

**ORGANOCHLORINE CONTAMINANTS AND YUKON FISH
Statistical Observations - Yukon Database**

For

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Submitted by

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Since unusually high levels of toxaphene, DDT and to a lesser extent PCBs were found in lake trout muscle and livers of burbot from Lake Laberge in 1990/91, a Yukon wide sampling and research program was initiated through the Federal Arctic Environmental Strategy to determine the source. The results of these programs suggest local disposal of DDT and PCB's, and atmospheric deposition of toxaphene, have contributed to these elevated contaminant levels in Lake Laberge fish. It was also determined that concentrations of organochlorines in fish varied greatly between lakes and species. Generally, fish or organs high in lipid contained higher levels of contaminants. It is also believed that lipid content is related to food chain dynamics within any particular lake. In addition, research elsewhere suggests levels of these types of persistent pollutants are in decline throughout the circumpolar region coincident with a decline in world use.

While these relationships have generally been presumed, statistical evaluations of Yukon fish data have been difficult, due to the small sample sizes and lack of temporal data. The large database that is now available makes valid comparisons possible. This project utilized the Yukon Contaminant Database (January 5, 2000) and investigated the following:

1. **Fish Community Effects:** Comparisons in contaminant levels (sDDT, sPCB, Toxaphene) as a function of lake trout growth, length-weight relationships and lipid content between Laberge, Kusawa and Quiet Lakes.
2. **Statistical Relationships:** Relationship of weight, length, age and lipid to contaminant levels (sDDT, sPCB, Toxaphene) in Yukon fish.
3. **Temporal Trends in Fish:** Temporal trends of contaminants (sDDT, sPCB, Toxaphene) in lake trout and burbot from Lake Laberge, 1990-1999.

Conclusions

1. Community Effects

- For any given length, lake trout from Lake Laberge on average weigh more than lake trout from Kusawa and Quiet Lakes.
- Lake trout from Lake Laberge grow at a faster rate (larger growth coefficient) than lake trout stocks within Kusawa and Quiet Lakes.
- Muscle lipid content is significantly greater in lake trout from Lake Laberge than those lake trout sampled from either Kusawa or Quiet Lakes.
- 1991 and 1999 lake trout catch/effort statistics are lower for Lake Laberge than those derived for Kusawa Lake in 1993.
- Lake trout abundance has almost doubled between 1991 and 1999 within Lake Laberge.
- Lake trout are proportionally less abundant in relation to other fish species in Lake Laberge than either Kusawa or Quiet Lakes.
- Long nose sucker and coregonids dominated the catches in the Lake Laberge survey.

2. Statistical Relationships

- There is no apparent statistical relationship between organochlorine contaminant (DDT, PCB and toxaphene) concentrations and fish weight, length or age.
- There is a statistical relationship between tissue lipid and organochlorine contaminant (DDT, PCB and toxaphene) concentrations.
- Samples of tissue containing higher levels of lipid generally translate to higher levels of organochlorine contaminants.

3. Temporal Trends in Lake Laberge Fish

- Mean levels of DDT, PCB and toxaphene (ug/kg ww at 1% lipid) have declined in lake trout muscle tissue from samples obtained from Lake Laberge over the last decade.
- After a sharp decrease 1990, mean levels of DDT in burbot liver (ug/kg ww at 1% lipid) have remained constant over the past decade.
- Mean levels of PCB (ug/kg ww at 1% lipid) in burbot livers are low relative to other contaminants and have generally remained low over the past decade.
- Mean levels of toxaphene (ug/kg ww at 1% lipid) in burbot livers have decreased from the early nineties.

Table 1. Parameter values “a” and “b” of weight-length functions and calculated weight at selected fork lengths of lake trout (*Salvelinus namaycush*) from Kusawa, Laberge and Quiet Lakes, 1991-94.

Lake	Weight-length relation			Calculated weight at standard fork-lengths						
	“a”	“b”	r ²	200	250	300	350	400	500	600
Kusawa	4.37E-06	3.14	0.9692	73	148	262	426	647	1305	2313
Laberge	4.65E-06	3.16	0.9710	87	176	313	510	777	1573	2798
Quiet	2.14E-06	3.27	0.9621	72	148	269	446	690	1432	2600

Table 2. Mean fork length-at-age and estimates of L_∞' and K' for lake trout (*Salvelinus namaycush*) from Kusawa, Laberge and Quiet Lakes, 1991-94.

Lake	Ages Used	Sample Size	L _∞ '	K'	Fork length (mm) at assessed age (years)						
					1	5	10	15	20	25	30
Kusawa	3,7-9,11,13-20	99	802	.067	52	228	392	508	592	652	695
Laberge	5,7-10,12,14	60	722	.107	73	300	475	577	637	673	693
Quiet	7-9,11-14,19,22	63	806	.072	56	244	414	532	615	673	713

Table 3. Comparison of lake trout (*Salvelinus namaycush*) muscle lipid levels from Lake Laberge to other Yukon lakes. Lipid levels were derived from OC contaminant sampling program of Yukon fish, 1991-99.

Area	Lake Trout Muscle Lipid Content (%)	Sample Size
Lake Laberge	5.29 ¹	31
Kusawa and Quiet Lakes	2.54	18
22 Yukon Lakes	2.51	141

¹significantly different using ANOVA

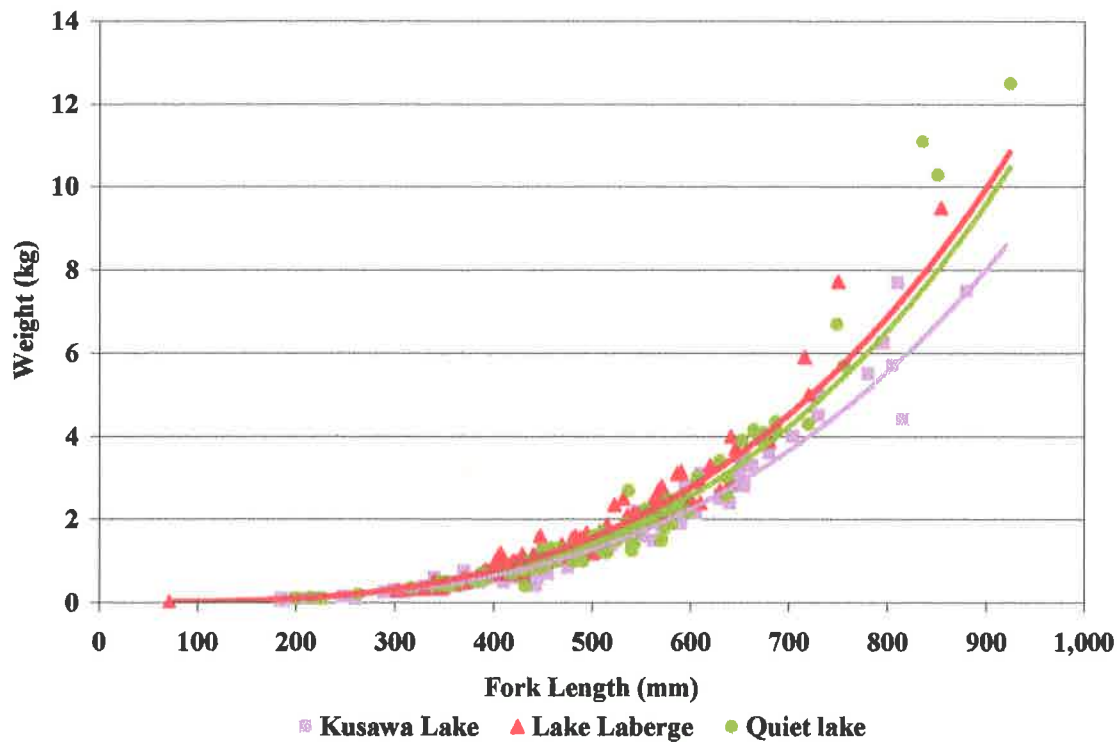


Figure 1 Length-weight scatter plots and fitted curves for lake trout (*Salvelinus namaycush*) collected from Kusawa, Laberge and Quiet Lakes, 1991-1994.

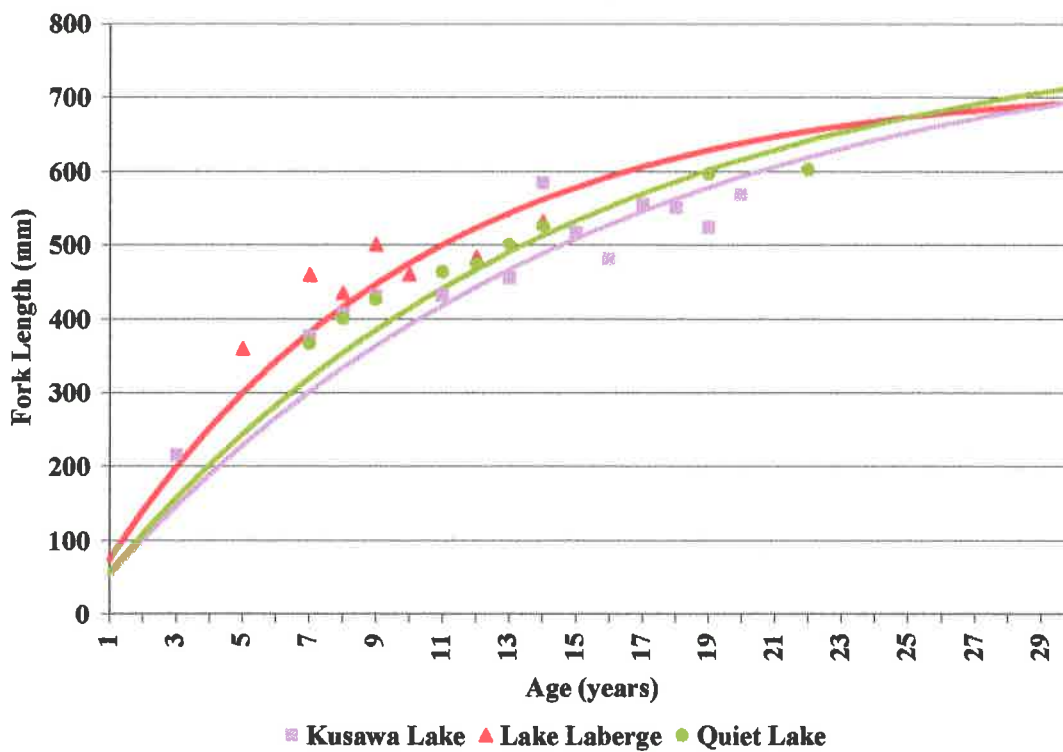


Figure 2 Scatter plot of mean fork length-at-age and fitted growth curves from calculated Von Bertalanffy parameters of lake trout (*Salvelinus namaycush*) collected from Kusawa, Laberge and Quiet Lakes, 1991-1994.

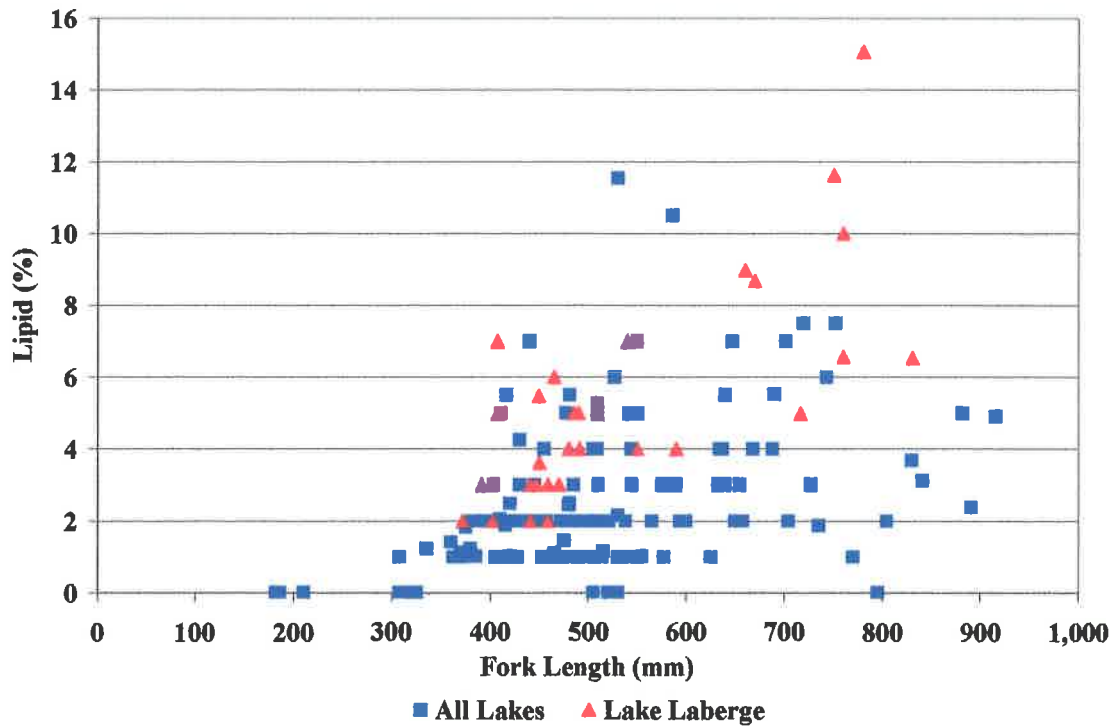


Figure 3 Relationship between fork length and muscle lipid of lake trout (*Salvelinus namaycush*) collected from Lake Laberge and 22 other Yukon Lakes, 1991-99.

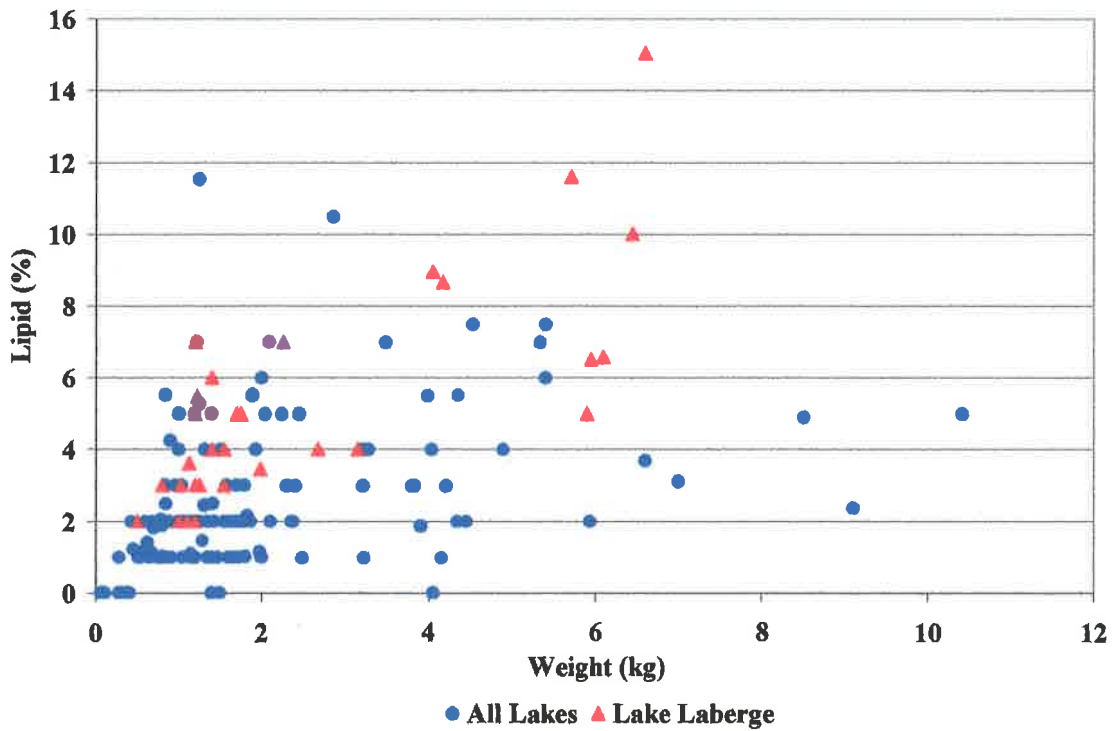


Figure 4 Relationship between body weight and muscle lipid of lake trout (*Salvelinus namaycush*) collected from Lake Laberge and 22 other Yukon Lakes, 1991-99.

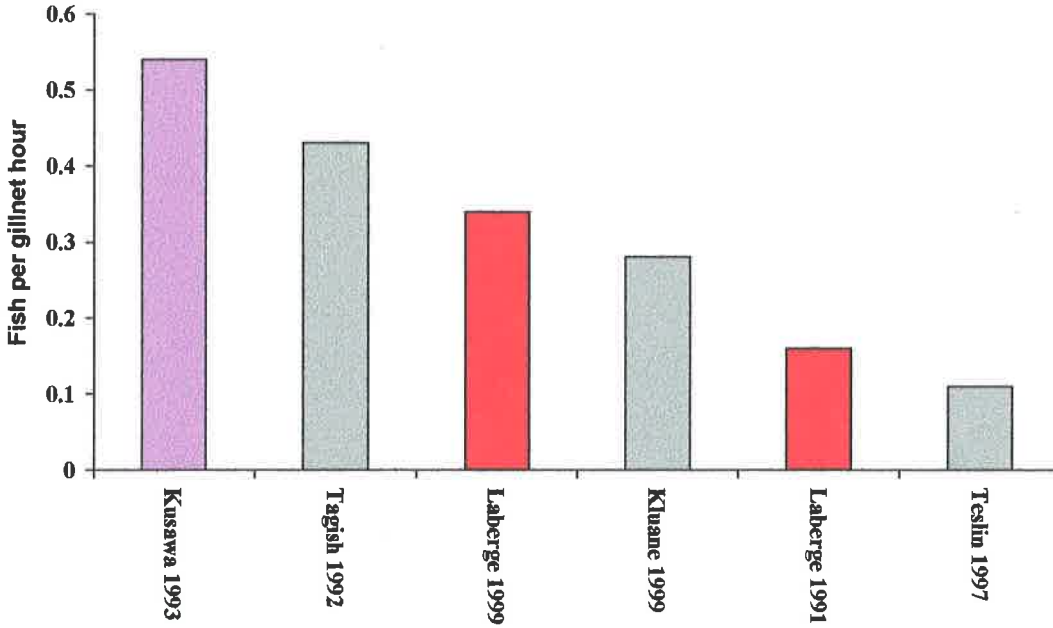


Figure 5 Comparison of lake trout (*Salvelinus namaycush*) abundance statistics from small mesh gillnet surveys of Lake Laberge, Kluane, Kusawa, Tagish and Teslin Lakes, 1991-99.

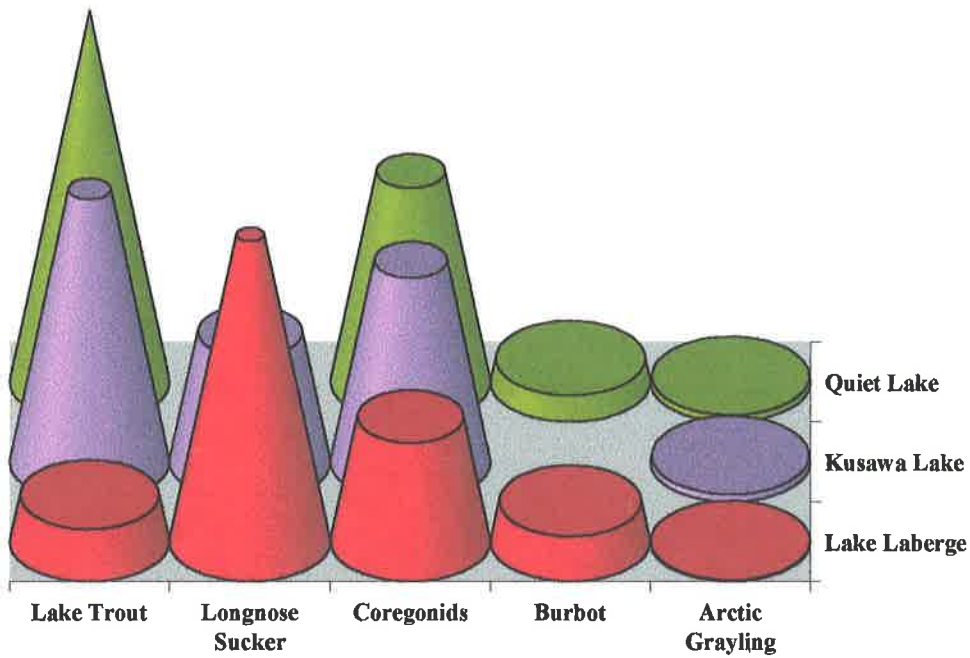


Figure 6 Catch composition from experimental (index) gillnet surveys of Kusawa, Laberge and Quiet Lakes, 1993-94.

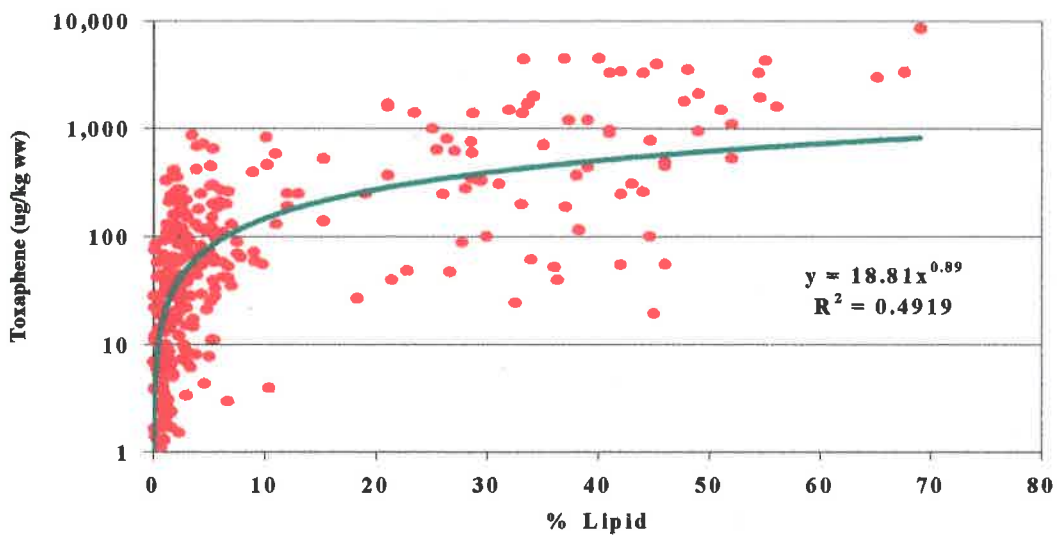
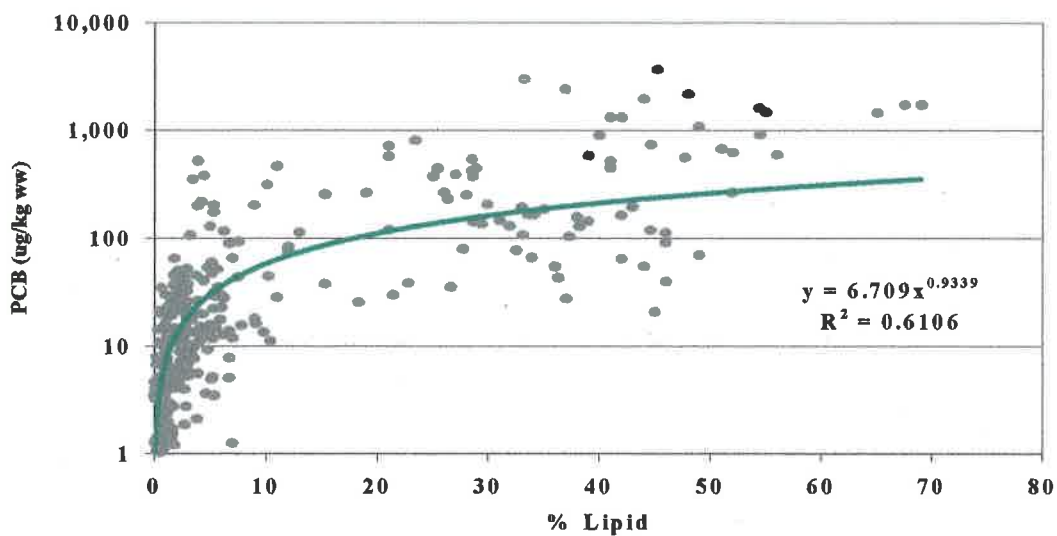
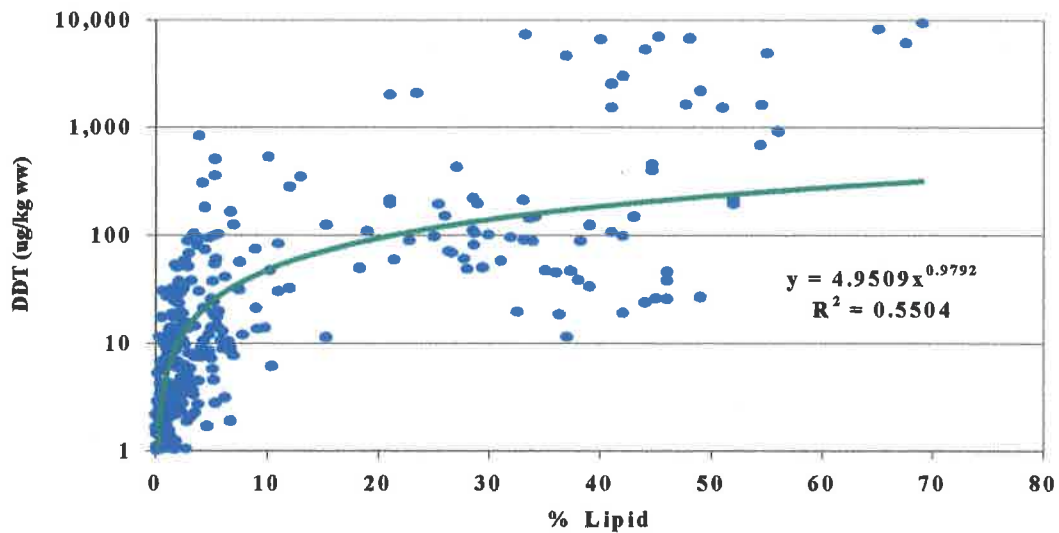


Figure 7 Relationship of DDT, PCB and toxaphene levels in lipid derived from sampling fish tissue (liver, eggs, muscle, stomach) collected from 34 different locations in the Yukon Territory, 1990-1997.

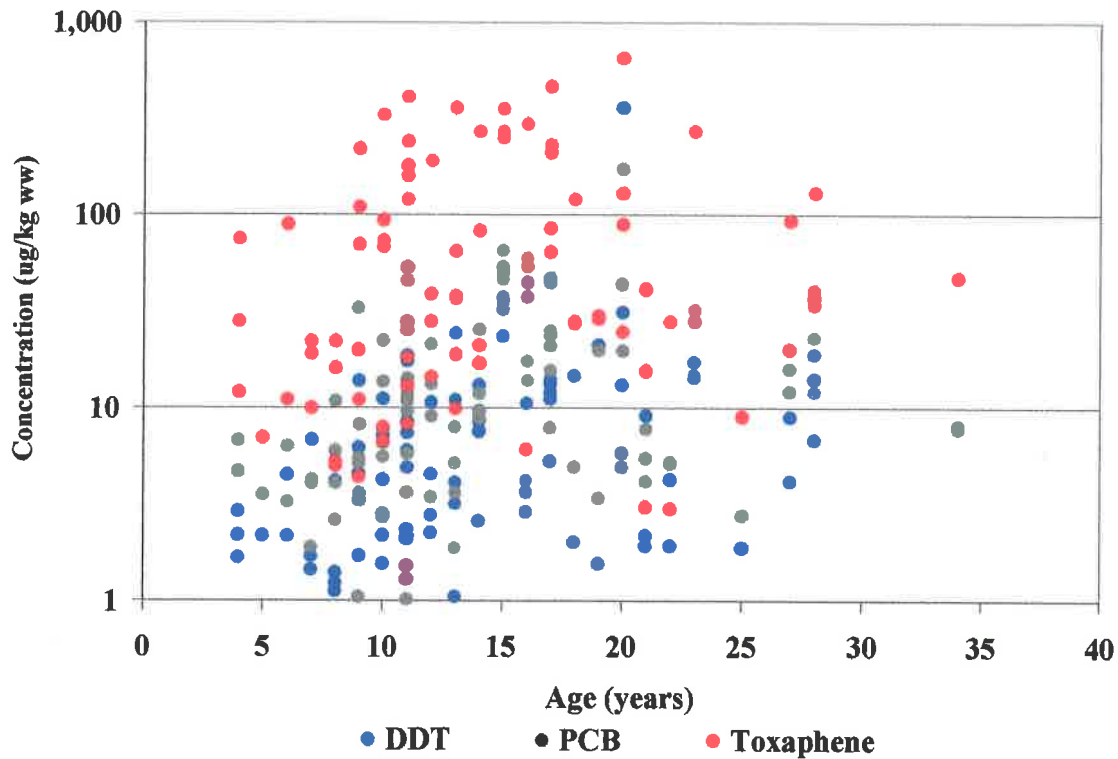


Figure 8 Relationship between age and levels of DDT, PCB and toxaphene derived from sampling lake trout muscle from 15 different locations in the Yukon Territory, 1991-1992.

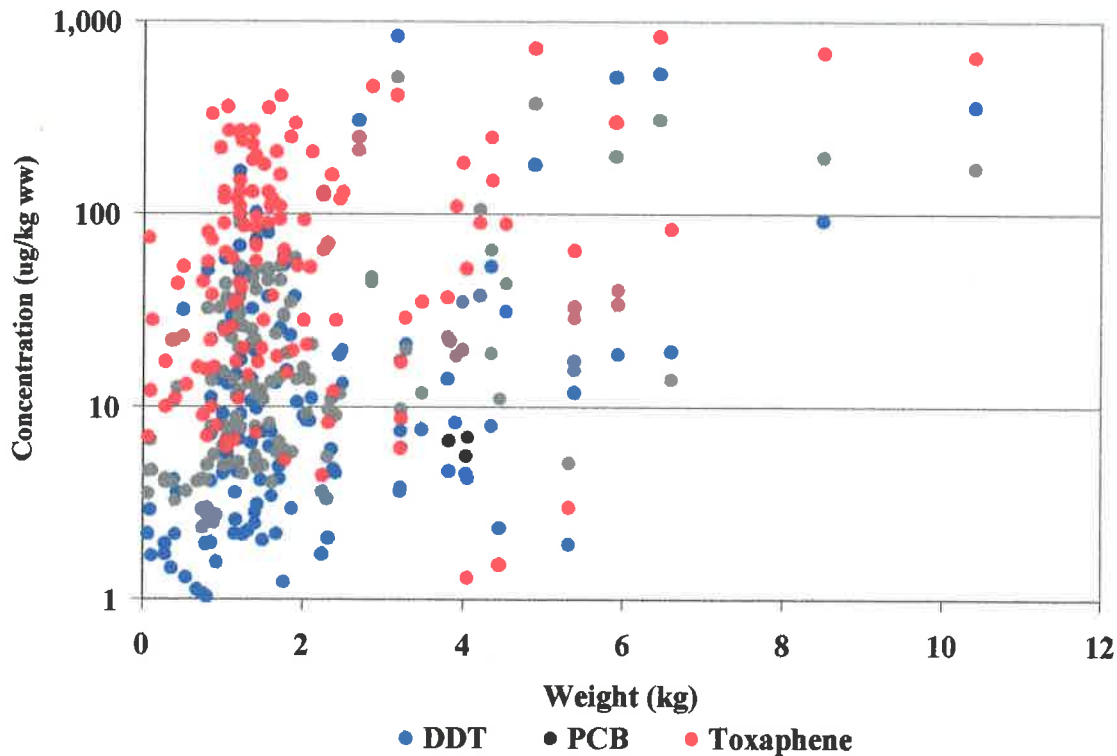


Figure 9 Relationship between lake trout (*Salvelinus namaycush*) body weight and levels of DDT, PCB and toxaphene derived from sampling lake trout muscle from 22 different locations in the Yukon Territory, 1991-1996

Table 4 Levels of DDT, PCB and toxaphene compounds in burbot liver and lake trout muscle from Lake Laberge, 1990-99.

Year	Species	Size Range (kg)	Sex	Tissue	N	sDDT (µg/kg ww)	sPCB (µg/kg ww)	Toxaphene (µg/kg ww)	% Lipid	sDDT (µg/kg ww at 1% lipid)	sPCB (µg/kg ww at 1% lipid)	Toxaphene (µg/kg ww at 1% lipid)	Reference
1990	Burbot	.5 - 2.9	M&F	liver	21	5,841	1,520	3,847	45.1	136.0	36.3	90.5	YCC database
1992		NR	M&F	liver	6	NR	NR	2,957	34.6	NR	NR	82.3	Muir et al 1993
1993		.4 - 2.5	M&F	liver	15	2,291	1,159	1,629	45.2	51.1	26.1	36.5	Connor et al 1993
1996		.8 - 2.1	M&F	liver	8	2,281	977	2,390	45.5	50.4	21.5	52.3	YCC database
1999		.7 - 2.4	M&F	liver	11	2,850	1,621	NR	53.8	51.3	29.1	NR	YCC database
1992	Lake Trout	NR	M&F	muscle	6	NR	NR	559	8.4	NR	NR	65.2	Muir et al 1993
1993		.5 - 5.9	M&F	muscle	19	143	80	150	3.5	37.9	22.1	43.9	YCC database
1996		1.1 - 6.5	M&F	muscle	10	147	86	96	5.3	26.2	15.7	15.7	YCC database
1998		1.2 - 6.6	M&F	muscle	7	53	43	NR	9.0	6.2	4.9	NR	YCC database
1999		2.0	M	muscle	1	20	23	NR	3.5	5.7	6.6	NR	YCC database

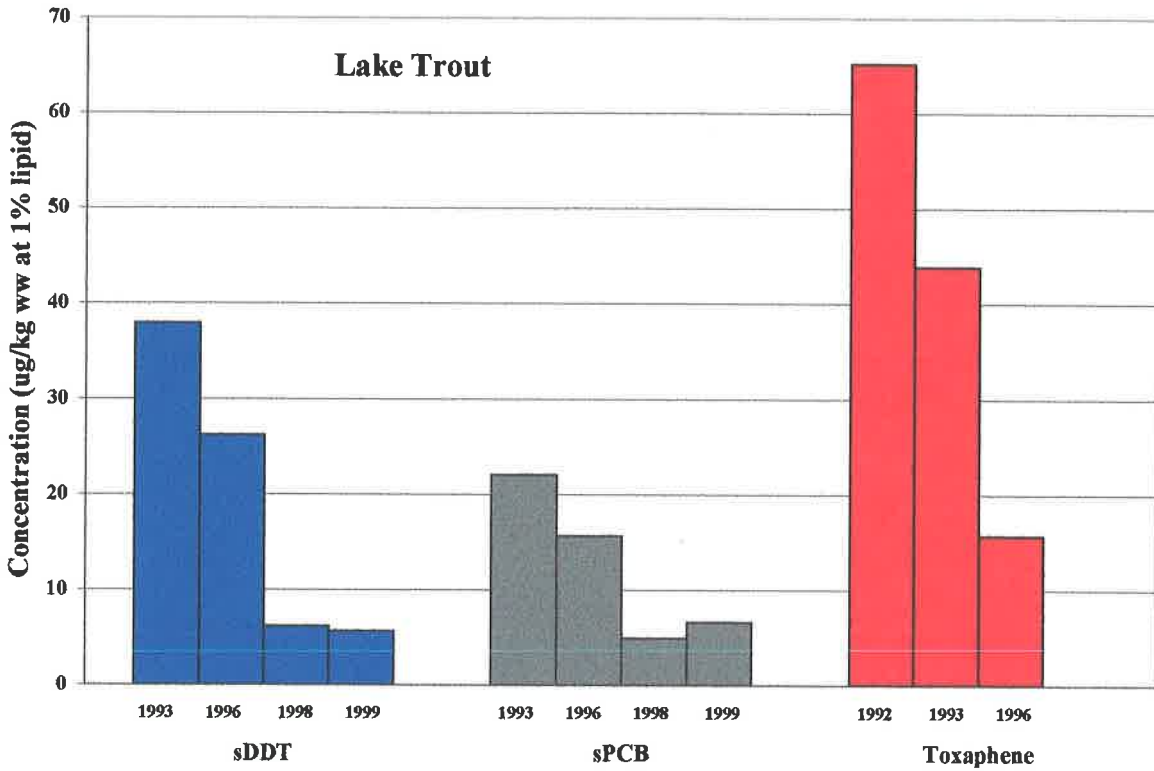


Figure 10 Temporal trends in mean levels (ug/kg ww at 1% lipid) of DDT, PCB and toxaphene in lake trout muscle (*Salvelinus namaycush*) from Lake Laberge, 1990-99.

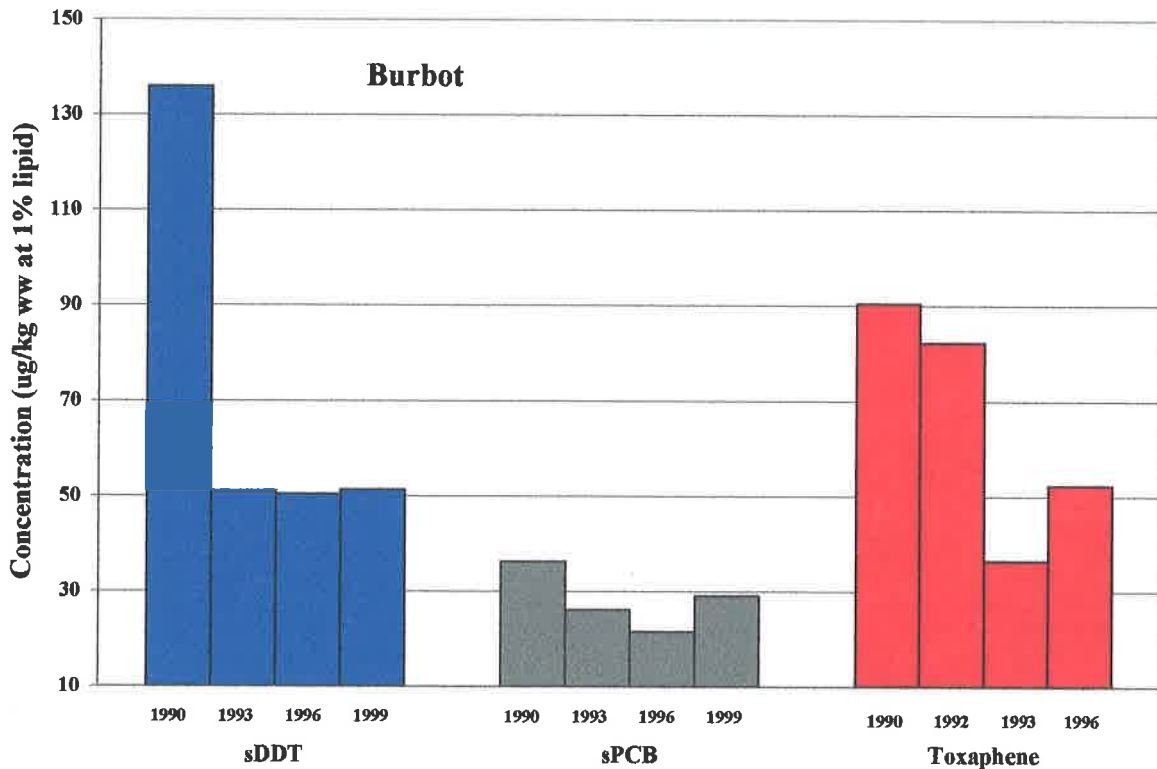


Figure 11 Temporal trends in mean levels (ug/kg ww at 1% lipid) of DDT, PCB and toxaphene in liver of burbot (*Lota lota*) from Lake Laberge, 1990-99.