.3 ± 1.5
	Heptachlor epoxide	0.4	0	to	7.9	(3/4)	4.0 ± 3.7
	Hexachlorobenzene	0.1	0.8	to	2.1	(4/4)	1.5 ± 0.6
	Mirex	2	0	to	7.0	(2/4)	2.8 ± 3.4
	trans-nonachlor	1	0	to	2.0	(1/4)	0.5 ± 1.0
	Oxychlordane	1	0	to	10.0	(3/4)	5.0 ± 4.4
MCR	Cis-chlordane	1	0	to	2.0	(1/2)	1.0 ± 1.4
	p,p'-DDE	0.5	2.8	to	15.0	(2/2)	8.9 ± 8.6
	p,p'-DDT	1	2	to	5.0	(2/2)	3.5 ± 2.1
	Dieldrin	1	0	to	5.0	(1/2)	2.5 ± 3.5
	Heptachlor epoxide	0.4	2.4	to	4.3	(2/2)	3.4 ± 1.3
	Hexachlorobenzene	0.1	0.8	to	1.2	(2/2)	1.0 ± 0.3
	Mirex	2	2	to	16.0	(2/2)	9.0 ± 9.9
	Oxychlordane	1	0	to	7.0	(1/2)	3.5 ± 4.9
P	alpha-HCH	0.2	0	to	5.6	(1/2)	2.8 ± 4.0
	Cis-chlordane	1	1	to	2.0	(2/2)	1.5 ± 0.7
	p,p'-DDE	0.5	8	to	11.0	(2/2)	9.5 ± 2.1
	Dieldrin	1	1	to	9.0	(2/2)	5.0 ± 5.7
	Endosulfan Sulphate	2	0	to	9.0	(1/2)	4.5 ± 6.4
	Heptachlor epoxide	0.4	0.6	to	3.9	(2/2)	2.3 ± 2.3
	Hexachlorobenzene	0.1	0.8	to	3.5	(2/2)	2.2 ± 1.9
	gamma-HCH	0.2	0.2	to	4.2	(2/2)	2.2 ± 2.8
	trans-nonachlor	1	1	to	1.0	(2/2)	1.0 ± 0.0
	Oxychlordane	1	1	to	5.0	(2/2)	3.0 ± 2.8
PR1	alpha-HCH	0.2				(1/1)	1.7
	beta-HCH	0.2				(1/1)	0.3
	Cis-chlordane	1				(1/1)	12.0
	p,p'-DDE	0.5				(1/1)	33.0
	p,p'-DDT	1				(1/1)	1.0
	Dieldrin	1				(1/1)	2.0
	Endosulfan Sulphate	2				(1/1)	2.0
	Heptachlor epoxide	0.4				(1/1)	1.6
	Hexachlorobenzene	0.1				(1/1)	6.4

Location	Compound[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
	trans-nonachlor	1				(1/1)	13.0
	Oxychlordane	1				(1/1)	4.0
PR2	alpha-HCH	0.2	1.8	to	2.5	(1/1)	2.2 ± 0.5
	Cis-chlordane	1	6	to	10.0	(1/1)	8.0 ± 2.8
	p,p'-DDE	0.5	35	to	63.0	(1/1)	49.0 ± 19.8
	p,p'-DDT	1	0	to	2.0	(1/1)	1.0 ± 1.4
	Dieldrin	1	1	to	2.0	(1/1)	1.5 ± 0.7
	Heptachlor epoxide	0.4	1.7	to	2.1	(1/1)	1.9 ± 0.3
	Hexachlorobenzene	0.1	3.1	to	5.0	(1/1)	4.1 ± 1.3
	trans-nonachlor	1	4	to	7.0	(1/1)	5.5 ± 2.1
	Oxychlordane	1	3	to	4.0	(1/1)	3.5 ± 0.7
PR3	alpha-HCH	0.2	0	to	1.5	(1/2)	0.8 ± 1.1
	Cis-chlordane	1	0	to	2.0	(1/2)	1.0 ± 1.4
	p,p'-DDE	0.5	8.7	to	9.3	(2/2)	9.0 ± 0.4
	Dieldrin	1	0	to	2.0	(1/2)	1.0 ± 1.4
	Endosulfan I	1	0	to	3.0	(1/2)	1.5 ± 2.1
	Heptachlor epoxide	0.4	0	to	4.3	(1/2)	2.2 ± 3.0
	Hexachlorobenzene	0.1	0	to	0.8	(1/2)	0.4 ± 0.6
	gamma-HCH	0.2	0	to	1.3	(1/2)	0.7 ± 0.9
	trans-nonachlor	1	0	to	1.0	(1/2)	0.5 ± 0.7
	Oxychlordane	1	0	to	4.0	(1/2)	2.0 ± 2.8
SR1	alpha-HCH	0.2	1.2	to	4.0	(7/7)	2.3 ± 0.9
	Cis-chlordane	1	1	to	44.0	(7/7)	18.0 ± 16.6
	p,p'-DDE	0.5	0	to	77.0	(6/7)	25.3 ± 27.5
	Dieldrin	1	0	to	9.0	(6/7)	4.9 ± 3.9
	Endosulfan Sulphate	2	0	to	31.0	(5/7)	12.4 ± 11.8
	Heptachlor epoxide	0.4	0	to	7.4	(5/7)	3.5 ± 3.1
	Hexachlorobenzene	0.1	0.8	to	4.2	(7/7)	2.5 ± 1.0
	gamma-HCH	0.2	0	to	2.2	(6/7)	1.3 ± 0.7
	trans-nonachlor	1	2	to	18.0	(7/7)	6.4 ± 5.8
	Oxychlordane	1	0	to	7.0	(6/7)	3.6 ± 2.4
SR	alpha-HCH	0.2	0.4	to	8.1	(17/17)	3.1 ± 2.1
	beta-HCH	0.2	0	to	1.4	(1/17)	0.1 ± 0.3
	Cis-chlordane	1	0	to	50.0	(15/17)	12.8 ± 16.9
	p,p'-DDE	0.5	6.3	to	68.0	(17/17)	27.1 ± 15.9
	o,p'-DDT	1	0	to	10.0	(6/17)	1.9 ± 3.1
	p,p'-DDD	1	0	to	7.0	(5/17)	0.9 ± 1.9
	p,p'-DDT	1	0	to	9.0	(12/17)	3.2 ± 3.0
	Dieldrin	1	0	to	29.0	(16/17)	11.4 ± 7.1
	Endosulfan Sulphate	2	0	to	10.0	(9/17)	2.5 ± 3.0
	Endrin	1	0	to	46.0	(3/17)	3.1 ± 11.1
	Heptachlor epoxide	0.4	0	to	14.0	(15/17)	5.8 ± 4.6
	Hexachlorobenzene	0.1	5.4	to	20.0	(17/17)	13.1 ± 2.9
	gamma-HCH	0.2	0	to	3.9	(10/17)	0.7 ± 1.0
	Mirex	2	0	to	5.0	(5/17)	0.8 ± 1.5

Location	Compound[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
	trans-nonachlor	1	13	to	61.0	(17/17)	32.5 ± 14.0
	Oxychlordane	1	2	to	38.0	(17/17)	18.6 ± 10.2
	Toxaphene	10	0	to	110.0	(3/17)	12.4 ± 30.1
WAB1	alpha-HCH	0.2	0	to	6.0	(3/4)	2.8 ± 2.7
	Cis-chlordane	1	0	to	4.0	(2/4)	1.5 ± 1.9
	p,p'-DDE	0.5	2.8	to	22.0	(4/4)	10.5 ± 9.3
	p,p'-DDT	1	0	to	14.0	(2/4)	5.3 ± 6.7
	Dieldrin	1	0	to	18.0	(2/4)	5.3 ± 8.6
	Endosulfan Sulphate	2	0	to	8.0	(1/4)	2.0 ± 4.0
	Heptachlor epoxide	0.4	0	to	5.4	(3/4)	3.2 ± 2.4
	Hexachlorobenzene	0.1	0	to	2.8	(3/4)	1.7 ± 1.2
	gamma-HCH	0.2	0	to	7.6	(3/4)	2.9 ± 3.3
	trans-nonachlor	1	0	to	2.0	(1/4)	0.5 ± 1.0
	Oxychlordane	1	0	to	7.0	(3/4)	3.8 ± 3.3
	Toxaphene	10	0	to	80.0	(1/4)	20.0 ± 40.0
WR1	alpha-HCH	0.2	0.6	to	1.0	(2/2)	0.8 ± 0.3
	beta-HCH	0.2	0	to	1.0	(1/2)	0.5 ± 0.7
	p,p'-DDE	0.5	10	to	58.0	(2/2)	34.0 ± 33.9
	p,p'-DDD	1	0	to	1.0	(1/2)	0.5 ± 0.7
	Dieldrin	1	1	to	1.0	(2/2)	1.0 ± 0.0
	Endosulfan Sulphate	2	0	to	4.0	(1/2)	2.0 ± 2.8
	Heptachlor epoxide	0.4	2.4	to	3.5	(2/2)	3.0 ± 0.8
	Hexachlorobenzene	0.1	2.7	to	3.2	(2/2)	3.0 ± 0.4
	gamma-HCH	0.2	0.2	to	0.7	(2/2)	0.5 ± 0.4
	trans-nonachlor	1	2	to	9.0	(2/2)	5.5 ± 4.9
	Oxychlordane	1	4	to	5.0	(2/2)	4.5 ± 0.7
WR2	alpha-HCH	0.2	0.7	to	3.7	(8/8)	1.9 ± 1.2
	Cis-chlordane	1	0	to	29.0	(5/8)	11.1 ± 11.5
	p,p'-DDE	0.5	16	to	120.0	(8/8)	56.9 ± 36.2
	p,p'-DDD	1	0	to	3.0	(1/8)	0.4 ± 1.1
	p,p'-DDT	1	0	to	5.0	(2/8)	1.3 ± 2.3
	Dieldrin	1	0	to	17.0	(6/8)	4.1 ± 5.6
	Endosulfan I	1	0	to	2.0	(2/8)	0.5 ± 0.9
	Endosulfan Sulphate	2	0	to	33.0	(6/8)	6.6 ± 10.9
	Endrin	1	0	to	2.0	(1/8)	0.3 ± 0.7
	Heptachlor epoxide	0.4	0	to	8.2	(7/8)	3.6 ± 2.6
	Hexachlorobenzene	0.1	1.7	to	5.1	(8/8)	3.8 ± 1.1
	gamma-HCH	0.2	0	to	1.3	(6/8)	0.6 ± 0.5
	Mirex	2	0	to	2.0	(1/8)	0.3 ± 0.7
	trans-nonachlor	1	2	to	48.0	(8/8)	10.1 ± 15.6
	Oxychlordane	1	2	to	9.0	(8/8)	4.3 ± 2.7

[1] - Only organochlorines detected in at least one sample from each site are reported.

Table C5. Levels of PCBs (ng g^{-1} wet wt) in Burbot Livers, Fall 1994.

Location	Congener[1]	Detection Limit ng g^{-1}	Low High	# of Detects	Mean ± SD ng g^{-1}
A1	PCB 31	0.05	0 to 0.7	(1/7)	0.1 ± 0.3
	PCB 33	0.05	0 to 5.6	(5/7)	2.9 ± 2.3
	PCB 22	0.05	0 to 1.3	(1/7)	0.2 ± 0.5
	PCB 52	0.05	4.7 to 7.7	(7/7)	6.0 ± 1.3
	PCB 49	0.03	0 to 1.8	(3/7)	0.7 ± 0.9
	PCB 44	0.03	0 to 1.8	(5/7)	1.0 ± 0.7
	PCB 70/76	0.03	0 to 3.6	(6/7)	2.1 ± 1.1
	PCB 66/95	0.03	0 to 5.4	(2/7)	1.3 ± 2.2
	PCB 56/60	0.02	0 to 2.1	(4/7)	0.7 ± 0.8
	PCB 84	0.02	0 to 4.8	(4/7)	1.7 ± 1.9
	PCB 89	0.02	0 to 2.1	(2/7)	0.4 ± 0.8
	PCB 101	0.03	5.7 to 23.0	(7/7)	12.8 ± 6.1
	PCB 87	0.02	1.6 to 9.8	(7/7)	4.9 ± 3.0
	PCB 110	0.02	0 to 12.0	(6/7)	5.2 ± 4.2
	PCB 151	0.02	0 to 12.0	(6/7)	5.5 ± 4.1
	PCB 149	0.02	0 to 57.0	(4/7)	9.5 ± 21.1
	PCB 118	0.03	0 to 60.0	(6/7)	18.9 ± 20.7
	PCB 146	0.02	0 to 6.5	(5/7)	3.7 ± 2.7
	PCB 153	0.02	6.8 to 51.0	(7/7)	29.0 ± 17.0
	PCB 105	0.02	1.5 to 15.0	(7/7)	7.3 ± 5.6
	PCB 141	0.02	1.0 to 9.1	(7/7)	4.6 ± 3.1
	PCB 137	0.02	0 to 3.0	(5/7)	1.3 ± 1.2
	PCB 138	0.02	5.7 to 58.0	(7/7)	30.1 ± 20.4
	PCB 129	0.02	0 to 0.6	(2/7)	0.1 ± 0.3
	PCB 182/187	0.02	0.9 to 6.9	(7/7)	3.7 ± 2.3
	PCB 183	0.02	1.5 to 11.0	(7/7)	5.7 ± 3.6
	PCB 128	0.02	1.9 to 28.0	(7/7)	12.8 ± 9.9
	PCB 185	0.02	0 to 0.9	(2/7)	0.3 ± 0.4
	PCB 174	0.02	0 to 2.1	(3/7)	0.8 ± 1.0
	PCB 177	0.02	0 to 1.0	(2/7)	0.3 ± 0.4
	PCB 171/202	0.02	0 to 4.7	(4/7)	1.4 ± 1.9
	PCB 180	0.02	6 to 180.0	(7/7)	65.4 ± 63.5
	PCB 191	0.02	0 to 0.9	(2/7)	0.2 ± 0.4
	PCB 170	0.02	1.3 to 25.0	(7/7)	11.0 ± 9.2
	PCB 201	0.02	0 to 2.5	(2/7)	0.6 ± 1.0
	PCB 196/203	0.02	0 to 8.5	(5/7)	3.6 ± 3.3
	PCB 189	0.02	0 to 1.1	(2/7)	0.3 ± 0.5
	PCB 195/208	0.02	0 to 2.9	(3/7)	1.0 ± 1.3
	PCB 194	0.02	0 to 11.0	(6/7)	4.7 ± 3.9
	PCB 206	0.02	0 to 1.6	(2/7)	0.4 ± 0.7
	PCB - Total	1	58.0 to 560.0	(7/7)	260.0 ± 190.0
A2	PCB 15	0.3	0 to 2.8	(1/8)	0.4 ± 1.0

Location	Congener[1]	Detection Limit ng g^{-1}	Low to High	# of Detects	Mean ± SD ng g^{-1}
	PCB 31	0.05	0 to 1.1	(2/8)	0.2 ± 0.4
	PCB 33	0.05	0 to 6.0	(3/8)	1.0 ± 2.1
	PCB 22	0.05	0 to 1.0	(2/8)	0.2 ± 0.4
	PCB 52	0.05	1.3 to 7.1	(8/8)	3.0 ± 2.2
	PCB 49	0.03	0 to 1.2	(4/8)	0.3 ± 0.4
	PCB 44	0.03	0 to 1.3	(6/8)	0.5 ± 0.4
	PCB 70/76	0.03	0.38 to 2.8	(8/8)	1.4 ± 0.8
	PCB 66/95	0.03	0 to 3.4	(5/8)	1.5 ± 1.4
	PCB 56/60	0.02	0 to 1.3	(4/8)	0.3 ± 0.5
	PCB 84	0.02	0.76 to 3.2	(8/8)	1.7 ± 1.1
	PCB 89	0.02	0 to 1.1	(4/8)	0.3 ± 0.4
	PCB 101	0.03	0.9 to 15.0	(8/8)	6.9 ± 5.1
	PCB 87	0.02	0.65 to 4.9	(8/8)	2.7 ± 1.4
	PCB 110	0.02	1.2 to 5.0	(8/8)	2.9 ± 1.3
	PCB 151	0.02	1.4 to 8.3	(8/8)	4.6 ± 2.3
	PCB 149	0.02	0 to 4.2	(5/8)	1.4 ± 1.6
	PCB 118	0.03	1.8 to 31.0	(8/8)	13.9 ± 10.9
	PCB 146	0.02	0 to 4.8	(6/8)	2.2 ± 1.8
	PCB 153	0.02	5.2 to 44.0	(8/8)	20.3 ± 12.5
	PCB 105	0.02	0.82 to 7.8	(8/8)	3.7 ± 2.3
	PCB 141	0.02	0.87 to 5.1	(8/8)	2.6 ± 1.5
	PCB 137	0.02	0 to 1.6	(7/8)	0.9 ± 0.5
	PCB 138	0.02	3.7 to 37.0	(8/8)	18.3 ± 10.7
	PCB 129	0.02	0 to 0.1	(1/8)	0.0 ± 0.0
	PCB 182/187	0.02	0.28 to 3.7	(8/8)	2.1 ± 1.2
	PCB 183	0.02	0.76 to 7.6	(8/8)	3.8 ± 2.1
	PCB 128	0.02	1.8 to 14.0	(8/8)	8.1 ± 4.3
	PCB 185	0.02	0 to 0.4	(2/8)	0.1 ± 0.2
	PCB 174	0.02	0 to 1.2	(3/8)	0.4 ± 0.5
	PCB 177	0.02	0 to 0.5	(2/8)	0.1 ± 0.2
	PCB 171/202	0.02	0 to 2.4	(4/8)	0.9 ± 1.1
	PCB 180	0.02	2 to 86.0	(8/8)	34.5 ± 26.1
	PCB 191	0.02	0 to 0.2	(1/8)	0.0 ± 0.1
	PCB 170	0.02	0 to 11.0	(6/8)	3.8 ± 3.7
	PCB 196/203	0.02	0 to 3.8	(7/8)	1.9 ± 1.3
	PCB 189	0.02	0 to 0.3	(1/8)	0.0 ± 0.1
	PCB 195/208	0.02	0 to 1.5	(4/8)	0.5 ± 0.6
	PCB 194	0.02	0.54 to 7.4	(8/8)	3.3 ± 2.4
	PCB 206	0.02	0 to 1.3	(3/8)	0.4 ± 0.6
	PCB - Total	1	29 to 310.0	(8/8)	150.0 ± 90.5
	PCB 77	5	0 to 0.0	(1/8)	0.0 ± 0.0
	PCB 126	5	0 to 0.0	(0/8)	0.0 ± 0.0
A3	PCB 18	0.05	0 to 1.5	(2/9)	0.3 ± 0.6
	PCB 31	0.05	0 to 1.0	(3/9)	0.3 ± 0.4
	PCB 28	0.05	0 to 1.2	(1/9)	0.1 ± 0.4

Location	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
	PCB 33	0.05	0	to	4.2	(4/9)	1.1 ± 1.6
	PCB 52	0.05	1.7	to	5.2	(9/9)	3.7 ± 1.4
	PCB 49	0.03	0	to	1.6	(4/9)	0.4 ± 0.6
	PCB 44	0.03	0	to	1.8	(5/9)	0.6 ± 0.7
	PCB 70/76	0.03	0	to	3.2	(5/9)	1.2 ± 1.3
	PCB 66/95	0.03	0	to	4.2	(4/9)	1.1 ± 1.5
	PCB 56/60	0.02	0	to	2.0	(4/9)	0.6 ± 0.7
	PCB 84	0.02	0	to	5.5	(7/9)	2.0 ± 1.8
	PCB 89	0.02	0	to	1.5	(4/9)	0.4 ± 0.5
	PCB 101	0.03	3.9	to	17.0	(9/9)	9.0 ± 4.3
	PCB 87	0.02	0	to	6.5	(8/9)	3.1 ± 2.1
	PCB 110	0.02	0	to	9.5	(7/9)	3.8 ± 3.2
	PCB 151	0.02	0	to	12.0	(7/9)	5.7 ± 4.2
	PCB 149	0.02	0	to	37.5	(6/9)	7.4 ± 12.1
	PCB 118	0.03	0	to	17.0	(8/9)	10.4 ± 5.3
	PCB 146	0.02	0	to	5.6	(7/9)	2.9 ± 2.1
	PCB 153	0.02	10	to	43.0	(9/9)	26.3 ± 9.7
	PCB 105	0.02	0	to	7.6	(8/9)	3.9 ± 2.2
	PCB 141	0.02	1.3	to	4.9	(9/9)	3.1 ± 1.3
	PCB 137	0.02	0	to	1.8	(5/9)	0.7 ± 0.8
	PCB 138	0.02	1.7	to	35.0	(9/9)	21.2 ± 11.4
	PCB 129	0.02	0	to	0.1	(1/9)	0.0 ± 0.0
	PCB 183	0.02	2.5	to	8.3	(9/9)	5.2 ± 2.0
	PCB 128	0.02	5.6	to	18.0	(9/9)	10.6 ± 4.4
	PCB 185	0.02	0	to	0.8	(1/9)	0.1 ± 0.3
	PCB 174	0.02	0	to	1.9	(4/9)	0.6 ± 0.7
	PCB 177	0.02	0	to	1.0	(1/9)	0.1 ± 0.3
	PCB 171/202	0.02	0	to	4.3	(6/9)	1.8 ± 1.6
	PCB 180	0.02	18	to	74.5	(9/9)	42.3 ± 20.7
	PCB 191	0.02	0	to	2.0	(1/9)	0.2 ± 0.7
	PCB 170	0.02	3.7	to	14.5	(9/9)	8.2 ± 3.7
	PCB 201	0.02	0	to	1.7	(2/9)	0.3 ± 0.7
	PCB 196/203	0.02	1.6	to	6.1	(9/9)	3.4 ± 1.5
	PCB 189	0.02	0	to	1.2	(2/9)	0.2 ± 0.5
	PCB 195/208	0.02	0	to	2.3	(4/9)	0.7 ± 0.9
	PCB 194	0.02	1.7	to	7.2	(9/9)	3.6 ± 1.9
	PCB 206	0.02	0	to	2.0	(4/9)	0.5 ± 0.7
	PCB - Total	1	95	to	335.0	(9/9)	190.0 ± 83.8
	PCB 77	5	0	to	0.0	(1/9)	0.0 ± 0.0
A4	PCB 18	0.05	0	to	5.7	(3/10)	1.1 ± 2.0
	PCB 52	0.05	0	to	2.2	(6/10)	1.0 ± 0.9
	PCB 49	0.03	0	to	0.5	(1/10)	0.0 ± 0.1
	PCB 44	0.03	0	to	0.7	(5/10)	0.3 ± 0.3
	PCB 70/76	0.03	0	to	1.2	(6/10)	0.6 ± 0.5
	PCB 66/95	0.03	0	to	1.0	(1/10)	0.1 ± 0.3

Location	Congener[1]	Detection Limit ng g⁻¹	Low		High	# of Detects	Mean ± SD ng g⁻¹
	PCB 56/60	0.02	0	to	0.9	(2/10)	0.2 ± 0.3
	PCB 84	0.02	0	to	1.5	(6/10)	0.7 ± 0.6
	PCB 101	0.03	1.2	to	6.1	(10/10)	4.2 ± 1.6
	PCB 87	0.02	0	to	2.2	(6/10)	1.1 ± 1.0
	PCB 110	0.02	0	to	5.1	(8/10)	2.1 ± 1.6
	PCB 151	0.02	0	to	5.0	(9/10)	3.0 ± 1.5
	PCB 149	0.02	0	to	2.7	(7/10)	1.6 ± 1.2
	PCB 118	0.03	1.6	to	8.6	(10/10)	5.8 ± 1.8
	PCB 146	0.02	0	to	3.3	(8/10)	2.0 ± 1.2
	PCB 153	0.02	2.5	to	23.0	(10/10)	14.6 ± 5.5
	PCB 105	0.02	0	to	2.2	(7/10)	1.2 ± 0.9
	PCB 141	0.02	0	to	2.6	(7/10)	1.5 ± 1.1
	PCB 137	0.02	0	to	0.7	(5/10)	0.3 ± 0.4
	PCB 138	0.02	1.9	to	17.0	(10/10)	10.9 ± 4.5
	PCB 129	0.02	0	to	1.2	(2/10)	0.1 ± 0.4
	PCB 182/187	0.02	0	to	2.5	(7/10)	1.5 ± 1.1
	PCB 183	0.02	0	to	6.0	(8/10)	3.3 ± 1.5
	PCB 128	0.02	1.2	to	6.0	(10/10)	3.9 ± 1.5
	PCB 174	0.02	0	to	0.6	(3/10)	0.2 ± 0.3
	PCB 171/202	0.02	0	to	2.9	(7/10)	1.5 ± 1.1
	PCB 180	0.02	2.6	to	81.0	(10/10)	24.8 ± 21.3
	PCB 170	0.02	0	to	9.1	(9/10)	4.2 ± 2.4
	PCB 196/203	0.02	0	to	3.6	(6/10)	1.4 ± 1.3
	PCB 195/208	0.02	0	to	0.7	(1/10)	0.1 ± 0.2
	PCB 194	0.02	0	to	3.2	(6/10)	1.5 ± 1.3
	PCB 206	0.02	0	to	3.0	(2/10)	0.4 ± 0.9
	PCB - Total	1	17	to	130.0	(10/10)	95.0 ± 36.7
A5	PCB 18	1.3	0	to	5.6	(1/9)	0.9 ± 2.0
	PCB 52	8.3	0	to	2.0	(6/9)	0.7 ± 0.7
	PCB 66/95	13.3	0	to	1.8	(5/9)	0.6 ± 0.7
	PCB 56/60	14.3	0	to	0.6	(2/9)	0.1 ± 0.2
	PCB 84	15.3	0	to	0.3	(1/9)	0.0 ± 0.1
	PCB 101	17.3	1.3	to	6.1	(9/9)	3.2 ± 2.0
	PCB 87	18.3	0	to	1.6	(5/9)	0.5 ± 0.6
	PCB 110	20.3	0	to	7.9	(3/9)	0.9 ± 2.6
	PCB 151	21.3	0	to	3.6	(8/9)	1.6 ± 1.2
	PCB 149	22.3	0	to	0.7	(1/9)	0.1 ± 0.2
	PCB 118	23.3	1.95	to	11.0	(9/9)	5.1 ± 2.9
	PCB 146	24.3	0	to	1.2	(3/9)	0.3 ± 0.5
	PCB 153	25.3	4.4	to	21.0	(9/9)	10.1 ± 5.9
	PCB 105	26.3	0	to	2.1	(5/9)	0.8 ± 0.8
	PCB 141	27.3	0	to	1.5	(4/9)	0.5 ± 0.6
	PCB 138	29.3	2.75	to	14.0	(9/9)	6.7 ± 4.0
	PCB 182/187	31.3	0	to	1.7	(7/9)	0.7 ± 0.5
	PCB 183	32.3	1.05	to	3.8	(9/9)	1.9 ± 1.0

Location	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
	PCB 128	33.3	0	to	3.9	(8/9)	1.8 ± 1.3
	PCB 171/202	37.3	0	to	1.7	(7/9)	0.9 ± 0.6
	PCB 180	38.3	11	to	99.0	(9/9)	52.1 ± 30.0
	PCB 170	40.3	0	to	3.9	(8/9)	1.9 ± 1.2
	PCB 196/203	42.3	0	to	1.7	(6/9)	0.8 ± 0.7
	PCB 194	46.3	0	to	2.0	(6/9)	1.0 ± 0.8
	PCB 206	48.3	0	to	1.0	(2/9)	0.2 ± 0.4
	PCB 209	49.3	0	to	1.1	(1/9)	0.1 ± 0.4
	PCB - Total	50.3	29	to	180.0	(9/9)	94.0 ± 45.9
CW	PCB 151	0.02	0	to	2.7	(3/4)	1.8 ± 1.2
	PCB 153	0.02	1.7	to	2.9	(4/4)	2.5 ± 0.5
	PCB 138	0.02	1.1	to	1.6	(4/4)	1.3 ± 0.2
	PCB 180	0.02	0.88	to	2.2	(4/4)	1.6 ± 0.7
	PCB - Total	1	5	to	9.0	(4/4)	7.0 ± 1.8
LSV	PCB 18	0.05	0	to	14.0	(12/18)	4.6 ± 4.1
	PCB 28	0.05	0	to	2.3	(10/18)	0.8 ± 0.8
	PCB 33	0.05	0	to	0.8	(1/18)	0.0 ± 0.2
	PCB 52	0.05	0	to	4.4	(16/18)	2.4 ± 1.2
	PCB 49	0.03	0	to	1.5	(6/18)	0.3 ± 0.5
	PCB 44	0.03	0	to	1.2	(12/18)	0.4 ± 0.4
	PCB 70/76	0.03	0	to	1.7	(10/18)	0.6 ± 0.7
	PCB 66/95	0.03	0	to	1.7	(4/18)	0.3 ± 0.6
	PCB 56/60	0.02	0	to	1.2	(11/18)	0.5 ± 0.4
	PCB 84	0.02	0	to	1.4	(2/18)	0.1 ± 0.4
	PCB 89	0.02	0	to	0.5	(1/18)	0.0 ± 0.1
	PCB 101	0.03	2.2	to	7.5	(18/18)	4.2 ± 1.7
	PCB 87	0.02	0	to	3.1	(15/18)	1.3 ± 0.9
	PCB 110	0.02	0	to	3.5	(12/18)	1.5 ± 1.3
	PCB 151	0.02	2	to	7.6	(18/18)	4.0 ± 1.7
	PCB 149	0.02	0	to	3.4	(8/18)	0.8 ± 1.1
	PCB 118	0.03	2.1	to	14.0	(18/18)	7.0 ± 3.9
	PCB 146	0.02	0	to	2.2	(4/18)	0.5 ± 0.9
	PCB 153	0.02	5.1	to	29.0	(18/18)	14.8 ± 6.8
	PCB 105	0.02	0	to	3.2	(15/18)	1.5 ± 1.0
	PCB 141	0.02	0	to	3.2	(16/18)	1.7 ± 1.0
	PCB 137	0.02	0	to	1.7	(3/18)	0.2 ± 0.5
	PCB 138	0.02	3.7	to	20.0	(18/18)	10.5 ± 4.9
	PCB 129	0.02	0	to	0.3	(1/18)	0.0 ± 0.1
	PCB 182/187	0.02	0	to	2.3	(12/18)	0.9 ± 0.8
	PCB 183	0.02	0	to	5.4	(17/18)	3.0 ± 1.5
	PCB 128	0.02	0	to	6.0	(7/18)	1.7 ± 2.4
	PCB 174	0.02	0	to	1.8	(5/18)	0.4 ± 0.7
	PCB 171/202	0.02	0	to	2.9	(13/18)	1.2 ± 1.0
	PCB 180	0.02	1.5	to	43.0	(18/18)	16.2 ± 10.1
	PCB 170	0.02	0	to	6.5	(17/18)	3.3 ± 1.8

Location	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
	PCB 196/203	0.02	0	to	2.9	(15/18)	1.3 ± 1.0
	PCB 195/208	0.02	0	to	1.2	(1/18)	0.1 ± 0.3
	PCB 194	0.02	0	to	6.0	(15/18)	1.7 ± 1.4
	PCB 206	0.02	0	to	1.8	(1/18)	0.1 ± 0.4
	PCB - Total	1	31	to	140.0	(18/18)	88.3 ± 38.4
MCR2	PCB 18	0.05	0	to	17.0	(1/4)	4.3 ± 8.5
	PCB 52	0.05	0	to	5.5	(1/4)	1.4 ± 2.8
	PCB 101	0.03	0	to	5.3	(3/4)	2.6 ± 2.4
	PCB 151	0.02	0	to	2.5	(1/4)	0.6 ± 1.3
	PCB 149	0.02	0	to	2.3	(1/4)	0.6 ± 1.2
	PCB 118	0.03	0	to	11.0	(3/4)	5.4 ± 5.3
	PCB 146	0.02	0	to	2.5	(1/4)	0.6 ± 1.3
	PCB 153	0.02	0	to	17.0	(3/4)	8.0 ± 7.5
	PCB 137	0.02	0	to	3.3	(1/4)	0.8 ± 1.7
	PCB 138	0.02	0	to	17.0	(3/4)	7.5 ± 7.6
	PCB 183	0.02	0	to	6.6	(1/4)	1.7 ± 3.3
	PCB 128	0.02	0	to	5.5	(1/4)	1.4 ± 2.8
	PCB 180	0.02	0	to	43.0	(3/4)	17.2 ± 18.9
	PCB 170	0.02	0	to	3.6	(1/4)	0.9 ± 1.8
	PCB 194	0.02	0	to	5.3	(1/4)	1.3 ± 2.7
	PCB - Total	1	17.0	to	130.0	(4/4)	54.3 ± 53.3
	PCB 77	5	0	to	0.1	(1/4)	0.0 ± 0.0
	PCB 169	5	0	to	0.1	(1/4)	0.0 ± 0.0
MCR	PCB 101	0.03	1.3	to	2.6	(2/2)	2.0 ± 0.9
	PCB 118	0.03	3	to	8.6	(2/2)	5.8 ± 4.0
	PCB 153	0.02	6.6	to	12.0	(2/2)	9.3 ± 3.8
	PCB 138	0.02	4.1	to	6.7	(2/2)	5.4 ± 1.8
	PCB 183	0.02	0	to	1.4	(1/2)	0.7 ± 1.0
	PCB 128	0.02	0	to	0.9	(1/2)	0.4 ± 0.6
	PCB 180	0.02	11	to	16.0	(2/2)	13.5 ± 3.5
	PCB 170	0.02	0	to	2.1	(1/2)	1.1 ± 1.5
	PCB 196/203	0.02	0	to	1.4	(1/2)	0.7 ± 1.0
	PCB 194	0.02	0	to	2.7	(1/2)	1.4 ± 1.9
	PCB - Total	1	34	to	46.0	(2/2)	40.0 ± 8.5
P	PCB 52	0.05	0	to	1.2	(1/2)	0.6 ± 0.8
	PCB 66/95	0.03	0	to	0.8	(1/2)	0.4 ± 0.6
	PCB 101	0.03	1.3	to	3.1	(2/2)	2.2 ± 1.3
	PCB 110	0.02	0	to	0.8	(1/2)	0.4 ± 0.6
	PCB 149	0.02	0	to	0.8	(1/2)	0.4 ± 0.6
	PCB 118	0.03	1.2	to	5.9	(2/2)	3.6 ± 3.3
	PCB 146	0.02	0	to	1.4	(1/2)	0.7 ± 1.0
	PCB 153	0.02	3.4	to	16.0	(2/2)	9.7 ± 8.9
	PCB 138	0.02	2.1	to	9.5	(2/2)	5.8 ± 5.2
	PCB 183	0.02	0	to	3.1	(1/2)	1.6 ± 2.2

Location	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
	PCB 180	0.02	1.7	to	18.0	(2/2)	9.9 ± 11.5
	PCB 170	0.02	0	to	3.7	(1/2)	1.9 ± 2.6
	PCB 194	0.02	0	to	2.5	(1/2)	1.3 ± 1.8
	PCB - Total	1	13	to	63.0	(2/2)	38.0 ± 35.4
PR1	PCB 18	0.05				(1/1)	1.5
	PCB 28	0.05				(1/1)	0.9
	PCB 52	0.05				(1/1)	4.0
	PCB 49	0.03				(1/1)	1.3
	PCB 44	0.03				(1/1)	1.5
	PCB 70/76	0.03				(1/1)	2.6
	PCB 66/95	0.03				(1/1)	3.0
	PCB 56/60	0.02				(1/1)	0.9
	PCB 84	0.02				(1/1)	2.5
	PCB 89	0.02				(1/1)	0.7
	PCB 101	0.03				(1/1)	12.0
	PCB 87	0.02				(1/1)	4.7
	PCB 110	0.02				(1/1)	5.6
	PCB 151	0.02				(1/1)	12.0
	PCB 118	0.03				(1/1)	20.0
	PCB 146	0.02				(1/1)	3.1
	PCB 153	0.02				(1/1)	20.0
	PCB 105	0.02				(1/1)	5.0
	PCB 141	0.02				(1/1)	2.5
	PCB 137	0.02				(1/1)	1.7
	PCB 138	0.02				(1/1)	21.0
	PCB 182/187	0.02				(1/1)	1.3
	PCB 183	0.02				(1/1)	3.3
	PCB 128	0.02				(1/1)	17.0
	PCB 180	0.02				(1/1)	25.0
	PCB 170	0.02				(1/1)	3.2
	PCB 196/203	0.02				(1/1)	1.3
	PCB - Total	1				(1/1)	180.0
	PCB 77	5				(1/1)	6.0
	PCB 169	5				(1/1)	14.0
PR2	PCB 31	0.05	0.3	to	0.4	(1/1)	0.4 ± 0.1
	PCB 28	0.05	0.3	to	0.4	(1/1)	0.4 ± 0.1
	PCB 33	0.05	0.4	to	0.6	(1/1)	0.5 ± 0.1
	PCB 52	0.05	1.2	to	2.1	(1/1)	1.7 ± 0.6
	PCB 49	0.03	0.7	to	1.0	(1/1)	0.9 ± 0.2
	PCB 44	0.03	0.6	to	1.0	(1/1)	0.8 ± 0.3
	PCB 70/76	0.03	0.7	to	1.6	(1/1)	1.2 ± 0.6
	PCB 66/95	0.03	1.6	to	2.7	(1/1)	2.2 ± 0.8
	PCB 56/60	0.02	0.4	to	0.6	(1/1)	0.5 ± 0.1
	PCB 84	0.02	0.9	to	1.6	(1/1)	1.3 ± 0.5

Location	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
	PCB 89	0.02	0	to	0.6	(1/1)	0.3 ± 0.4
	PCB 101	0.03	5.2	to	8.8	(1/1)	7.0 ± 2.5
	PCB 87	0.02	2.2	to	4.0	(1/1)	3.1 ± 1.3
	PCB 110	0.02	2.2	to	4.7	(1/1)	3.5 ± 1.8
	PCB 151	0.02	3.7	to	7.0	(1/1)	5.4 ± 2.3
	PCB 118	0.03	15	to	27.0	(1/1)	21.0 ± 8.5
	PCB 146	0.02	1.8	to	3.1	(1/1)	2.5 ± 0.9
	PCB 153	0.02	16	to	28.0	(1/1)	22.0 ± 8.5
	PCB 105	0.02	3	to	6.1	(1/1)	4.6 ± 2.2
	PCB 141	0.02	1.2	to	2.3	(1/1)	1.8 ± 0.8
	PCB 137	0.02	1.1	to	2.1	(1/1)	1.6 ± 0.7
	PCB 138	0.02	16	to	28.0	(1/1)	22.0 ± 8.5
	PCB 182/187	0.02	1	to	2.0	(1/1)	1.5 ± 0.7
	PCB 183	0.02	2.5	to	5.0	(1/1)	3.8 ± 1.8
	PCB 128	0.02	6.9	to	13.0	(1/1)	10.0 ± 4.3
	PCB 174	0.02	0	to	0.4	(1/1)	0.2 ± 0.3
	PCB 180	0.02	16	to	30.0	(1/1)	23.0 ± 9.9
	PCB 191	0.02	0	to	0.3	(1/1)	0.2 ± 0.2
	PCB 170	0.02	3.4	to	6.8	(1/1)	5.1 ± 2.4
	PCB 196/203	0.02	1.2	to	2.2	(1/1)	1.7 ± 0.7
	PCB 189	0.02	0	to	0.4	(1/1)	0.2 ± 0.3
	PCB 195/208	0.02	0	to	0.3	(1/1)	0.2 ± 0.2
	PCB 194	0.02	1	to	2.3	(1/1)	1.7 ± 0.9
	PCB 205	0.02	0	to	0.6	(1/1)	0.3 ± 0.4
	PCB 206	0.02	0.3	to	1.7	(1/1)	1.0 ± 1.0
	PCB - Total	1	110	to	200.0	(1/1)	160.0 ± 63.6
PR3	PCB 18	0.05	4.6	to	59.0	(2/2)	31.8 ± 38.5
	PCB 101	0.03	0	to	1.1	(1/2)	0.6 ± 0.8
	PCB 151	0.02	0	to	1.7	(1/2)	0.9 ± 1.2
	PCB 118	0.03	2.2	to	6.0	(2/2)	4.1 ± 2.7
	PCB 153	0.02	4	to	5.1	(2/2)	4.6 ± 0.8
	PCB 138	0.02	3.2	to	3.7	(2/2)	3.5 ± 0.4
	PCB 183	0.02	0	to	1.2	(1/2)	0.6 ± 0.8
	PCB 128	0.02	0	to	1.3	(1/2)	0.7 ± 0.9
	PCB 180	0.02	0	to	1.8	(1/2)	0.9 ± 1.3
	PCB - Total	1	23	to	72.0	(2/2)	47.5 ± 34.6
SR1	PCB 18	0.05	0	to	8.4	(1/7)	1.2 ± 3.2
	PCB 31	0.05	0	to	0.9	(1/7)	0.1 ± 0.3
	PCB 33	0.05	0	to	2.3	(3/7)	0.7 ± 1.0
	PCB 52	0.05	3.3	to	14.0	(7/7)	7.9 ± 4.0
	PCB 49	0.03	0	to	3.5	(6/7)	1.8 ± 1.1
	PCB 44	0.03	0	to	2.8	(6/7)	1.6 ± 0.9
	PCB 70/76	0.03	0	to	5.2	(6/7)	2.7 ± 1.6
	PCB 66/95	0.03	0	to	8.4	(6/7)	4.6 ± 2.7
	PCB 56/60	0.02	0	to	0.3	(1/7)	0.0 ± 0.1

Location	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
	PCB 84	0.02	0	to	14.0	(6/7)	5.8 ± 4.8
	PCB 89	0.02	0	to	0.4	(1/7)	0.1 ± 0.2
	PCB 101	0.03	10	to	57.0	(7/7)	27.1 ± 17.0
	PCB 87	0.02	4.5	to	21.0	(7/7)	10.7 ± 5.9
	PCB 85	0.02	0	to	13.0	(1/7)	1.9 ± 4.9
	PCB 110	0.02	0.6	to	15.0	(7/7)	8.6 ± 5.0
	PCB 151	0.02	0	to	9.6	(0/7)	4.3 ± 3.1
	PCB 149	0.02	0	to	5.6	(2/7)	1.3 ± 2.3
	PCB 118	0.03	17	to	290.0	(7/7)	81.4 ± 96.2
	PCB 146	0.02	2.3	to	13.0	(7/7)	5.9 ± 3.8
	PCB 153	0.02	20	to	150.0	(7/7)	56.3 ± 45.9
	PCB 105	0.02	5.3	to	64.0	(7/7)	20.4 ± 20.5
	PCB 141	0.02	2.3	to	16.0	(7/7)	6.4 ± 4.8
	PCB 137	0.02	0	to	16.0	(6/7)	5.2 ± 5.3
	PCB 138	0.02	23	to	180.0	(7/7)	67.0 ± 55.5
	PCB 129	0.02	0	to	2.2	(4/7)	0.9 ± 1.0
	PCB 182/187	0.02	0	to	2.4	(5/7)	1.1 ± 0.9
	PCB 183	0.02	0	to	13.0	(6/7)	4.5 ± 4.2
	PCB 128	0.02	6.4	to	64.0	(7/7)	21.1 ± 20.1
	PCB 185	0.02	0	to	1.3	(1/7)	0.2 ± 0.5
	PCB 180	0.02	8.8	to	67.0	(7/7)	24.1 ± 19.6
	PCB 191	0.02	0	to	21.0	(1/7)	3.0 ± 7.9
	PCB 170	0.02	3.4	to	30.0	(7/7)	10.2 ± 9.5
	PCB 201	0.02	0	to	2.3	(1/7)	0.3 ± 0.9
	PCB 196/203	0.02	0	to	4.3	(4/7)	1.2 ± 1.5
	PCB 189	0.02	0	to	1.6	(1/7)	0.2 ± 0.6
	PCB 194	0.02	0	to	4.1	(5/7)	1.5 ± 1.4
	PCB - Total	1	110	to	1100.0	(7/7)	390.0 ± 340.0
	PCB 77	5	0	to	0.0	(2/7)	0.0 ± 0.0
SR	PCB 18	0.05	0	to	3.9	(6/17)	0.8 ± 1.3
	PCB 31	0.05	0	to	1.0	(8/17)	0.3 ± 0.3
	PCB 28	0.05	0	to	1.4	(7/17)	0.3 ± 0.5
	PCB 52	0.05	1.5	to	3.9	(17/17)	2.4 ± 0.6
	PCB 49	0.03	0	to	1.5	(15/17)	0.9 ± 0.4
	PCB 44	0.03	0	to	1.6	(14/17)	0.8 ± 0.5
	PCB 70/76	0.03	0	to	2.0	(14/17)	0.9 ± 0.6
	PCB 66/95	0.03	0	to	5.1	(15/17)	2.3 ± 1.2
	PCB 56/60	0.02	0	to	2.3	(3/17)	0.4 ± 0.8
	PCB 84	0.02	0.97	to	3.1	(17/17)	1.8 ± 0.5
	PCB 89	0.02	0	to	2.5	(14/17)	1.3 ± 0.8
	PCB 101	0.03	2.7	to	9.9	(17/17)	5.4 ± 1.8
	PCB 87	0.02	0	to	3.7	(16/17)	1.9 ± 0.8
	PCB 110	0.02	2.4	to	6.3	(17/17)	4.4 ± 1.3
	PCB 151	0.02	13	to	63.0	(17/17)	35.6 ± 12.0
	PCB 149	0.02	0	to	7.6	(16/17)	2.9 ± 1.5

Location	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
	PCB 118	0.03	1.6	to	9.9	(17/17)	5.0 ± 2.5
	PCB 146	0.02	0	to	8.4	(15/17)	3.1 ± 2.3
	PCB 153	0.02	5.4	to	41.0	(17/17)	15.0 ± 8.6
	PCB 105	0.02	0	to	3.0	(12/17)	1.1 ± 1.0
	PCB 141	0.02	0	to	2.0	(16/17)	1.0 ± 0.5
	PCB 137	0.02	0	to	2.6	(3/17)	0.4 ± 1.0
	PCB 138	0.02	3.5	to	22.0	(17/17)	9.7 ± 4.6
	PCB 129	0.02	0	to	1.5	(4/17)	0.2 ± 0.4
	PCB 182/187	0.02	0	to	4.7	(17/17)	2.0 ± 1.1
	PCB 183	0.02	0	to	14.0	(16/17)	5.4 ± 3.1
	PCB 128	0.02	13	to	92.0	(17/17)	39.2 ± 20.6
	PCB 185	0.02	0	to	4.5	(1/17)	0.3 ± 1.1
	PCB 174	0.02	0	to	2.1	(2/17)	0.2 ± 0.5
	PCB 171/202	0.02	0	to	2.3	(12/17)	1.0 ± 0.7
	PCB 180	0.02	1.1	to	9.7	(17/17)	3.9 ± 2.1
	PCB 170	0.02	0	to	3.1	(12/17)	1.0 ± 0.8
	PCB 196/203	0.02	0	to	1.7	(10/17)	0.5 ± 0.5
	PCB 207	0.02	0	to	2.2	(2/17)	0.2 ± 0.6
	PCB 194	0.02	0	to	5.2	(3/17)	0.4 ± 1.3
	PCB - Total	1	67	to	280.0	(17/17)	150.0 ± 51.7
	PCB 77	5	0	to	0.1	(2/17)	0.0 ± 0.0
	PCB 169	5	0	to	0.0	(1/17)	0.0 ± 0.0
WAB1	PCB 18	0.05	0	to	12.0	(1/4)	3.0 ± 6.0
	PCB 49	0.03	0	to	5.4	(1/4)	1.4 ± 2.7
	PCB 101	0.03	0	to	5.3	(2/4)	1.7 ± 2.5
	PCB 151	0.02	0	to	2.1	(1/4)	0.5 ± 1.1
	PCB 118	0.03	0	to	4.8	(1/4)	1.2 ± 2.4
	PCB 153	0.02	1.5	to	7.9	(4/4)	3.6 ± 2.9
	PCB 138	0.02	0	to	5.9	(3/4)	2.6 ± 2.5
	PCB 180	0.02	0	to	5.1	(2/4)	2.1 ± 2.5
	PCB - Total	1	4	to	37.0	(4/4)	16.3 ± 14.4
WR1	PCB 22	0.05	0	to	1.2	(1/2)	0.6 ± 0.8
	PCB 52	0.05	2.4	to	8.8	(2/2)	5.6 ± 4.5
	PCB 49	0.03	0	to	2.5	(1/2)	1.3 ± 1.8
	PCB 44	0.03	0.76	to	1.8	(2/2)	1.3 ± 0.7
	PCB 70/76	0.03	1.3	to	3.1	(2/2)	2.2 ± 1.3
	PCB 66/95	0.03	1.4	to	4.2	(2/2)	2.8 ± 2.0
	PCB 84	0.02	1.5	to	7.7	(2/2)	4.6 ± 4.4
	PCB 89	0.02	0	to	0.5	(1/2)	0.3 ± 0.4
	PCB 101	0.03	7.5	to	32.0	(2/2)	19.8 ± 17.3
	PCB 87	0.02	3.1	to	12.0	(2/2)	7.6 ± 6.3
	PCB 110	0.02	3.9	to	8.9	(2/2)	6.4 ± 3.5
	PCB 151	0.02	2.2	to	4.2	(2/2)	3.2 ± 1.4
	PCB 149	0.02	0	to	1.8	(1/2)	0.9 ± 1.3
	PCB 118	0.03	10	to	64.0	(2/2)	37.0 ± 38.2

Location	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
	PCB 146	0.02	2.2	to	4.5	(2/2)	3.4 ± 1.6
	PCB 153	0.02	13	to	53.0	(2/2)	33.0 ± 28.3
	PCB 105	0.02	3.2	to	22.0	(2/2)	12.6 ± 13.3
	PCB 141	0.02	2.2	to	6.1	(2/2)	4.2 ± 2.8
	PCB 137	0.02	0.9	to	5.3	(2/2)	3.1 ± 3.1
	PCB 138	0.02	13	to	61.0	(2/2)	37.0 ± 33.9
	PCB 129	0.02	0	to	1.4	(1/2)	0.7 ± 1.0
	PCB 182/187	0.02	0.65	to	0.8	(2/2)	0.7 ± 0.1
	PCB 183	0.02	2.1	to	5.3	(2/2)	3.7 ± 2.3
	PCB 128	0.02	4	to	18.0	(2/2)	11.0 ± 9.9
	PCB 180	0.02	15	to	87.0	(2/2)	51.0 ± 50.9
	PCB 170	0.02	2	to	8.5	(2/2)	5.3 ± 4.6
	PCB 196/203	0.02	0	to	1.8	(1/2)	0.9 ± 1.3
	PCB 194	0.02	0	to	2.3	(1/2)	1.2 ± 1.6
	PCB - Total	1	94	to	430.0	(2/2)	260.0 ± 240.0
WR2	PCB 18	0.05	0	to	4.6	(4/8)	1.7 ± 2.0
	PCB 31	0.05	0	to	10.0	(2/8)	1.8 ± 3.6
	PCB 28	0.05	0	to	3.6	(6/8)	1.9 ± 1.4
	PCB 33	0.05	0	to	1.9	(1/8)	0.2 ± 0.7
	PCB 22	0.05	0	to	1.2	(1/8)	0.2 ± 0.4
	PCB 52	0.05	3.8	to	15.0	(8/8)	10.0 ± 3.3
	PCB 49	0.03	1.6	to	3.9	(8/8)	3.0 ± 0.7
	PCB 44	0.03	1.2	to	4.4	(8/8)	3.2 ± 1.1
	PCB 70/76	0.03	3	to	8.7	(8/8)	6.8 ± 1.8
	PCB 66/95	0.03	3.6	to	9.6	(8/8)	7.7 ± 2.1
	PCB 56/60	0.02	0	to	2.1	(4/8)	0.7 ± 0.8
	PCB 84	0.02	0	to	8.2	(7/8)	4.5 ± 2.6
	PCB 89	0.02	0	to	0.9	(4/8)	0.4 ± 0.4
	PCB 101	0.03	0	to	34.0	(7/8)	23.3 ± 11.9
	PCB 87	0.02	5.7	to	16.0	(8/8)	11.8 ± 3.5
	PCB 110	0.02	5.4	to	17.0	(8/8)	13.6 ± 3.6
	PCB 151	0.02	2	to	6.3	(8/8)	4.4 ± 1.5
	PCB 149	0.02	0	to	6.9	(5/8)	3.0 ± 2.9
	PCB 118	0.03	20	to	75.0	(8/8)	41.9 ± 15.7
	PCB 146	0.02	2.7	to	6.7	(8/8)	4.1 ± 1.5
	PCB 153	0.02	16	to	51.0	(8/8)	32.8 ± 13.4
	PCB 105	0.02	6.3	to	20.0	(8/8)	12.0 ± 4.5
	PCB 141	0.02	2.1	to	6.4	(8/8)	3.8 ± 1.5
	PCB 137	0.02	1.1	to	3.7	(8/8)	2.2 ± 0.9
	PCB 138	0.02	19	to	63.0	(8/8)	38.3 ± 13.8
	PCB 129	0.02	0	to	1.7	(5/8)	0.7 ± 0.7
	PCB 182/187	0.02	0.8	to	2.9	(8/8)	1.4 ± 0.7
WR2	PCB 183	0.02	1.5	to	5.4	(8/8)	3.2 ± 1.4
	PCB 128	0.02	4.9	to	17.0	(8/8)	9.3 ± 3.9
	PCB 174	0.02	0	to	2.9	(4/8)	0.7 ± 1.0

Location	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
	PCB 171/202	0.02	0	to	8.8	(4/8)	3.0 ± 3.6
	PCB 180	0.02	36	to	380.0	(8/8)	160.0 ± 140.0
	PCB 170	0.02	2.4	to	8.6	(8/8)	4.7 ± 2.0
	PCB 196/203	0.02	0	to	3.6	(3/8)	0.8 ± 1.3
	PCB 194	0.02	0	to	3.8	(4/8)	0.9 ± 1.3
	PCB - Total	1	180	to	700.0	(8/8)	420.0 ± 180.0
	PCB 77	5	0	to	0.2	(4/8)	0.1 ± 0.1
	PCB 126	5	0	to	0.3	(1/8)	0.0 ± 0.1

[1] - Only PCB congeners detected in at least one sample from each site are reported.

Appendix C6. Pearson Correlation Coefficients for PCBs, ΣDDT and lipid in burbot liver - 1992 collection

		log ΣPC ng g^{-1}	log CB153 ng g^{-1}	log ΣDDT ng g^{-1}	ΣPCB ng g^{-1}	ΣDDT ng g^{-1}	CB153 ng g^{-1}	Lipid (%)
log ΣPCB	r	-	0.714	0.313	0.678	0.274	0.628	0.243
	Prob	-	0.0001	0.002	0.0001	0.0071	0.0001	0.0528
	N	-	95	95	95	95	95	64
log CB153	r	0.714	-	0.511	0.614	0.313	0.672	0.176
	Prob	0.0001	-	0.0001	0.0001	0.002	0.0001	0.1632
	N	95	-	95	95	95	95	64
log ΣDDT	r	0.313	0.511	-	0.264	0.598	0.346	0.296
	Prob	0.002	0.0001	-	0.0097	0.0001	0.0006	0.0178
	N	95	95	-	95	95	95	64
ΣPCB	r	0.678	0.614	0.264	-	0.263	0.950	0.212
	Prob	0.0001	0.0001	0.0097	-	0.0101	0.0001	0.0922
	N	95	95	95	-	95	95	64
ΣDDT	r	0.274	0.313	0.598	0.263	-	0.392	0.020
	Prob	0.0071	0.002	0.0001	0.0101	-	0.0001	0.8768
	N	95	95	95	95	-	95	64
CB153	r	0.628	0.672	0.346	0.950	0.392	-	0.185
	Prob	0.0001	0.0001	0.0006	0.0001	0.0001	-	0.1439
	N	95	95	95	95	95	-	64
Lipid (%)	r	0.243	0.176	0.296	0.212	0.020	0.185	-
	Prob	0.0528	0.1632	0.0178	0.0922	0.8768	0.1439	-
	N	64	64	64	64	64	64	-

Appendix C7. Pearson correlation coefficients for DDT and PCB related compounds in burbot liver (1994) with age, % lipid, length and weight[a]

Compounds		ΣPCB	CB52	CB153	p,p'-DDE	ΣDDT	Age	Lipid (%)	Length	Weight
Units		ng g^{-1}	ng g^{-1}	ng g^{-1}	ng g^{-1}	ng g^{-1}	(yrs)		(cm)	(g)
ΣPCB	r	-	0.754	0.901	0.618	0.590	0.161	0.482	0.124	0.122
	Prob	-	0.0001	0.0001	0.0001	0.0001	0.0608	0.0001	0.1475	0.1533
	N	-	122	151	152	152	137	145	139	139
CB52	r	0.754	-	0.764	0.218	0.197	-0.095	0.366	-0.345	-0.417
	Prob	0.0001	-	0.0001	0.0158	0.0295	0.3221	0.0001	0.0002	0.0001
	N	122	-	122	122	122	111	117	113	113
CB153	r	0.901	0.764	-	0.615	0.595	0.183	0.542	0.099	0.048
	Prob	0.0001	0.0001	-	0.0001	0.0001	0.0325	0.0001	0.2487	0.5724
	N	151	122	-	151	151	136	144	138	138
p,p'-DDE	r	0.618	0.218	0.615	-	0.978	0.286	0.319	0.319	0.323
	Prob	0.0001	0.0158	0.0001	-	0.0001	0.0007	0.0001	0.0001	0.0001
	N	152	122	151	-	152	137	145	139	139
ΣDDT	r	0.590	0.197	0.595	0.978	-	0.264	0.320	0.331	0.331
	Prob	0.0001	0.0295	0.0001	0.0001	-	0.0018	0.0001	0.0001	0.0001
	N	152	122	151	152	-	137	145	139	139
Age	r	0.161	-0.095	0.183	0.286	0.264	-	0.076	0.524	0.569
	Prob	0.0608	0.3221	0.0325	0.0007	0.0018	-	0.3821	0.0001	0.0001
	N	137	111	136	137	137	-	134	137	136
Lipid (%)	r	0.482	0.366	0.542	0.319	0.320	0.076	-	0.072	0.082
	Prob	0.0001	0.0001	0.0001	0.0001	0.0001	0.3821	-	0.4048	0.3445
	N	145	117	144	145	145	134	-	136	136
Length	r	0.124	-0.345	0.099	0.319	0.331	0.524	0.072	-	0.935
	Prob	0.1475	0.0002	0.2487	0.0001	0.0001	0.0001	0.4048	-	0.0001
	N	139	113	138	139	139	137	136	-	138
Weight	r	0.122	-0.417	0.048	0.323	0.331	0.569	0.082	0.935	-
	Prob	0.1533	0.0001	0.5724	0.0001	0.0001	0.0001	0.3445	0.0001	-
	N	139	113	138	139	139	136	136	138	-

[a] All parameters are $\log_{10}$ transformed except for % lipid

Table D1. Levels of OC pesticides (ng g^{-1} wet wt) in Long nose sucker liver from downstream of Hinton, Spring 1992.

Compound	Detection limit ng g^{-1}	N	Low High	Mean[a] ± SD ng g^{-1}
Aldrin	0.20	22	0 to 0.05	0.043 ± 0.018
alpha-HCH	0.20	22	0 to 0.25	0.055 ± 0.046
beta-HCH	0.20	22	0 to 0.05	0.043 ± 0.018
gamma-HCH	0.20	22	0 to 0.05	0.043 ± 0.018
Cis-chlordane	1.00	22	0 to 0.05	0.043 ± 0.018
Trans-chlordane	1.00	22	0 to 0.05	0.043 ± 0.018
trans-nonachlor	1.00	22	0 to 3.5	0.468 ± 0.912
Oxychlordane	1.00	22	0 to 0.05	0.043 ± 0.018
Heptachlor	0.20	22	0 to 0.4	0.102 ± 0.134
Heptachlor epoxide	0.40	22	0 to 0.1	0.086 ± 0.035
p,p'- DDE	0.50	22	0 to 4.7	1.043 ± 1.093
p,p'-DDD	1.00	22	0 to 2	0.175 ± 0.456
p,p'-DDT	1.00	22	0 to 6	0.402 ± 1.318
o,p'-DDT	1.00	22	0 to 0.05	0.043 ± 0.018
Dieldrin	1.00	22	0 to 0.05	0.043 ± 0.018
Endosulfan I	1.00	22	0 to 0.05	0.043 ± 0.018
Endosulfan II	1.00	22	0 to 0.05	0.043 ± 0.018
Endosulfan Sulphate	2.00	22	0 to 0.1	0.086 ± 0.035
Endrin	1.00	22	0 to 0.05	0.043 ± 0.018
Hexachlorobenzene	0.10	22	0.1 to 1.1	0.325 ± 0.211
Methoxychlor	2.00	22	0 to 0.1	0.086 ± 0.035
Mirex	2.00	22	0 to 0.1	0.086 ± 0.035
Toxaphene	0.01	19	1 to 40	7.0 ± 11.3

[a] - Mean concentrations calculated using half-detection limit for non-detects. This results in means lower than detection limit where almost all samples are at the detection limit.

Table D2. Levels of PCB congeners including non-ortho PCBs (ng g^{-1} wet wt) in Long nose sucker liver from downstream of Hinton, Spring 1992.

Congener	Detection limit (ng g^{-1})	N	Low		High	Mean[a] ± SD ng g^{-1}
PCB 5/8	0.30	22	0.00	to	0.15	0.13 ± 0.05
PCB 18	0.05	22	0.00	to	0.03	0.02 ± 0.01
PCB 15	0.30	22	0.00	to	0.15	0.13 ± 0.05
PCB 16/32	0.05	22	0.00	to	0.03	0.02 ± 0.01
PCB 31	0.05	22	0.00	to	0.03	0.02 ± 0.01
PCB 28	0.05	22	0.00	to	0.42	0.14 ± 0.13
PCB 33	0.05	22	0.00	to	0.25	0.03 ± 0.05
PCB 22	0.05	22	0.00	to	0.84	0.35 ± 0.28
PCB 52	0.05	22	0.00	to	0.47	0.10 ± 0.12
PCB 49	0.03	22	0.00	to	0.69	0.13 ± 0.16
PCB 44	0.03	22	0.00	to	4.40	0.40 ± 0.90
PCB 40	0.03	22	0.00	to	0.10	0.04 ± 0.04
PCB 70/76	0.03	22	0.02	to	1.60	0.44 ± 0.39
PCB 66/95	0.03	22	0.00	to	0.02	0.01 ± 0.01
PCB 56/60	0.02	22	0.00	to	0.27	0.08 ± 0.08
PCB 84	0.02	22	0.00	to	0.41	0.10 ± 0.13
PCB 89	0.02	22	0.00	to	0.38	0.14 ± 0.11
PCB 101	0.03	22	0.25	to	2.30	0.94 ± 0.48
PCB 87	0.02	22	0.10	to	1.00	0.47 ± 0.25
PCB 85	0.02	22	0.00	to	0.01	0.01 ± 0.00
PCB 110	0.02	22	0.01	to	1.25	0.46 ± 0.43
PCB 118	0.03	22	0.02	to	4.90	1.58 ± 1.32
PCB 105	0.02	22	0.00	to	0.49	0.17 ± 0.17
PCB 151	0.02	22	0.05	to	0.67	0.33 ± 0.15
PCB 149	0.02	22	0.00	to	0.74	0.24 ± 0.26
PCB 146	0.02	22	0.00	to	0.60	0.15 ± 0.16
PCB 153	0.02	22	0.55	to	9.10	2.45 ± 1.96
PCB 141	0.02	22	0.00	to	0.72	0.25 ± 0.18
PCB 137	0.02	22	0.00	to	0.36	0.08 ± 0.09
PCB 138	0.02	22	0.42	to	7.30	1.99 ± 1.58
PCB 129	0.02	22	0.00	to	0.74	0.30 ± 0.21
PCB 128	0.02	22	0.04	to	1.10	0.37 ± 0.24
PCB 182/187	0.02	22	0.01	to	3.30	0.83 ± 0.75
PCB 183	0.02	22	0.01	to	1.70	0.49 ± 0.42
PCB 185	0.02	22	0.00	to	0.36	0.09 ± 0.10
PCB 174	0.02	22	0.00	to	0.96	0.27 ± 0.21
PCB 177	0.02	22	0.01	to	2.00	0.91 ± 0.58
PCB 171/202	0.02	22	0.00	to	1.10	0.12 ± 0.23
PCB 180	0.02	22	0.01	to	8.20	1.53 ± 1.77
PCB 170	0.02	22	0.14	to	3.10	0.72 ± 0.69
PCB 191	0.02	22	0.00	to	0.17	0.02 ± 0.03
PCB 201	0.02	22	0.01	to	3.70	1.24 ± 0.92
PCB 196/203	0.02	22	0.00	to	1.40	0.26 ± 0.31

Congener	Detection limit (ng g^{-1})	N	Low		High	Mean[a] ± SD ng g^{-1}
PCB 189	0.02	22	0.00	to	0.16	0.02 ± 0.04
PCB 195/208	0.02	22	0.00	to	0.95	0.11 ± 0.24
PCB 194	0.02	22	0.00	to	1.40	0.25 ± 0.31
PCB 207	0.02	22	0.00	to	0.26	0.06 ± 0.08
PCB 205	0.02	22	0.00	to	0.23	0.03 ± 0.06
PCB 206	0.02	22	0.00	to	0.27	0.04 ± 0.07
PCB 209	0.02	22	0.00	to	0.01	0.01 ± 0.00
PCB 77	0.005	22	0	to	0.0025	0.00 ± 0.00
PCB 126	0.005	22	0	to	0.0025	0.00 ± 0.00
PCB 169	0.005	22	0	to	0.0025	0.00 ± 0.00

[a] - Mean concentrations calculated using half-detection limit for non-detects. This results in means lower than detection limit where almost all samples are at the detection limit.

Table D3. Levels of OC Pesticides (ng g^{-1} wet weight) in Northern Pike and Long Nose Sucker liver, Fall 1994.

Location	Fish Species	Compound[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean	±	SD ng g^{-1}
PR1	northern pike	p,p'-DDE	0.5	2.9	to	5.1	(2/2)	4.0	±	1.6
		Hexachlorobenzene	0.1	0.5	to	0.7	(2/2)	0.6	±	0.1
		trans-nonachlor	1	0	to	2	(1/2)	1.0	±	1.4
PR2	northern pike	p,p'-DDE	0.5				(1/1)	1.1		
		Hexachlorobenzene	0.1				(1/1)	0.5		
SR1	northern pike	p,p'-DDE	0.5	0	to	4	(1/2)	2.0	±	2.8
		Hexachlorobenzene	0.1	0.6	to	0.6	(2/2)	0.6	±	0.0
WR1	northern pike	p,p'-DDE	0.5	1.8	to	7.5	(4/4)	4.4	±	2.4
		Hexachlorobenzene	0.1	0	to	0.7	(3/4)	0.5	±	0.3
		trans-nonachlor	1	0	to	1	(1/4)	0.3	±	0.5
PR1	long-nose sucker	p,p'-DDE	0.5	0	to	1.3	(3/5)	0.6	±	0.6
		Hexachlorobenzene	0.1	0.6	to	0.9	(5/5)	0.7	±	0.1
PR2	long-nose sucker	p,p'-DDE	0.5	0	to	0.9	(3/5)	0.4	±	0.4
		Hexachlorobenzene	0.1	0	to	0.5	(4/5)	0.3	±	0.2
SR1	long-nose sucker	p,p'-DDE	0.5	0	to	11.0	(1/3)	3.7	±	6.4
		Hexachlorobenzene	0.1	0.3	to	1.4	(3/3)	0.7	±	0.6
WR1	long-nose sucker	p,p'-DDE	0.5	0	to	11.0	(3/5)	2.7	±	4.7
		Hexachlorobenzene	0.1	0	to	1.8	(4/5)	0.8	±	0.7
		Toxaphene	10	0	to	190	(1/5)	38.0	±	85.0

[1] - Only organochlorines detected in at least one sample from each site are reported.

Table D4. Levels of PCBs (ng g^{-1} wet wt) in Northern Pike and Long Nose Sucker liver, Fall 1994

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean	±	SD ng g^{-1}
PR1	northern pike	PCB 52	0.05	0	to	0.8	(1/2)	0.4	±	0.6
		PCB 49	0.03	0	to	0.5	(1/2)	0.3	±	0.4
		PCB 101	0.03	0	to	3.4	(1/2)	1.7	±	2.4
		PCB 87	0.02	0	to	1.5	(1/2)	0.8	±	1.1
		PCB 151	0.02	0	to	0.9	(1/2)	0.4	±	0.6
		PCB 118	0.03	0	to	3.7	(1/2)	1.9	±	2.6
		PCB 153	0.02	1.8	to	10.0	(2/2)	5.9	±	5.8
		PCB 141	0.02	0	to	1.0	(1/2)	0.5	±	0.7
		PCB 137	0.02	0	to	0.6	(1/2)	0.3	±	0.4
		PCB 138	0.02	1.2	to	9.7	(2/2)	5.5	±	6.0
		PCB 182/187	0.02	0	to	1.2	(1/2)	0.6	±	0.8
		PCB 183	0.02	0	to	1.4	(1/2)	0.7	±	1.0
		PCB 128	0.02	0	to	1.3	(1/2)	0.7	±	0.9
		PCB 174	0.02	0	to	0.5	(1/2)	0.2	±	0.3
		PCB 177	0.02	0	to	0.5	(1/2)	0.3	±	0.4
		PCB 180	0.02	0.7	to	3.5	(2/2)	2.1	±	2.0
		PCB 170	0.02	0	to	1.3	(1/2)	0.7	±	0.9
		PCB 196/203	0.02	0	to	0.6	(1/2)	0.3	±	0.4
		PCB - Total	1	4	to	42.0	(2/2)	23.0	±	26.9
PR2	northern pike	PCB 153	0.02				(1/1)	1.1		
		PCB 138	0.02				(1/1)	0.8		
		PCB 180	0.02				(1/1)	0.4		
		PCB - Total	1				(1/1)	2.0		
SR1	northern pike	PCB 52	0.05	1.4	to	6.3	(2/2)	3.9	±	3.5
		PCB 49	0.03	0	to	1.7	(1/2)	0.9	±	1.2
		PCB 44	0.03	0	to	1.9	(1/2)	1.0	±	1.3
		PCB 70/76	0.03	0	to	4.8	(1/2)	2.4	±	3.4
		PCB 101	0.03	5.4	to	32.0	(2/2)	18.7	±	18.8
		PCB 87	0.02	2.1	to	18.0	(2/2)	10.1	±	11.2
		PCB 110	0.02	0	to	29.0	(1/2)	14.5	±	20.5
		PCB 151	0.02	1	to	3.8	(2/2)	2.4	±	2.0
		PCB 118	0.03	5.3	to	30.0	(2/2)	17.7	±	17.5
		PCB 153	0.02	11	to	31.0	(2/2)	21.0	±	14.1
		PCB 105	0.02	2.1	to	17.0	(2/2)	9.6	±	10.5
		PCB 141	0.02	1.6	to	6.4	(2/2)	4.0	±	3.4
		PCB 137	0.02	1.0	to	3.7	(2/2)	2.3	±	1.9
		PCB 138	0.02	12	to	50.0	(2/2)	31.0	±	26.9
		PCB 129	0.02	0	to	4.0	(1/2)	2.0	±	2.8
		PCB 182/187	0.02	1.5	to	3.2	(2/2)	2.4	±	1.2
		PCB 183	0.02	1.4	to	2.6	(2/2)	2.0	±	0.8
		PCB 128	0.02	1.5	to	9.3	(2/2)	5.4	±	5.5
		PCB 174	0.02	0	to	0.9	(1/2)	0.4	±	0.6

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
SR1	northern pike	PCB 180	0.02	4.1	to	6.1	(2/2)	5.1 ± 1.4
		PCB 170	0.02	2	to	5.0	(2/2)	3.5 ± 2.1
		PCB 196/203	0.02	0	to	1.2	(1/2)	0.6 ± 0.8
		PCB 194	0.02	0	to	0.9	(1/2)	0.5 ± 0.7
		PCB - Total	1	56.0	to	270.0	(2/2)	160.0 ± 150.0
WR1	northern pike	PCB 52	0.05	0	to	3.3	(3/4)	1.6 ± 1.4
		PCB 49	0.03	0	to	1.0	(1/4)	0.2 ± 0.5
		PCB 70/76	0.03	0	to	1.3	(2/4)	0.6 ± 0.7
		PCB 101	0.03	1.8	to	6.9	(4/4)	3.9 ± 2.3
		PCB 87	0.02	0	to	3.1	(3/4)	1.5 ± 1.4
		PCB 110	0.02	1.0	to	4.0	(4/4)	2.3 ± 1.4
		PCB 151	0.02	0	to	1.1	(1/4)	0.3 ± 0.6
		PCB 118	0.03	1.1	to	6.7	(4/4)	3.6 ± 2.4
		PCB 153	0.02	2.9	to	9.1	(4/4)	5.9 ± 2.6
		PCB 105	0.02	0	to	3.0	(2/4)	1.2 ± 1.5
		PCB 141	0.02	0	to	1.2	(1/4)	0.3 ± 0.6
		PCB 137	0.02	0	to	0.8	(1/4)	0.2 ± 0.4
		PCB 138	0.02	2.4	to	12.0	(4/4)	6.5 ± 4.0
		PCB 182/187	0.02	0	to	1.4	(2/4)	0.5 ± 0.7
		PCB 183	0.02	0	to	1.3	(1/4)	0.3 ± 0.7
		PCB 128	0.02	0	to	1.7	(2/4)	0.7 ± 0.8
		PCB 177	0.02	0	to	0.6	(1/4)	0.2 ± 0.3
		PCB 180	0.02	2	to	9.0	(4/4)	5.6 ± 2.9
		PCB 170	0.02	0	to	1.2	(1/4)	0.3 ± 0.6
		PCB - Total	1	14.0	to	69.0	(4/4)	35.8 ± 23.8
PR1	long nose sucker	PCB 70/76	0.03	0	to	1.3	(1/5)	0.3 ± 0.6
		PCB 101	0.03	0	to	1.2	(2/5)	0.4 ± 0.6
		PCB 118	0.03	0	to	1.5	(1/5)	0.3 ± 0.7
		PCB 153	0.02	0	to	3.0	(4/5)	1.9 ± 1.1
		PCB 138	0.02	0	to	2.5	(4/5)	1.8 ± 1.0
		PCB 182/187	0.02	0	to	0.8	(1/5)	0.2 ± 0.4
		PCB 180	0.02	0	to	1.8	(2/5)	0.6 ± 0.8
		PCB 170	0.02	0	to	0.8	(1/5)	0.2 ± 0.3
		PCB - Total	1	0	to	10.0	(4/5)	5.8 ± 4.0
PR2	long nose sucker	PCB 118	0.03	0	to	0.7	(1/5)	0.1 ± 0.3
		PCB 153	0.02	0	to	2.2	(3/5)	0.9 ± 0.9
		PCB 138	0.02	0	to	1.3	(3/5)	0.6 ± 0.6
		PCB 128	0.02	0	to	0.5	(1/5)	0.1 ± 0.2
		PCB - Total	1	0	to	3.5	(3/5)	1.7 ± 1.6
SR1	long nose sucker	PCB 22	0.05	0	to	2.7	(1/3)	0.9 ± 1.6
		PCB 52	0.05	0	to	2.9	(1/3)	1.0 ± 1.7
		PCB 49	0.03	0	to	3.5	(1/3)	1.2 ± 2.0
		PCB 70/76	0.03	0	to	2.2	(1/3)	0.7 ± 1.3
		PCB 101	0.03	0	to	12.0	(2/3)	4.3 ± 6.7
		PCB 87	0.02	0	to	6.2	(2/3)	2.3 ± 3.4

Location	Fish Species	Congener[1]	Detection Limit ng g^{-1}	Low		High	# of Detects	Mean ± SD ng g^{-1}
		PCB 110	0.02	0	to	11.0	(1/3)	3.7 ± 6.4
		PCB 151	0.02	0	to	2.5	(1/3)	0.8 ± 1.4
		PCB 118	0.03	0	to	28.0	(2/3)	10.4 ± 15.3
		PCB 153	0.02	1.1	to	25.0	(3/3)	9.6 ± 13.4
		PCB 105	0.02	0	to	0.7	(1/3)	0.2 ± 0.4
		PCB 141	0.02	0	to	3.8	(1/3)	1.3 ± 2.2
		PCB 137	0.02	0	to	1.3	(1/3)	0.4 ± 0.8
		PCB 138	0.02	1.8	to	31.0	(3/3)	12.0 ± 16.5
		PCB 182/187	0.02	0	to	5.0	(1/3)	1.7 ± 2.9
		PCB 183	0.02	0	to	4.1	(1/3)	1.4 ± 2.4
		PCB 128	0.02	0.7	to	6.2	(3/3)	2.7 ± 3.0
		PCB 180	0.02	0.6	to	10.0	(3/3)	3.8 ± 5.4
		PCB 170	0.02	0	to	5.0	(1/3)	1.7 ± 2.9
		PCB 201	0.02	0	to	9.1	(2/3)	3.3 ± 5.1
		PCB 196/203	0.02	0	to	3.5	(1/3)	1.2 ± 2.0
		PCB 194	0.02	0	to	2.1	(1/3)	0.7 ± 1.2
		PCB - Total	1	4	to	180.0	(3/3)	66.0 ± 98.9
WR1	long nose sucker	PCB 52	0.05	0	to	2.0	(1/5)	0.4 ± 0.9
		PCB 49	0.03	0	to	2.0	(1/5)	0.4 ± 0.9
		PCB 44	0.03	0	to	1.9	(1/5)	0.4 ± 0.8
		PCB 70/76	0.03	0	to	1.2	(1/5)	0.2 ± 0.5
		PCB 101	0.03	0	to	9.6	(1/5)	1.9 ± 4.3
		PCB 87	0.02	0	to	6.4	(1/5)	1.3 ± 2.9
		PCB 110	0.02	0	to	8.6	(1/5)	1.7 ± 3.8
		PCB 118	0.03	0	to	14.0	(1/5)	2.8 ± 6.3
		PCB 153	0.02	0	to	18.0	(3/5)	4.3 ± 7.7
		PCB 105	0.02	0	to	4.6	(1/5)	0.9 ± 2.1
		PCB 141	0.02	0	to	1.5	(1/5)	0.3 ± 0.7
		PCB 137	0.02	0	to	1.5	(1/5)	0.3 ± 0.7
		PCB 138	0.02	1.5	to	23.0	(5/5)	7.3 ± 9.2
		PCB 129	0.02	0	to	1.3	(1/5)	0.3 ± 0.6
		PCB 182/187	0.02	0	to	2.2	(1/5)	0.4 ± 1.0
		PCB 183	0.02	0	to	2.0	(1/5)	0.4 ± 0.9
		PCB 128	0.02	0	to	3.8	(1/5)	0.8 ± 1.7
		PCB 174	0.02	0	to	1.3	(1/5)	0.3 ± 0.6
		PCB 177	0.02	0	to	2.2	(1/5)	0.4 ± 1.0
		PCB 180	0.02	0	to	4.5	(3/5)	1.4 ± 1.9
		PCB 170	0.02	0	to	2.5	(1/5)	0.5 ± 1.1
		PCB 201	0.02	0	to	3.4	(1/5)	0.7 ± 1.5
		PCB 196/203	0.02	0	to	1.0	(1/5)	0.2 ± 0.4
		PCB 194	0.02	0	to	1.0	(1/5)	0.2 ± 0.4
		PCB - Total	1	4.0	to	120.0	(5/5)	28.0 ± 51.5

[1] - Only PCB congeners detected in at least one sample from each site are reported.

Table D5. Levels of OC pesticides and PCB homologs in Northern Pike liver (ng g^{-1}, wet wt) Sept to Dec 1994

	PR1	PR2	SR1	WR1
OC Pesticides:				
ΣChlordane	<1	<1	<1	0.25 ± 0.50
ΣHCH	1.0 ± 1.4	<0.2	<0.2	<0.2
HCB	0.60 ± 0.14	0.5	0.60 ± 0	0.45 ± 0.31
o,p'- and p,p'-DDT	<1	<1	<1	<1
p,p'-DDE	4.0 ± 1.6	1.1	2.0 ± 2.8	4.4 ± 2.4
p,p'-DDD	<1	<1	<1	<1
toxaphene	<10	<10	<10	<10
PCBs				
total PCB	23 ± 27	2.0	160 ± 150	36 ± 24
di	<0.03	<0.3	<0.3	<0.3
tri	<0.05	<0.03	<0.05	<0.05
tetra	0.69 ± 0.98	<0.02	8.1 ± 9.4	2.4 ± 2.3
penta	4.3 ± 6.1	<0.03	70 ± 79	12 ± 8.8
hexa	13 ± 14	1.9	68 ± 57	14 ± 8.6
hepta	4.5 ± 5.5	0.4	13 ± 5	6.9 ± 4.7
octa	0.31 ± 0.44	<0.02	1.1 ± 1.5	<0.02
nona	<0.02	<0.02	<0.02	<0.02
deca	<0.02	<0.02	<0.02	<0.02

Table D6. Levels of OCs, CPs, and PCBs in Northern Pike Muscle (ng g^{-1}), Sept to Dec 1994.

	PR1	PR2	SR1	WR1
OC Pesticides:				
ΣChlordane	<1	<1	<1	<1
ΣHCH	<0.2	<0.2	<0.2	<0.2
HCB	0.74 ± 0.11	0.30 ± 0.20	0.70 ± 0.61	0.78 ± 0.66
o,p'- and p,p'-DDT	<1	<1	<	<1
p,p'-DDE	0.62 ± 0.61	0.44 ± 0.43	3.7 ± 6.4	2.7 ± 4.7
p,p'-DDD	<1	<1	<1	<1
toxaphene	<10	<10	<10	38 ± 85
PCBs				
total PCBs	5.8 ± 4.0	1.7 ± 1.6	66 ± 99	28 ± 51
di	<0.03	<0.3	<0.3	<0.3
tri	<0.05	<0.05	0.90 ± 1.6	<0.05
tetra	0.26 ± 0.58	<0.02	2.9 ± 5.0	1.4 ± 3.2
penta	0.71 ± 1.1	0.15 ± 0.33	21 ± 32	11 ± 19
hexa	3.7 ± 2.2	1.7 ± 1.6	27 ± 37	14 ± 21
hepta	0.92 ± 1.5	<0.02	8.5 ± 14	3.4 ± 6.3
octa	<0.02	<0.02	5.2 ± 8.3	<0.02
nona	<0.02	<0.02	<0.02	<0.02
deca	<0.02	<0.02	<0.02	<0.02

Table D7. Concentrations of PCB congeners and OC pesticides (ng g^{-1} wet wt) in pooled samples of burbot, northern pike, lake whitefish, walleye and goldeye t the Ft. Chipewyan Domestic Fishery Study (1994)[a]

Site[b]		LA	LA	LA	LA	LA	LA	QF	QF	QF	QF	QF	QF	JV	JV	JV
Species	Detection	Burbot	Burbot	N. Pike	Goldeye	Walleye	L. Whitefish	burbot	burbot	N. Pike	Goldeye	Walleye	L. Whitefish	Burbot	Burbot	L. Whitefish
Tissue	limit	Muscle	Liver	Muscle	Muscle	Muscie	Muscle	Muscle	liver	Muscle	Muscle	Muscle	Muscle	Muscle	liver	Muscle
Parameter	ng g^{-1}	n=1	n=1	n=1	n=1	n=1	n=1	n=1	n=2	n=1	n=1	n=1	n=1	n=1	n=1	n=2
PCB 5/8	0.30	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
PCB 18	0.05	0.03	0.45	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
PCB 15	0.30	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
PCB 16/32	0.05	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
PCB 31	0.05	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
PCB 28	0.05	0.03	0.73	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.38	0.03
PCB 33	0.05	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
PCB 22	0.05	0.03	0.23	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
PCB 52	0.05	0.03	0.88	0.03	0.03	0.03	0.19	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.73	0.03
PCB 49	0.03	0.02	0.35	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.27	0.02
PCB 44	0.03	0.02	0.41	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.34	0.02
PCB 40	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
PCB 70/76	0.03	0.02	0.37	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.46	0.02
PCB 66/95	0.03	0.02	0.61	0.02	0.08	0.10	0.02	0.02	0.02	0.02	0.09	0.02	0.02	0.02	1.30	0.02
PCB 56/60	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
PCB 118	0.03	0.02	0.98	0.23	0.13	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
PCB 105	0.02	0.01	0.32	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
PCB 84	0.02	0.01	0.59	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.51	0.01
PCB 89	0.02	0.01	0.46	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
PCB 101	0.03	0.02	1.50	0.13	0.14	0.12	0.02	0.02	0.39	0.02	0.18	0.02	0.02	0.02	2.00	0.02
PCB 87	0.02	0.01	0.51	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.68	0.01
PCB 85	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
PCB 110	0.02	0.01	1.10	0.01	0.12	0.08	0.01	0.01	0.18	0.01	0.16	0.01	0.01	0.01	1.40	0.01
PCB 151	0.02	0.13	6.20	0.09	0.17	0.26	0.01	0.01	0.68	0.01	0.27	0.15	0.01	0.34	8.40	0.07
PCB 149	0.02	0.01	0.43	0.11	0.21	0.14	0.01	0.01	0.01	0.01	0.35	0.01	0.01	0.01	3.20	0.01
PCB 146	0.02	0.01	0.70	0.19	0.09	0.01	0.01	0.01	0.44	0.01	0.16	0.01	0.01	0.01	1.60	0.01
PCB 153	0.02	0.25	5.90	0.84	0.46	0.37	0.12	0.01	2.40	0.11	0.68	0.18	0.07	0.23	6.40	0.23
PCB 141	0.02	0.01	0.56	0.01	0.01	0.01	0.01	0.01	0.22	0.01	0.01	0.01	0.01	0.01	0.94	0.01
PCB 137	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.48	0.01
PCB 138	0.02	0.01	3.60	0.55	0.28	0.26	0.08	0.01	1.10	0.07	0.48	0.14	0.05	0.18	5.60	0.18
PCB 129	0.02	0.01	0.53	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
PCB 128	0.02	0.01	5.40	0.14	0.12	0.29	0.01	0.01	1.07	0.01	0.32	0.17	0.01	0.19	10.00	0.01
PCB 182/187	0.02	0.01	0.81	0.26	0.16	0.13	0.01	0.01	0.01	0.01	0.23	0.01	0.01	0.01	1.60	0.01
PCB 183	0.02	0.01	1.90	0.16	0.14	0.13	0.01	0.01	0.56	0.01	0.23	0.01	0.01	0.01	2.70	0.01
PCB 185	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
PCB 174	0.02	0.01	0.17	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.51	0.01
PCB 177	0.02	0.01	0.01	0.11	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.59	0.01
PCB 171/202	0.02	0.01	0.65	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.83	0.01
PCB 180	0.02	0.14	3.90	0.50	0.60	0.20	0.06	0.01	1.40	0.03	0.46	0.09	0.06	0.14	5.20	0.14
PCB 170	0.02	0.01	1.30	0.14	0.11	0.01	0.01	0.01	0.72	0.01	0.19	0.01	0.01	0.01	2.20	0.01
PCB 191	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Site[b]		LA	LA	LA	LA	LA	LA	QF	QF	QF	QF	QF	QF	JV	JV	JV
Species	Detection	Burbot	Burbot	N. Pike	Goldeye	Walleye	L. Whitefish	burbot	burbot	N. Pike	Goldeye	Walleye	L. Whitefish	Burbot	Burbot	L. Whitefish
Tissue	limit	Muscle	Liver	Muscle	Muscle	Muscle	Muscle	Muscle	liver	Muscle	Muscle	Muscle	Muscle	Muscle	liver	Muscle
Parameter	ng g^{-1}	n=1	n=1	n=1	n=1	n=1	n=1	n=1	n=2	n=1	n=1	n=1	n=1	n=1	n=1	n=2
PCB 201	0.02	0.01	0.22	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.58	0.01
PCB 196/203	0.02	0.01	0.69	0.01	0.78	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1.50	0.01
PCB 189	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
PCB 195/208	0.02	0.01	0.43	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1.70	0.01
PCB 194	0.02	0.01	0.70	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	1.20	0.01
PCB 207	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
PCB 205	0.02	0.01	0.44	0.24	0.20	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
PCB 206	0.02	0.01	0.68	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.90	0.01
PCB 209	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
PCB - Total	1.00	0.50	45.00	4.00	4.00	2.00	0.50	0.50	9.00	0.50	4.00	0.50	0.50	1.00	64.00	0.50
PCB 77	0.005	0.001	0.001	0.001	0.001	0.001	0.024	0.001	0.00100	0.001	0.001	0.001	0.001	0.001	0.001	0.00100
PCB 126	0.005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.00100	0.001	0.001	0.001	0.001	0.001	0.001	0.00100
PCB 169	0.005	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.00100	0.001	0.001	0.001	0.001	0.001	0.001	0.00100
Aldrin	0.20	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
alpha-HCH	0.20	0.05	3.50	0.05	0.20	0.05	0.05	0.05	1.85	0.05	0.05	0.05	0.05	0.05	1.00	0.05
beta-HCH	0.20	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
gamma-HCH	0.20	0.05	0.80	0.05	0.05	0.05	0.05	0.05	0.18	0.05	0.05	0.05	0.05	0.05	0.30	0.05
Cis-chlordane	1.00	0.50	7.00	0.50	0.50	0.50	0.50	0.50	1.00	0.50	0.50	0.50	0.50	0.50	7.00	0.50
Trans-chlordane	1.00	0.50	0.50	0.50	0.50	0.50	0.50	0.50	1.25	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Trans-nonachlor	1.00	0.50	7.00	0.50	0.50	0.50	0.50	0.50	1.00	0.50	0.50	0.50	0.50	0.50	10.00	0.50
Oxychlordane	1.00	0.50	4.00	0.50	0.50	0.50	0.50	0.50	3.25	0.50	0.50	0.50	0.50	0.50	5.00	0.50
Heptachlor	0.20	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Heptachlor epoxide	0.40	0.10	2.30	0.10	0.50	0.10	0.10	0.10	2.10	0.10	0.10	0.10	0.10	0.10	2.70	0.10
p,p'-DDE	0.50	0.25	15.00	1.10	0.70	0.25	0.25	0.25	2.00	0.25	1.10	0.25	0.25	0.25	20.00	0.25
p,p'-DDD	1.00	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	1.00	0.50
o,p'-DDT	1.00	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
p,p'-DDT	1.00	0.50	2.00	0.50	0.50	0.50	0.50	0.50	1.25	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Dieldrin	1.00	0.50	1.00	0.50	0.50	0.50	0.50	0.50	1.75	0.50	0.50	0.50	0.50	0.50	5.00	0.50
Endosulfan I	1.00	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Endosulfan II	1.00	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Endosulfan Sulphate	2.00	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Endrin	1.00	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Hexachlorobenzene	0.10	0.10	4.90	0.05	0.20	0.10	0.20	0.10	1.55	0.05	0.30	0.05	0.10	0.20	3.00	0.10
Methoxychlor	2.00	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Mirex	2.00	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Toxaphene	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

[a] Results are reported using values of 1/2 detection limit rather than less thans or zero

b Sites - LA = Lake Athabasca, QF = Quartre Fourches, JV = Jackfish Village

Table E1. Interlab comparison of toxaphene in burbot liver samples from 1994[a]

Sample	Zenon	Lab 1	Lab 2
A5 - 17	n.d.[b]	40	8.5
SR - 10	50	250	210
LSV - 13	n.d.[b]	60	33
A4 - 16	n.a.[c]	41	23
A2 - 7	10	59	77
Detection limit	10 - 50	5	0.17

[a]Lab 1 - used GC-Electron impact MS (high resolution) monitoring the m/z 158.9768 ion. Lab 2 - used GC-negative ion MS (low resolution) monitoring M^-, and M-Cl ions for hexa- to decachlorobornanes. Zenon - used GC-ECD (Zenon 1992).

[b] n.d. - toxaphene not detected.

[c] n.a. - sample not analysed by Zenon

Appendix F1 - Terms of Reference

NORTHERN RIVER BASINS STUDY

SCHEDULE A - TERMS OF REFERENCE

2381-D3: Review and Interpretation of Organochlorine Data in Fish and Other Media - 1993 and 1994 Data Sets

I. BACKGROUND & OBJECTIVES

One of the major objectives of the Northern River Basins Study is to determine the levels of contaminants released by industrial effluents, and measure their impacts on the aquatic ecosystems of rivers in northern Alberta. Organochlorine compounds are of a particular concern, including polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs), polychlorinated biphenyls (PCBs), and other persistent organochlorines such as some pesticides (e.g., toxaphene). Dioxins and furans are highly persistent compounds with a strong affinity for sediments and a high potential for accumulating in biological tissues. They have been found in all compartments of the ecosystem including air, water, soil, sediments, animals and foods. Dioxins and furans enter the environment from four major sources: commercial chemicals (e.g., pentachlorophenol), pulp and paper mills that use chlorine bleaching, incineration, and both accidental fires and spills involving PCBs (Environment Canada 1990). PCBs were once used in a variety of industrial applications, but were never intended to be released directly into the environment. PCBs are extremely persistent in the environment and are bioaccumulated throughout the food chain (Eisler 1986). Many organochlorine pesticides were used in large quantities in North America for over a decade and may still be present in sediments at high concentrations. Similar to PCDD/Fs and PCBs, organochlorine pesticides are not easily degraded or metabolized and, therefore, persist and bioaccumulate in the environment.

A previous NRBS project (project 2381-C5) interpreted analytical results to determine the impact of contaminants, from industrial and municipal effluents, on the aquatic ecosystem of the Athabasca and Peace rivers. This study summarized and mapped the levels of PCDD/Fs in water, sediment, suspended sediment, invertebrates and fish samples collected during the spring of 1992 as part of the Reach Specific Study on the upper Athabasca River downstream of Hinton. Concentrations of PCDD/Fs in fishes collected further downstream on the Athabasca River and from the Peace River (including the Wapiti-Smoky rivers) were also discussed.

Since then, the pulp and paper industry has reduced the use of molecular chlorine. Weldwood Canada Ltd. at Hinton and Weyerhaeuser Canada at Grand Prairie have almost completely restricted the use of molecular chlorine by substituting chlorine dioxide in the bleaching process. These changes in the pulp bleaching technology were expected to reduce the concentrations of

PCDD/Fs emitted to the Wapiti and Athabasca rivers.

The purpose of this project is to interpret and summarize results for PCDD/Fs, PCBs and other organochlorines in abiotic and biotic samples collected downstream from bleached kraft pulp and paper mills on the Peace and Athabasca river systems during 1993 and 1994. This study will determine whether the current levels of contaminants in water, sediment, benthic invertebrates and fish have changed from results found in 1987-88, and 1991-92 (Alberta Environment 1988, Trudel 1991, Swanson *et al.* 1992, Pastershank and Muir 1994). The study will also elaborate on the partitioning, fate and bioaccumulation of this group of compounds following their discharge into northern Alberta river systems. These data will also be particularly relevant for the contaminant fate and food chain models being developed for the northern rivers by NRBS scientists (project 2381-D1).

II. GENERAL REQUIREMENTS

The contractor is required to interpret analytical data for organochlorines and produce comprehensive reports relative to the four tasks outlined in these terms of reference. The format of the reports should be consistent with Pastershank and Muir (1994; project 2381-C5) to facilitate inter-basin and inter-year comparisons of organochlorine data, and to allow for an assessment of ecosystem health in the northern rivers. The reports should include, but not necessarily be limited to, the following:

a) a background information section, including a review of physiochemical parameters of compounds, their persistence in the environment, toxicity, sources, fate, transport and biomagnification,
b) a methods section describing the types of samples, numbers, locations (include maps where appropriate), analytical procedures conducted by laboratories (include QA/QC), and statistical analyses,
c) a results and discussion section that presents the information, with the aid of tables and figures, in a manner enhancing the discussion and comparison of spatial and temporal trends of contaminant levels found in samples of effluent, water, sediments, benthic invertebrates and fish within the northern rivers, and
d) include appendices for the analytical data results from laboratories.

To obtain the necessary field collections reports, laboratory analyses reports and Laboratory Analysis Approval (LAA) numbers, the contractor is to contact Dr. Brian Brownlee [NWRI, Burlington (905) 336-4706] or the Component Coordinator at NRBS.

Task 1. Dioxins/Furans - 1993 Data Set

The results of dioxin/furan analyses for 1993 (including the fall 1992 fish collections) should be presented and interpreted as both congener specific and TEQs for each of the sample media analyzed. The focus of the fish results will be on the 2,3,7,8-substituted congeners of dioxins/furans because of their prominence in the fish tissues sampled in 1992. The contractor is also expected to report on the variations in the contaminant levels of fish caused by species, sex, sample location and lipid content. The report is to include predictions of bioaccumulation potential of specific contaminants (particularly 2,3,7,8-TCDD/F) by estimating Bioconcentration Factors (BCF) in fish and sediments. Comment on the levels of PCDD/Fs TEQs in effluent, water, sediment, invertebrates and fish and compare with the guideline limits recommended by Canadian Environmental Quality Guidelines (Environment Canada 1993).

Under this task, the contractor is required to interact on a regular basis with Golder Associates Ltd. [contact Gordon Macdonald at (403) 299-5600], providing them with 2,3,7,8-TCDF data from biotic and abiotic samples for use in the contaminant fate and food chain models.

Task 2. Other Organochlorines - 1992-93 Data Sets

This task will require the combined 1992-93 data on PCBs and other persistent organochlorines measured in biota by NRBS. The contractor is required to review and interpret PCB analyses conducted by laboratories on media samples, whether the PCBs have been analyzed as Aroclor equivalents (Schwartz *et al*. 1987) or as individual congeners which are summed to determine the total PCB concentration (McFarland and Clarke 1989).

Other organochlorine data that may be available from the analytical results include some organochlorine pesticides. The following organochlorine pesticides and metabolites are recommended as target analytes in screening studies by U.S.EPA (1993):

total chlorodane	heptachlor epoxide
dicofol	hexachlorobenzene
dieldrin	lindane (γ-hexachlorocyclohexane)
endosulfan (I and II)	mirex
endrin	toxaphene
total DDT (including its metabolites DDD and DDE)	

Comment on the levels of total PCBs and other persistent organochlorines in effluent, water, sediment, invertebrates and fish and how these compare with the guideline limits recommended by Canadian Environmental Quality Guidelines (Environment Canada 1993).

Task 3. Dioxins/Furans - 1994 Data Set

Interpret and present the results of dioxin/furan analyses for the 1994 data set, as the analytical information becomes available. The contractor should be aware that all of the PCDD/F samples collected in 1994 might not be analyzed in time for incorporation into this task. Similar to Task 1, the contractor is required to interact on a regular basis with Golder Associates Ltd. [contact Gordon Macdonald at (403) 299-5600], providing them with 2,3,7,8-TCDF data from biotic and abiotic samples for use in the contaminant fate and food chain models.

Task 4. Other Organochlorines - 1994 Data Set

Review and interpret the results of PCB and other organochlorine data for the 1994 data set, as the analytical information becomes available. The contractor should be aware that all of the PCB and other organochlorine samples collected in 1994 might not be analyzed in time for incorporation into this task.

III. REPORTING REQUIREMENTS

1. The contractor is to provide the study office with four reports as specified by the tasks outlined in these terms of reference. The following reports are proposed:

   a) Dioxins and Furans - 1993 Data Set
   b) Other Organochlorines - 1992-93 Data Set
   c) Dioxins and Furans - 1994
   d) Other Organochlorines - 1994 Data Set

   If the data for other organochlorines (task 2 and task 4) is insufficient, a review of the 1992-1994 data sets may have to be combined into one report.

2. A progress report is to be submitted to the study office by **January 31, 1994**.

3. Ten copies of each of the two Draft Reports III.1.a and III.1.b (1993 data set) along with electronic disk copies are to be submitted to the Component Coordinator by **March 31, 1995.**

   The Study Office recognizes that a complete set of the 1994 analytical data may not be available for preparation of two additional comprehensive draft reports by March 31, 1995. Nonetheless, the contractor is to make an effort to review and interpret as much of the 1994 laboratory results as possible in the given time period. After March, 1995, progress will be reviewed by the Component Leader and Science Directors to determine if the contract should be extended into the next fiscal year.

4. Three weeks after the receipt of review comments on the draft reports, the contractor is to provide the Component Coordinator with two unbound, camera ready copies and ten cerlox bound copies of each final report along with an electronic version.

5. The Contractor is to provide draft and final reports in the style and format outlined in the NRBS document, "A Guide for the Preparation of Reports," which will be supplied upon execution of the contract.

   The final report is to include the following: an acknowledgement section that indicates any local involvement in the project, Report Summary, Table of Contents, List of Tables, List of Figures and an Appendix with the Terms of Reference for this project.

   Text for the report should be set up in the following format:

   a) Times Roman 12 point (Pro) or Times New Roman (WPWIN60) font.
   b) Margins; are 1" at top and bottom, 7/8" on left and right.
   c) Headings; in the report body are labelled with hierarchical decimal Arabic numbers.
   d) Text; is presented with full justification; that is, the text aligns on both left and right margins.
   e) Page numbers; are Arabic numerals for the body of the report, centred at the bottom of each page and bold.

   - If photographs are to be included in the report text they should be high contrast black and white.
   - All tables and figures in the report should be clearly reproducible by a black and white photocopier.
   - Along with copies of the final report, the Contractor is to supply an electronic version of the report in Word Perfect 5.1 or Word Perfect for Windows Version 6.0 format.
   - Electronic copies of tables, figures and data appendices in the report are also to be submitted to the Project Liaison Officer along with the final report. These should be submitted in a spreadsheet (Quattro Pro preferred, but also Excel or Lotus) or database (dBase IV) format. Where appropriate, data in tables, figures and appendices should be geo-referenced.

6. All figures and maps are to be delivered in both hard copy (paper) and digital formats. Acceptable formats include: DXF, uncompressed E00, VEC/VEH, Atlas and ISIF. All digital maps must be properly geo-referenced.

7. All sampling locations presented in report and electronic format should be geo-referenced. This is to include decimal latitudes and longitudes (to six decimal places) and UTM coordinates. The first field for decimal latitudes / longitudes should be latitudes (10 spaces wide). The second field should be longitude (11 spaces wide).

8. A presentation package of 35 mm slides is to comprise of one original and four duplicates of each slide.

IV. DELIVERABLES

1. A report summarizing and interpreting the dioxin/furan data for biotic and abiotic samples collected in 1993 (including the fall 1992 fish samples).

2. A report summarizing and interpreting other organochlorine data for biotic and abiotic samples collected in 1992-93.

3. A report summarizing and interpreting the dioxin/furan data for biotic and abiotic samples collected in 1994.

4. A report summarizing and interpreting other organochlorine data for biotic and abiotic samples collected in 1994.

5. Ten to twenty-five 35 mm slides that can be used at public meetings to summarize the project, methods and key findings.

V. CONTRACT ADMINISTRATION

This project has been proposed by the Contaminants Component of the NRBS (Contaminants Component Leader - Dr. John Carey, NWRI, Burlington).

The Scientific Authorities for this project are:

Dr. Derek Muir
Research Scientist
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Research Scientist
National Water Research Institute
Environment Canada
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Phone: (905) 336-4706
Fax: (905) 336-4972

Questions of a technical nature should be directed to them.

The Component Coordinator for this project is:

Richard Chabaylo
Northern River Basins Study
690, Standard Life Centre
10405 Jasper Avenue
Edmonton, Alberta T5J 3N4
Bus. Phone: (403) 427-1742
Fax: (403 422-3055

Questions of an administrative nature should be directed to him.

VI. LITERATURE CITED

Alberta Environment. 1988. News Release No. 19. Alberta preliminary dioxin results. July 20, 1988.

Eisler, R. 1986. Dioxins hazards for fish, wildlife and invertebrates. U.S. Fish and Wildlife Service. Biological Report No. 85. 36 pp.

Environment Canada. 1990. Canadian Environmental Protection Act. Priority substances list assessment report No. 1: polychlorinated dibenzodioxins and polychlorinated dibenzofurans. Report prepared by Environment Canada and Health and Welfare Canada. En40-215/1E. 56 pp.

Environment Canada. 1993. Draft Canadian Environment Quality Guidelines for polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans. Prepared by D.D. Macdonald, Macdonald Environmental Services Ltd., B.C. 149 pp.

McFarland, V.A., and J.U. Clarke. 1989. Environmental occurrence, abundance, and potential toxicity of polychlorinated biphenyl congeners: considerations for a congener-specific analysis. Environ. Health Perspect. 81:225-239.

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