

GREAT LAKES INDIAN FISH & WILDLIFE COMMISSION

P. O. Box 9 • Odanah, WI 54861 • 715/682-6619 • FAX 715/682-9294



• MEMBER TRIBES •

MICHIGAN

Bay Mills Community
Keweenaw Bay Community
Lac Vieux Desert Band


WISCONSIN

Bad River Band
Lac Courte Oreilles Band
Lac du Flambeau Band

MINNESOTA

Fond du Lac Band
Mille Lacs Band

To: Ann McCammon-Soltis, Policy Analyst

From: Matt Hudson, Environmental Biologist 

Date: April 11, 2006

Re: Lake Trout Contaminant Testing Project – Final Memo Revised to Incorporate Corrected Data in Three Tables.

The attached memo is an updated and corrected version of my May 18th, 2005 memo to you entitled, “Reporting Results for U.S. EPA Grant Number: EQ97598601-0”. This updated memo replaces the one from May 18th, 2005.

Table 13 has been updated with corrected tissue weight values for whole fillet, muscle, fat, and skin samples for all lake trout except those in the smallest size group. In addition, an error was found in the calculations used to estimate chemical concentrations in skin-on trimmed (SOT) and skin-on untrimmed (SOUT) fillets. Tables 15 and 17 were updated to include these corrections. The muscle tissue concentrations reported in these tables were correct.

The data corrections did not affect any conclusions that would result from the data as presented in the memo. For instance, all muscle tissue, SOT, and SOUT fillets were still below all FDA chemical concentration limits for the commercial sale of fish.

cc Neil Kmiecik, Biological Services Director
John Coleman, Environmental Section Leader
James Thannum, Planning Director

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To: Ann McCammon-Soltis, Policy Analyst

From: Matt Hudson, Environmental Biologist 

Date: April 11, 2006

Re: Reporting Results for U.S. EPA Grant Number: EQ97598601-0

Attached are results for U.S. EPA Grant Number: EQ97598601-0. Also included are brief descriptions of the fish processing and analytical methods used to produce the data.

The objectives of this study were to:

1. Determine the wet weight of each fillet's skin, lipid dense trimmings, and muscle tissue collected from lake trout (*Salvelinus namaycush namaycush*) captured in management units MI-2, MI-3 and MI-4.
2. Determine the concentration of chemicals listed in Table 1 in 16 composite muscle samples; lipid and moisture content in 16 composite muscle, 16 lipid-dense, and 16 skin samples; and archive these 48 composite samples from management units MI-2, MI-3 and MI-4.
3. Based on tissue wet weights and chemical concentrations, mathematically estimate the chemical concentrations in skin-on trimmed fillets (SOT) and skin-on untrimmed fillets (SOUT).
4. Compare the mean chemical composite concentrations of the skin-off trimmed fillet (muscle), SOT and SOUT fillets to the U.S. Food and Drug Administration's environmental chemical concentration limits for the sale of fish.

Methods

Lake Trout Collection and Storage

Lake trout collections occurred in November 2003 using gillnets along the central south shore of Lake Superior in lake trout fisheries management units MI-2, MI-3, and MI-4 (Figure 1). Four length ranges of lake trout were collected: 43-48, 52-54.5, 61-63.5, and

70-72.5 centimeter (cm). The length ranges selected span the length range of lake trout commonly harvested by tribal commercial fishermen (Figure 2). Samples were handled in a similar manner to commercially harvested fish and placed on ice within hours of collection. Samples were frozen intact within 24 hours of collection and remained frozen (at temperatures at or below -10°C) until processing at the analytical laboratory. The date, time, and conditions of collection and storage were documented on chain-of-custody forms.

Lake Trout Processing into Composites

Total length, round weight, and aging material (sagittal otolith) were collected from each fish prior to freezing. The Great Lakes Indian Fish and Wildlife Commission's Great Lakes Fisheries Section aged the fish to the nearest year. Fish were selected for each composite group based on length and age. Lake trout were processed into composites at the Lake Superior Research Institute, University of Wisconsin-Superior in February and March of 2003. Mean length (cm) and age (yr) \pm one standard deviation are given for each composite size group in Table 2.

Fish were thawed before processing. Individual lake trout were filleted using a stainless steel knife. Fillets were segmented into skin, dorsal/ventral fatty tissue (fat), and muscle tissue. Laboratory personnel were trained by an experienced tribal fisherman during a previous GLIFWC study on the technique used to trim the fillets. Each individual fillet component was weighed separately before grinding and compositing, based on equal tissue weights, according to the pre-assigned groups. On each processing day, a can of commercial chunk light tuna (*Thunnus sp.*) was divided in half. One half was processed in the same manner as the lake trout composites and the other half was transferred directly to an amber sample jar. These samples were used as procedural blanks to check for contamination that may have been introduced during processing. All lab utensils and glassware were critically cleaned between composites of different tissue types and species. Moisture analyses were conducted on the composites. Remaining composite tissues were transferred to critically cleaned amber glass jars with Teflon lids and archived at in a freezer at temperatures at or below -10°C.

Chemical Extraction and Analysis

The muscle tissue composite of each sample was analyzed for 37 chemicals (Table 1). In addition, three skin and three fat composites were analyzed for the 36 organic chemicals between January and February of 2005 in order to compare measured organic chemical concentrations in the skin and fat tissue to the predicted values used to estimate concentrations of organic chemicals in skin-on trimmed fillets and skin-on untrimmed fillets.

Mercury was analyzed by LSRI according to LSRI SOP SA/13, *Cold Vapor Mercury Analysis in Biota*, based on EPA Method 245.6. Percent moisture was determined by LSRI using LSRI SOP H *Procedures for Determining Percent Moisture in Tissue Samples*. The organic chemicals were extracted according to EnChem SOP SOV-60

(based on EPA SW846 Method 3540C). Percent lipid was determined by EnChem SOP SOV-59, based on Standard Methods for the Examination of Water and Wastewater # 5520, 1992. Lipids were removed from the sample extracts using gel permeation chromatography (EnChem SOP 3-SOV-26, based on EPA SW846 Method 3640A). Following removal of lipids, the samples were filtered through a silica gel column to separate the chlorinated pesticides from the PCBs (EnChem SOP SOV-58, based on EPA SW846 Method 3630C). The final extracts were analyzed for PCBs according to EnChem SOP SOV-52 (based on EPA Method 8082) and chlorinated pesticides according to EnChem SOP SOV-51 (based on EPA Method 8081A).

A more complete description of the methods can be found in the Quality Assurance Project Plan (QAPP) for this project entitled “Lake Trout Collection, Compositing, and Environmental Chemical Contaminant Analysis Quality Assurance Project Plan”.

Results

Quality Control

Results from quality control (QC) analyses used to monitor data quality for the organic chemical analyses can be found in Tables 3 - 8. QC results from the total mercury analyses can be found in Tables 9 - 12.

Objective #1 - Determine the wet weight of each fillet's skin, lipid dense trimmings, and muscle tissue collected from lake trout captured in management units MI-2, MI-3 and MI-4.

Table 13 lists descriptive data including tag number, sex, age, and length, along with the weight of muscle, skin, and fat tissues for the lake trout that make up each composite. Each fish was represented equally by weight in the composites, so the tissue weights listed in Table 13 are not the weight of tissue used for each fish in the composites. Weights of tissues from each fish in each composite were recorded by LSRI.

Objective #2 - Determine the concentration of chemicals listed in Table 1 in 16 composite muscle samples; lipid and moisture content in 16 composite muscle, 16 lipid-dense, and 16 skin samples; and archive these 48 composite samples from management units MI-2, MI-3 and MI-4.

Objective #3 - Based on tissue wet weights and chemical concentrations mathematically estimate the chemical concentrations in skin-on trimmed fillets (SOT) and skin-on untrimmed fillets (SOUT).

Table 14 displays skin and fat tissue composite mean \pm one standard deviation percent moisture and percent lipid measurements. Table 15 displays the lake trout data by chemical. Table 15 also includes mean \pm one standard deviation of muscle composite chemical concentrations for each size group and estimated mean \pm one standard deviation of chemical concentrations in SOT and SOUT fillets. These estimates were calculated

using the assumption that organic, PBT contaminants partition primarily to the lipid tissue of organisms (Mackay 1982) and were based on tissue weights recorded during fish tissue processing, and percent lipid measured in each tissue.

Figures 3-11 display mean \pm one standard deviation of composite muscle tissue concentrations by lake trout size group for seven of the nine chemicals targeted for zero discharge by the Lake Superior Binational Program.

In an effort to compare the PBT lipid partitioning assumptions used to calculate concentrations of chemicals in the SOT and SOUT fillets to measured data in those same tissues, three skin and three fat composite samples were analyzed for the same 36 organic chemicals as the muscle composites. Relative percent differences between the measured and predicted concentrations are given in Table 16. A plot of the measured and predicted concentrations in the fat composites is given in Figure 12 and a plot of the measured and predicted concentrations in the skin composites is given in Figure 13.

All tissue composites have been archived at LSRI in critically cleaned amber glass jars with Teflon lids, frozen at temperatures at or below -10°C .

Objective #4 - Compare the mean chemical composite concentrations of the skin-off trimmed fillet (muscle), SOT and SOUT fillets to the U.S. Food and Drug Administration's environmental chemical concentration limits for the sale of fish.

The United States Food and Drug Administration (FDA) regulates the sale of fish based on concentrations of various chemicals measured in fish fillets that are to be sold commercially. Table 17 compares Lake Superior lake trout muscle tissue concentrations of chemicals and chemical groups to FDA action levels for those chemicals/groups.

GLIFWC conducted a study of PBT contaminants in Lake Superior fish (including lake trout) in 1999. Table 18 compares concentrations of three chemicals measured in lake trout muscle tissue composites in 1999 to those measured in the current study (2003).

References

Mackay, D. Correlation of bioconcentration factors. *Environmental Science and Technology*. 1982. 16: 274-278.

cc Neil Kmiecik, Biological Services Director
John Coleman, Environmental Section Leader
James Thannum, Planning Director

TABLES

Table 1. Chemical and non-chemical analyses conducted on muscle tissue (e.g. trimmed, skin-off fillets) composite samples of Lake Superior lake trout (*Salvelinus namaycush namaycush*).

No	Chemical Analyses	Lab Conducting Analysis	No	Chemical Analyses	Lab Conducting Analysis
1	Total Chlordane	Calculated by GLIFWC	22	Toxaphene	En Chem
2	Cis-Chlordane	En Chem	23	Aldrin	En Chem
3	Trans-Chlordane	En Chem	24	Dieldrin	En Chem
4	Cis-nonachlor	En Chem	25	Heptachlor	En Chem
5	Trans-nonachlor	En Chem	26	Heptachlor epoxide	En Chem
6	Oxychlordane	En Chem	27	Endrin Ketone	En Chem
7	Total PCBs	En Chem	28	Methoxychlor	En Chem
8	1016	En Chem	29	Hexachlorobenzene	En Chem
9	1221	En Chem	30	Mirex	En Chem
10	1232	En Chem	31	Pentachloroanisole	En Chem
11	1242	En Chem	32	Endosulfan	En Chem
12	1248	En Chem	33	Endrin	En Chem
13	1254	En Chem	34	Endosulfan sulfate	En Chem
14	1260	En Chem	35	Endrin aldehyde	En Chem
15	Total DDT	Calculated by GLIFWC	36	α -benzene hexachloride	En Chem
16	4,4'-DDT	En Chem	37	β -benzene hexachloride	En Chem
17	4,4'-DDE	En Chem	38	δ -benzene hexachloride	En Chem
18	4,4'-DDD	En Chem	39	γ -benzene hexachloride	En Chem
19	2,4'-DDT	En Chem	40	Total mercury	LSRI
20	2,4'-DDE	En Chem	41	Lipid Determination	En Chem
21	2,4'-DDD	En Chem	42	Moisture Determination	LSRI

Table 2. Mean length and age (\pm one standard deviation) of each lake trout (*Salvelinus namaycush namaycush*) composite size group.

Size Group (cm)	Mean Length (cm)	Mean Age
43-48	45.7 \pm 1.8	4.9 \pm 1.4
52-54.5	53.6 \pm 1.0	11.3 \pm 1.3
61-63.5	62.0 \pm 1.0	11.4 \pm 1.4
70-72.5	70.6 \pm 1.0	14.5 \pm 1.2

Table 3. Relative Percent Agreement (RPA) of lipid concentration in duplicate lake trout (*Salvelinus namaycush namaycush*) samples analyzed by EnChem. No criteria given for acceptance.

Date of Analysis	Composite No.	Sample 1	Sample 2	RPA*
5/19/2004	SN61-63.5-L2	22.8	20.6	89.9%
5/19/2004	SN70-72.5-L4	16.7	18.5	89.8%
5/19/2004	SN61-63.5-S3	9.61	9.64	99.7%
5/19/2004	SN70-72.5-S4	11.8	10.9	92.1%
5/19/2004	SN52-54.5-TF2	6.05	5.77	95.3%
5/19/2004	SN61-63.5-TF1	6.50	5.66	86.2%

*RPA is: $1 - (\text{absolute value of the difference between the two samples} / \text{mean of the two samples})$

Table 4. Relative Percent Agreement (RPA*) of PCB and pesticide concentrations in duplicate samples analyzed by EnChem. No criteria given for acceptance.

Compound	SN54-TF2	SN62-TF1
Arochlor 1016	NC	NC
Arochlor 1221	NC	NC
Arochlor 1232	NC	NC
Arochlor 1242	NC	NC
Arochlor 1248	NC	NC
Arochlor 1254	NC	NC
Arochlor 1260	94.9%	98.1%
Total PCBs	94.9%	98.1%
2,4'-DDD	NC	NC
2,4'-DDE	NC	NC
2,4'-DDT	NC	NC
4,4'-DDD	NC	NC
4,4'-DDE	68.4%	68.4%
4,4'-DDT	33.3%	63.0%
Aldrin	NC	NC
alpha-BHC	71.4%	92.6%
alpha-Chlordane	81.0%	56.5%
beta-BHC	NC	NC
cis-nonachlor	88.9%	67.1%
delta-BHC	NC	NC
Dieldrin	93.3%	95.3%
Endosulfan I	NC	NC
Endosulfan II	NC	NC
Endosulfan Sulfate	NC	NC
Endrin	NC	NC
Endrin Aldehyde	NC	NC
Endrin Ketone	NC	NC
gamma-BHC (Lindane)	NC	55.1%
gamma-Chlordane	NC	NC
Heptachlor	NC	NC
Heptachlor Epoxide	94.3%	90.5%
Hexachlorobenzene	95.3%	95.9%
Methoxychlor	NC	NC
Mirex	NC	NC
Oxychlordane	88.2%	89.8%
Pentachloroanisole	NC	NC
Toxaphene	73.2%	91.3%
Trans-nonachlor	90.7%	91.3%

NC - Not Calculable, because one or both of the samples was below detection limit

*RPA is: $1 - (\text{absolute value of the difference between the two samples} / \text{mean of the two samples})$

Table 5. Spike Recovery of PCBs and Pesticides in Lake Trout (*Salvelinus namaycush namaycush*) Samples Analyzed by EnChem.

Compound	SN54-TF1	SN62-TF2	QC Limits
Arochlor 1254	120	128	43-130
alpha-BHC	113	108	69-123
beta-BHC	100	110	35-128
delta-BHC	110	120	57-126
gamma-BHC (Lindane)	110	115	52-126
Aldrin	105	115	52-122
Heptachlor	60	110	50-128
Heptachlor epoxide	96	109	51-130
Endosulfan I	85	110	45-140
Dieldrin	106	115	42-135
4,4'-DDE	128	168*	46-152
Endrin	112	112	43-136
Endosulfan II	108	116	46-147
4,4'-DDD	124	132	48-160
Endosulfan sulfate	105	118	54-132
4,4'-DDT	90	103	49-148
Methoxychlor	93	110	36-159
Endrin ketone	102	120	61-139
Endrin aldehyde	50	70	6-115
alpha-Chlordane	115	127	52-139
gamma-Chlordane	105	115	55-136
2,4'-DDD	160	160	40-160
2,4'-DDE	135	135	40-160
2,4'-DDT	92	92	40-160
cis-Nonachlor	188*	188*	40-160
trans-Nonachlor	148	148	40-160
Oxychlordane	123	123	40-160
Hexachlorobenzene	107	107	40-160
Pentachloroanisole	86	86	40-160
Mirex	130	130	40-160
Toxaphene	116	116	40-160

* Spiked sample recovery not within control limits.

Table 6. Procedural Blank Samples Before and After Grinding Analyzed for PCBs and Pesticides.

Compound	Tuna before grinding on 4/7/04	Tuna after grinding on 4/7/04	Tuna before grinding on 5/5/04	Tuna after grinding on 5/5/04
Arochlor 1016	ND	ND	ND	ND
Arochlor 1221	ND	ND	ND	ND
Arochlor 1232	ND	ND	ND	ND
Arochlor 1242	ND	ND	ND	ND
Arochlor 1248	ND	ND	ND	ND
Arochlor 1254	ND	ND	ND	ND
Arochlor 1260	ND	ND	ND	ND
Total PCBs	ND	ND	ND	ND
2,4'-DDD	ND	ND	ND	ND
2,4'-DDE	ND	ND	ND	ND
2,4'-DDT	ND	ND	ND	ND
4,4'-DDD	ND	ND	ND	ND
4,4'-DDE	ND	ND	ND	ND
4,4'-DDT	ND	ND	ND	ND
Aldrin	ND	ND	ND	ND
alpha-BHC	ND	ND	ND	ND
alpha-Chlordane	ND	ND	ND	ND
beta-BHC	ND	ND	ND	ND
cis-nonachlor	ND	ND	ND	ND
delta-BHC	ND	ND	ND	ND
Dieldrin	ND	ND	ND	ND
Endosulfan I	ND	ND	ND	ND
Endosulfan II	ND	ND	ND	ND
Endosulfan Sulfate	ND	ND	ND	ND
Endrin	ND	ND	ND	ND
Endrin Aldehyde	ND	ND	ND	ND
Endrin Ketone	ND	ND	ND	ND
gamma-BHC (Lindane)	ND	ND	ND	ND
gamma-Chlordane	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND
Heptachlor Epoxide	ND	ND	ND	ND
Hexachlorobenzene	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND
Mirex	ND	ND	ND	ND
Oxychlordane	ND	ND	ND	ND
Pentachloroanisole	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND
Trans-nonachlor	ND	ND	ND	ND

ND - Not Detectable.

Table 7. Spike recovery of PCBs and pesticides in lab control spikes (LCS) and lab control spike duplicates (LCS dup) analyzed by EnChem. Samples BBLK53, SVK1079-041, and SVK1079-046 were analyzed along with the additional skin and fat samples (1-2/2005). All other samples were part of the original muscle tissue composite analysis (5-6/2004).

Compound	BBLK43 LCS	BBLK43 LCS dup	BBLK49 LCS	BBLK44 LCS	BBLK44 LCS dup	BBLK53 LCS	BBLK53 LCS dup	SVK1079- 041F2MB LCS	SVK1079- 041F2MB LCS dup	SVK1079- 046F2MB LCS	SVK1079- 046F2MB LCS dup	QC Limits 5-6/2004	QC Limits 1-2/2004
Arochlor 1254	100	96		108	112			100	97	105	109	40-128	40-128
alpha-BHC	115	110		115	115			95	95	85	105	65-117	65-117
beta-BHC	90	85		95	95			85	80	80	95	58-109	58-115
delta-BHC	115	110		115	115			85	75	75	95	63-117	63-117
gamma-BHC (Lindane)	110	100		115	110			95	90	85	105	65-115	65-115
Aldrin	110	100		115	115			100	95	120*	120*	60-115	60-115
Heptachlor	60	60		115	110			95	80	100	100	58-118	58-118
Heptachlor epoxide	105	100		110	105			95	90	90	105	63-118	63-118
Endosulfan I	90	85		105	100			90	85	80	95	54-129	54-129
Dieldrin	108	100		115	110			90	85	82	100	63-117	63-117
4,4'-DDE	138	130		170*	168*			108	105	138	135	60-150	60-150
Endrin	110	102		110	105			88	82	82	100	55-116	55-116
Endosulfan II	102	95		102	95			82	85	78	92	57-120	57-120
4,4'-DDD	125	118		122	120			90	90	82	100	63-128	63-128
Endosulfan sulfate	105	95		105	102			82	80	75	88	61-123	61-123
4,4'-DDT	72	85		95	85			70	90	72	22*	62-127	62-127
Methoxychlor	95	90		100	95			85	85	80	100	33-141	33-141
Endrin ketone	102	95		105	102			90	90	80	98	64-132	64-132
Endrin aldehyde	65	65		68	60			60	48	60	68	16-75	16-115
alpha-Chlordane	100	100		120	115			90	95	80	90	58-125	58-125
gamma-Chlordane	100	100		110	105			85	85	80	85	64-120	64-120
2,4'-DDD			158*			120	122					60-150	70-130
2,4'-DDE			145			92	92					60-150	70-130
2,4'-DDT			100			125	125					60-150	70-130
cis-Nonachlor			182*			162*	165*					60-150	70-130
trans-Nonachlor			148			115	115					60-150	70-130
Oxychlordane			128			100	100					60-150	70-130
Hexachlorobenzene			110			85	85					60-150	70-130
Pentachloroanisole			90			100	95					60-150	70-130
Mirex			122			98	95					60-150	70-130
Toxaphene			120			105	105					60-150	60-140

* Spiked sample recovery not within control limits.

Table 8. Results of Standard Reference Material (SRM) analysis. SRM-1946 was the Certified Standard Reference Material used. SRM 43, 44, and SRM S&F refer to the SRM 1946 samples analyzed by EnChem. Results are compared to Quality Control (QC) ranges issued for SRM 1946 and to En Chem's QC ranges for the same analytes.

Compound Name	SRM 1946	SRM 1946	SRM QC		SRM 43	SRM 44	SRM S&F	En Chem Matrix	En Chem QC		SRM 43	SRM 44	SRM S&F
	Conc. µg/Kg	Uncertainty	Range (ug/kg)					spike QC limits	Range (ug/kg)				
Hexachlorobenzene	7.25	±0.83	8.08	6.42	9.1*	10*	9.5 J*	60-150	4.4	10.9	9.1	10	9.5 J
Alpha-BHC	5.72	±0.65	6.37	5.07	6.1	6.1	5.3 J	65-117	3.7	6.7	6.1	6.1	5.3 J
Gamma-BHC	1.14	±0.18	1.32	0.96	0.92*	0.94*	1.1 J	65-115	0.7	1.3	0.92	0.94	1.1 J
Heptachlor epoxide	5.50	±0.23	5.73	5.27	7.1*	7.6*	5.7	63-118	3.5	6.5	7.1*	7.6*	5.7
Oxychlorodane	18.9	±1.5	20.4	17.4	17*	16*	18	60-150	11.3	28.4	17	16	18
Alpha-chlordane	32.5	±1.8	33.33	30.7	32	36*	27*	58-125	18.9	40.6	32	36	27
Gamma-chlordane	8.36	±0.91	9.27	7.45	11*	12*	9.8*	55-136	4.6	11.4	11	12*	9.8
Cis-nonachlor	59.1	±3.6	62.7	55.5	55*	83*	74*	60-150	35.5	88.7	55	83	74
Trans-nonachlor	99.6	±7.6	107.2	92	110*	140*	120*	60-150	59.8	149.4	110	140	120
Dieldrin	32.5	±3.5	36	29	37*	44*	31	63-117	20.5	38.0	37	44*	31
Mirex	6.47	±0.77	7.24	5.7	5.2*	10*	6.7 U	60-150	3.9	9.7	5.2	10*	6.7 U
4,4'-DDE	373	±48	421	325	430*	460*	360	60-150	223.8	559.5	430	460	360
2,4'-DDD	2.20	±0.25	2.45	1.95	1.6 U	1.6 U	1.9 U	60-150	1.3	3.3	1.6 U	1.6 U	1.9 U
4,4'-DDD	17.7	±2.8	20.5	14.9	8.4 U	30*	4.6 J*	60-150	10.6	26.6	8.4 U	30*	4.6 J*
4,4'-DDT	37.2	±3.5	40.7	33.7	30*	52*	35.0	62-127	23.1	47.2	30	52*	35.0
% Lipid	10.2	±0.48	10.7	9.72	10.6	10.6	10.5						

U- Analyte was not detected at or above the reporting limit.

J – Analyte was above method detection limit but below estimated quantitation limit.

* Analyte concentration was outside of given quality control (QC) range.

Table 9. Relative Percent Agreement (RPA) of Procedural Blank Samples [Commercial Tuna Fish (*Thunnus sp.*) Before and After Grinding] for Total Mercury Analysis by the Lake Superior Research Institute.

Date of Analysis	Grinding Date	Before Grinding (µg Hg/g)	After Grinding (µg Hg/g)	RPA
6/29/2004	4/7/2004	0.066	0.070	94.1
7/7/2004	4/13/2004	0.027	0.028	96.4
6/29/2004	4/23/2004	0.083	0.103	78.5
6/29/2004	4/28/2004	0.079	0.078	98.7
6/29/2004	5/5/2004	0.100	0.090	89.5

*RPA is: $1 - (\text{absolute value of the difference between the two samples} / \text{mean of the two samples})$

Table 10. Mercury Concentration of Dogfish Tissue Supplied by the National Research Council Canada (DORM-2) and analyzed by the Lake Superior Research Institute. The Tissue has a Certified Mercury Concentration of $4.64 \pm 0.26 \mu\text{gHg/g}$ Tissue.

Date of Analysis	Sample 1 ($\mu\text{g Hg/g}$)	Sample 2 ($\mu\text{g Hg/g}$)	Mean	Std. Dev.	Percent of Expected
6/29/2004	3.85	4.02	3.94	0.11	84.8
6/29/2004	4.21	4.35	4.28	0.09	92.3

Table 11. Relative Percent Agreement (RPA) Between Duplicate Analysis for Total Mercury (Wet Weight) Content in Skinless Fillet Tissue of Compositated Lake Trout (*Salvelinus namaycush namaycush*) Analyzed by Lake Superior Research Institute.

Date of Analysis	Sample ID	Sample 1 ($\mu\text{g Hg/g}$)	Sample 2 ($\mu\text{g Hg/g}$)	RPA*
6/29/2004	SN43-48TF4	0.181	0.16	87.7
6/29/2004	SN61-63.5TF1	0.23	0.224	97.4

*RPA is: $1 - (\text{absolute value of the difference between the two samples/mean of the two samples})$

Table 12. Percent of Mercury Recovered from Skinless Fillet Tissue of Compositated Lake Trout (*Salvelinus namaycush namaycush*) Spiked with a Known Quantity of Mercury by the Lake Superior Research Institute.

Date of Analysis	Sample ID	Spike #1	Spike #2	Mean	Std. Dev.
6/29/2004	SN43-48TF4	101.9	97.3	99.6	3.34
6/29/2004	SN61-63.5TF1	103.0	75.3	89.1	19.58

Table 13. Individual Lake Superior lake trout (*Salvelinus namaycush namaycush*) descriptive data for fish contained in each composite. Tissue weights are wet weight values. Each fish was represented equally by weight in the composites, so the tissue weights listed here are not the weight of tissue used for each fish in the composites.

Sample ID	Length* Range	Tag Num	Mgmt Unit	Sex	Age (yr)	Length (cm)	# Fillets in Sample	Round Wt (g)**	Whole Fillet Wt (g)	Muscle Wt (g)	Fat Wt (g)	Skin Wt (g)
846447-037	43-48-1	1410	MI-2	F	4	43.2	2	750	173.0	122.4	30.9	16.4
846447-037	43-48-1	1442	MI-2	F	3	43.9	2	700	163.7	113.4	26.0	18.0
846447-038	43-48-2	1425	MI-2	M	4	44.7	2	900	192.2	135.9	32.0	21.3
846447-038	43-48-2	1449	MI-2	M	4	47.0	2	900	227.9	161.6	37.7	25.4
846447-039	43-48-3	5	MI-3	F	7	46.2	2	650	185.5	145.1	22.4	17.6
846447-039	43-48-3	14	MI-3	M	5	47.2	2	1000	259.8	193.2	41.1	24.2
846447-040	43-48-4	3	MI-3	M	6	48.0	2	700	172.4	124.6	26.2	20.7
846447-040	43-48-4	13	MI-3	M	6	46.0	2	1050	291.0	219.3	42.5	26.3
846447-041	52-54.5-1	825	MI-4	M	10	53.8	1	1500	414.7	319.2	47.9	45.2
846447-041	52-54.5-1	890	MI-4	M	10	53.8	1	1350	361.0	274.5	46.3	40.7
846447-041	52-54.5-1	814	MI-4	M	10	55.4	1	1200	338.0	248.2	46.9	33.9
846447-041	52-54.5-1	319	MI-4	M	9	54.4	1	1500	392.3	307.2	46.2	42.0
846447-042	52-54.5-2	820	MI-4	M	11	51.6	1	1000	312.4	232.0	43.0	34.3
846447-042	52-54.5-2	822	MI-4	M	11	51.3	1	1000	311.9	232.6	40.7	34.8
846447-042	52-54.5-2	125	MI-3	M	11	53.1	1	1100	333.7	250.6	49.7	30.8
846447-042	52-54.5-2	1	MI-3	F	11	53.3	1	1350	379.0	282.8	60.9	33.8
846447-043	52-54.5-3	10	MI-3	F	11	53.8	1	1450	386.8	293.4	50.9	32.6
846447-043	52-54.5-3	8	MI-3	M	11	54.9	1	1450	320.6	248.5	35.9	33.3
846447-043	52-54.5-3	2	MI-3	M	11	54.6	1	1200	328.9	248.6	40.3	37.6
846447-043	52-54.5-3	6	MI-3	M	11	54.1	1	1200	348.3	255.1	58.3	32.8
846447-044	52-54.5-4	7	MI-3	F	14	53.3	1	1150	252.3	170.5	49.1	30.9
846447-044	52-54.5-4	332	MI-4	M	13	52.3	1	1000	269.0	203.2	38.7	25.2
846447-044	52-54.5-4	11	MI-3	F	13	54.4	1	1100	352.9	266.7	44.8	38.2
846447-044	52-54.5-4	9	MI-3	F	13	53.3	1	1250	298.8	208.9	52.7	34.4
846447-045	61-63.5-1	1409	MI-2	M	9	61.5	1	2100	567.8	420.8	76.0	50.4
846447-045	61-63.5-1	122	MI-3	M	10	62.2	1	2000	520.6	394.1	67.3	52.0
846447-045	61-63.5-1	326	MI-4	M	9	61.7	1	2100	561.2	414.4	93.2	48.2
846447-045	61-63.5-1	329	MI-4	M	10	61.7	1	2000	523.2	403.8	67.8	49.6
846447-046	61-63.5-2	123	MI-3	M	11	62.2	1	1800	502.3	369.9	77.7	47.3
846447-046	61-63.5-2	1431	MI-2	M	11	63.5	1	2300	629.8	475.5	97.9	49.8
846447-046	61-63.5-2	811	MI-4	M	11	61.0	1	2000	559.4	384.4	116.1	49.9
846447-046	61-63.5-2	120	MI-4	M	11	61.0	1	2000	547.7	406.4	82.3	56.8
846447-047	61-63.5-3	895	MI-3	M	12	61.2	1	1800	551.3	429.8	70.4	48.1
846447-047	61-63.5-3	341	MI-4	M	12	61.0	1	1700	473.2	363.0	43.1	50.5
846447-047	61-63.5-3	315	MI-4	F	12	61.0	1	2000	433.9	329.6	60.7	38.7
846447-047	61-63.5-3	345	MI-4	M	12	61.5	1	2000	496.5	385.1	64.7	43.9
846447-048	61-63.5-4	121	MI-3	M	13	63.5	1	2000	498.4	377.6	70.5	47.8
846447-048	61-63.5-4	126	MI-3	U	13	63.5	1	2000	457.6	351.2	60.1	42.5
846447-048	61-63.5-4	807	MI-4	M	13	63.0	1	2000	468.9	349.6	71.6	45.1
846447-048	61-63.5-4	342	MI-4	M	13	64.0	1	2000	604.2	456.6	89.8	48.4

Table 13 continued...

Sample ID	Length Range	Tag Num	Mgmt Unit	Sex	Age (yr)	Length (cm)	# Fillets in Sample	Round Wt (g)	Whole Fillet Wt (g)	Muscle Wt (g)	Fat Wt (g)	Skin Wt (g)
846447-049	70-72.5-1	124	MI-3	M	13	70.6	1	2500	758.2	597.6	96.2	58.5
846447-049	70-72.5-1	896	MI-3	M	13	70.9	1	3200	829.1	614.9	137.1	71.8
846447-049	70-72.5-1	891	MI-4	M	13	70.4	1	2750	750.5	585.4	96.2	61.1
846447-049	70-72.5-1	340	MI-4	M	13	72.4	1	3500	926.3	659.3	147.6	98.5
846447-050	70-72.5-2	128	MI-3	M	14	71.1	1	2600	766.3	581.7	109.6	70.9
846447-050	70-72.5-2	350	MI-4	M	14	69.1	1	2600	710.5	530.6	103.4	68.6
846447-050	70-72.5-2	826	MI-4	M	14	69.3	1	2500	700.0	546.2	82.8	66.1
846447-050	70-72.5-2	823	MI-4	M	14	69.6	1	2700	790.5	584.8	122.8	78.2
846447-051	70-72.5-3	129	MI-3	M	15	71.4	1	3500	968.1	769.7	107.0	85.6
846447-051	70-72.5-3	313	MI-4	M	15	70.4	1	3000	826.9	670.2	83.7	67.7
846447-051	70-72.5-3	323	MI-4	M	15	71.1	1	3000	738.5	600.2	75.3	57.7
846447-051	70-72.5-3	322	MI-4	M	15	72.1	1	3500	864.9	690.2	97.9	73.5
846447-052	70-72.5-4	898	MI-3	F	16	69.9	1	3050	799.0	630.5	101.3	61.8
846447-052	70-72.5-4	899	MI-3	M	16	71.6	1	3550	930.0	745.3	106.6	69.1
846447-052	70-72.5-4	817	MI-4	M	16	69.9	1	2700	728.3	578.4	84.2	61.5
846447-052	70-72.5-4	311	MI-4	M	16	71.4	1	2700	615.6	471.1	84.8	55.3

* Fillet tissue data for the 43-48 cm size group is the average of both fillets from the fish.

** Round weight refers to the unprocessed weight of the fish in the field.

Table 14. Percent lipid and mean \pm one standard deviation of percent moisture measured in fat and skin tissues from Lake Superior lake trout (*Salvelinus namaycush namaycush*) fillets.

Composite ID	FAT			SKIN		
	Mean	STDEV	% Lipid	Mean	STDEV	% Lipid
	% moisture			% moisture		
SN43-48-1	72.8	0.153	9.04	62.0	1.44	10.7
SN43-48-2	71.2	0.265	10.6	56.5	0.666	15
SN43-48-3	73.5	0.200	9.12	60.9	0.436	8.62
SN43-48-4	65.9	0.569	17.1	58.0	0.917	11.8
SN52-54.5-1	65.7	0.153	19.6	58.3	0.656	11.1
SN52-54.5-2	65.4	0.611	18.2	56.0	0.600	12.9
SN52-54.5-3	66.1	1.83	16.6	62.4	1.10	8.65
SN52-54.5-4	66.4	1.22	17.8	59.3	0.493	11.4
SN61-63.5-1	60.4	2.58	22.3	58.0	0.265	12.1
SN61-63.5-2	61.9	0.666	21.7*	57.0	0.493	14.2
SN61-63.5-3	67.2	0.833	17.4	60.4	1.16	9.63*
SN61-63.5-4	71.1	0.351	11.9	60.8	0.503	11.2
SN70-72.5-1	58.6	0.929	25.1	61.1	0.700	12.2
SN70-72.5-2	66.3	0.666	16.6	59.4	0.321	11.7
SN70-72.5-3	63.3	0.907	19.1	57.8	0.755	13.1
SN70-72.5-4	64.3	1.87	17.6*	59.4	0.569	11.4*

* Value listed is the mean of duplicate samples.

Table 15. Individual Lake Superior lake trout (*Salvelinus namaycush namaycush*) composite chemical concentrations. Concentrations listed for skin-on trimmed fillets (SOT) and skin-on untrimmed fillets (SOUT) are estimated values based on the wet weight of tissues in the composites and percent lipid in those tissues. Values given for “Percent Moisture” and Percent Lipid” are percentages. All other data are wet weight concentrations in units of ug/kg. Significant figures are consistent with lab reported values.

Chemical Parameter	Method Detection Limit***	Estimated Quantitation Limit	Length Group*	Composite Number				Replicate**		Length Group Average	Length Group STDEV	Skin-on Trimmed (SOT) Fillet Average	Skin-on Trimmed (SOT) Fillet STDEV	Skin-on Untrimmed (SOUT) Fillet Average	Skin-on Untrimmed (SOUT) Fillet STDEV
				1	2	3	4	1	2						
Percent Moisture			43 to 48.0 cm	76.4	75.8	77.6	75.0			76.2	1.1	.	.	.	.
			52 to 54.5 cm	75.9	75.0	77.0	75.6	75.0	.	75.9	0.9	.	.	.	.
			61 to 63.5 cm	74.9	74.0	77.1	77.6	74.9	.	75.9	1.7	.	.	.	.
			70 to 72.5 cm	73.7	77.1	74.8	74.3			75.0	1.5	.	.	.	.
Percent Moisture Standard Deviation			43 to 48.0 cm	0.25	0.12	0.42	0.50			0.32	0.2	.	.	.	.
			52 to 54.5 cm	0.91	0.25	0.32	0.50	0.25	.	0.50	0.3	.	.	.	.
			61 to 63.5 cm	0.87	1.9	0.29	0.00	0.87	.	0.77	0.8	.	.	.	.
			70 to 72.5 cm	0.76	0.67	0.81	0.23			0.62	0.3	.	.	.	.
Percent Lipids			43 to 48.0 cm	3.25	3.42	2.78	5.57			3.76	1.24	.	.	.	.
			52 to 54.5 cm	4.66	5.91	4.30	5.78	6.05	5.77	5.16	0.80	.	.	.	.
			61 to 63.5 cm	6.08	6.03	4.04	3.25	6.50	5.66	4.85	1.43	.	.	.	.
			70 to 72.5 cm	6.81	4.22	5.98	5.26			5.57	1.10	.	.	.	.
2,4'-DDD	0.82	5.0	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
			52 to 54.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			61 to 63.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			70 to 72.5 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
2,4'-DDE	1.2***	5.0	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
			52 to 54.5 cm	ND	ND	ND	1.7	ND	ND	1.7	.	1.9	.	2.4	.
			61 to 63.5 cm	ND	1.4	1.6	2.2	ND	ND	1.7	0.42	2.1	0.62	2.7	0.71
			70 to 72.5 cm	2.7	2.2	5.1	ND			3.3	1.6	3.7	1.7	4.7	1.8
2,4'-DDT	1.1	5.0	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
			52 to 54.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			61 to 63.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			70 to 72.5 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.

Table 15 continued...

Chemical Parameter	Method Detection Limit	Estimated Quantitation Limit	Length Group*	Composite Number				Replicate**		Length Group Average	Length Group STDEV	Skin-on Trimmed (SOT) Fillet Average	Skin-on Trimmed (SOT) Fillet STDEV	Skin-on Untrimmed (SOUT) Fillet Average	Skin-on Untrimmed (SOUT) Fillet STDEV
				1	2	3	4	1	2						
4,4'-DDD	1.0	5.0	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
			52 to 54.5 cm	1.2	ND	1.3	1.7	ND	ND	1.4	0.26	1.6	0.28	2.1	0.32
			61 to 63.5 cm	1.6	1.2	ND	2.4	1.6	ND	1.7	0.61	2.1	0.86	2.7	1.0
			70 to 72.5 cm	1.8	3.2	7.1	5.8			4.5	2.4	5.0	2.7	6.3	3.0
4,4'-DDE	0.74	5.0	43 to 48.0 cm	12	8	12	39			18	14	22	15	26	19
			52 to 54.5 cm	20	19	35	47	22	16	30	13	34	15	44	19
			61 to 63.5 cm	29	34	35	61	33	24	40	15	47	20	61	25
			70 to 72.5 cm	66	58	130	170			110	53	120	58	150	68
4,4'-DDT	1.1	5.0	43 to 48.0 cm	1.3	1.3	1.2	3.8			1.9	1.3	2.3	1.3	2.8	1.7
			52 to 54.5 cm	1.8	2.9	2.8	3.7	1.9	3.8	2.8	0.78	3.2	0.85	4.0	1.0
			61 to 63.5 cm	2.7	4.7	5.4	6.2	2.2	3.2	4.8	1.5	5.6	2.0	7.3	2.5
			70 to 72.5 cm	7.4	6.0	13	14			10	4.0	11	4.3	14	4.8
Aldrin	0.42	2.5	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
			52 to 54.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			61 to 63.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			70 to 72.5 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
Alpha-BHC	0.86	2.5	43 to 48.0 cm	1.1	1.4	ND	2.0			1.5	0.46	1.9	0.44	2.3	0.59
			52 to 54.5 cm	1.4	2.5	1.4	2.0	2.8	2.1	1.8	0.51	2.1	0.58	2.6	0.66
			61 to 63.5 cm	2.7	2.3	ND	0.9	2.8	2.6	2.0	0.93	2.3	0.97	3.0	1.3
			70 to 72.5 cm	2.5	ND	2.6	ND			2.6	0.07	2.8	0.13	3.5	0.12
Alpha-Chlordane	0.42	2.5	43 to 48.0 cm		1.1	1.2	5.9			2.7	2.7	3.3	3.0	4.0	3.7
			52 to 54.5 cm	1.9	2.1	2.3	4.1	2.3	1.9	2.6	1.0	3.0	1.1	3.8	1.4
			61 to 63.5 cm	2.3	2.6	2.4	3.3	2.8	1.8	2.7	0.45	3.1	0.72	4.1	0.85
			70 to 72.5 cm	4.4	3.1	2.6	8.8			4.7	2.8	5.3	3.1	6.7	3.8
Aroclor 1016	12	50	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
			52 to 54.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			61 to 63.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			70 to 72.5 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.

Table 15 continued...

Chemical Parameter	Method Detection Limit	Estimated Quantitation Limit	Length Group*	Composite Number				Replicate**		Length Group Average	Length Group STDEV	Skin-on Trimmed (SOT) Fillet Average	Skin-on Trimmed (SOT) Fillet STDEV	Skin-on Untrimmed (SOUT) Fillet Average	Skin-on Untrimmed (SOUT) Fillet STDEV	
				1	2	3	4	1	2							
Aroclor 1221	12	50	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.	
			52 to 54.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.	
			61 to 63.5 cm	ND	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			70 to 72.5 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.	
Aroclor 1232	12	50	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.	
			52 to 54.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.	
			61 to 63.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.	
			70 to 72.5 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.	
Aroclor 1242	12	50	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.	
			52 to 54.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.	
			61 to 63.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.	
			70 to 72.5 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.	
Aroclor 1248	12	50	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.	
			52 to 54.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.	
			61 to 63.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.	
			70 to 72.5 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.	
Aroclor 1254	12	50	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.	
			52 to 54.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.	
			61 to 63.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.	
			70 to 72.5 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.	
Aroclor 1260	12	50	43 to 48.0 cm	28	23	28	86			41	30	50	31	61	40	
			52 to 54.5 cm	35	39	64	93	38	40	58	27	65	30	84	37	
			61 to 63.5 cm	54	69	79	110	54	53	78	24	92	34	120	41	
			70 to 72.5 cm	110	95	200	530			230	200	260	220	330	270	
Beta-BHC	1.1	2.5	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.	
			52 to 54.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.	
			61 to 63.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.	
			70 to 72.5 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.	

Table 15 continued...

Chemical Parameter	Method Detection Limit	Estimated Quantitation Limit	Length Group*	Composite Number				Replicate**		Length Group Average	Length Group STDEV	Skin-on Trimmed (SOT) Fillet Average	Skin-on Trimmed (SOT) Fillet STDEV	Skin-on Untrimmed (SOUT) Fillet Average	Skin-on Untrimmed (SOUT) Fillet STDEV
				1	2	3	4	1	2						
Cis-nonachlor	1.0	5.0	43 to 48.0 cm	3.2	2.6	4.3	11			5.3	3.9	6.4	4.1	7.8	5.2
			52 to 54.5 cm	5.9	5.4	9.5	11	5.7	5.1	8.0	2.7	9.0	3.0	12	3.8
			61 to 63.5 cm	7.9	7.8	8.3	12	9.2	6.6	9.0	2.0	11	3.0	14	3.6
			70 to 72.5 cm	14	12	23	31			20	8.8	22	9.5	28	11
Delta-BHC	0.68	2.5	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
			52 to 54.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			61 to 63.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			70 to 72.5 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
Dieldrin	1.1	5.0	43 to 48.0 cm	5.0	4.9	4.2	13			6.8	4.2	8.4	4.3	10	5.5
			52 to 54.5 cm	6.8	7.5	6.6	11	7.2	7.7	8.0	2.1	9.1	2.3	12	2.8
			61 to 63.5 cm	8.6	9.9	6.7	6.5	8.8	8.4	7.9	1.6	9.2	1.6	12	2.4
			70 to 72.5 cm	15	9.8	11	13			12	2.3	14	2.1	17	3.2
Endosulfan I	0.43	2.5	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
			52 to 54.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			61 to 63.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			70 to 72.5 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
Endosulfan II	0.8	5.0	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
			52 to 54.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			61 to 63.5 cm	ND	1.6	ND	1.4	ND	ND	1.5	0.14	1.8	0.05	2.4	0.17
			70 to 72.5 cm	2.3	ND	ND	ND			2.3	.	2.5	.	3.3	.
Endosulfan Sulfate	2.0	5.0	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
			52 to 54.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			61 to 63.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			70 to 72.5 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
Endrin	0.84	5.0	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
			52 to 54.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			61 to 63.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			70 to 72.5 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.

Table 15 continued...

Chemical Parameter	Method Detection Limit	Estimated Quantitation Limit	Length Group*	Composite Number				Replicate**		Length Group Average	Length Group STDEV	Skin-on Trimmed (SOT) Fillet Average	Skin-on Trimmed (SOT) Fillet STDEV	Skin-on Untrimmed (SOUT) Fillet Average	Skin-on Untrimmed (SOUT) Fillet STDEV
				1	2	3	4	1	2						
Endrin Aldehyde	1.0***	5.0	43 to 48.0 cm	ND	ND	ND	5.6			5.6	.	6.4	.	7.9	.
			52 to 54.5 cm	ND	ND	2.8	4.9	ND	ND	3.9	1.5	4.3	1.7	5.6	2.0
			61 to 63.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			70 to 72.5 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
Endrin Ketone	0.9	5.0	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
			52 to 54.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			61 to 63.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			70 to 72.5 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
Gamma-BHC (Lindane)	0.48	2.5	43 to 48.0 cm	ND	ND	ND	0.50			0.5	.	0.6	.	0.7	.
			52 to 54.5 cm	ND	0.56	ND	ND	0.56	ND	0.6	.	0.6	.	0.8	.
			61 to 63.5 cm	0.74	ND	ND	ND	0.90	0.57	0.7	.	0.8	.	1.1	.
			70 to 72.5 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
Gamma-Chlordane	1.6	2.5	43 to 48.0 cm		ND	ND	ND			ND	.	ND	.	ND	.
			52 to 54.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			61 to 63.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			70 to 72.5 cm	ND	ND	1.7	1.6			1.7	0.07	1.8	0.08	2.2	0.04
Heptachlor	0.72	2.5	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
			52 to 54.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			61 to 63.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			70 to 72.5 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
Heptachlor Epoxide	0.66	2.5	43 to 48.0 cm	1.3	1.1	1.1	2.9			1.6	0.9	2.0	0.9	2.4	1.1
			52 to 54.5 cm	1.7	1.8	1.6	2.4	1.8	1.7	1.9	0.4	2.1	0.4	2.7	0.5
			61 to 63.5 cm	2.1	2.3	1.5	1.3	2.2	2.0	1.8	0.5	2.1	0.5	2.7	0.7
			70 to 72.5 cm	3.1	1.9	1.8	2.4			2.3	0.6	2.6	0.6	3.3	0.9
Hexachlorobenzene	0.45	2.5	43 to 48.0 cm	1.2	1.3	1.2	2.5			1.6	0.6	1.9	0.6	2.3	0.8
			52 to 54.5 cm	1.6	2.2	1.9	2.3	2.2	2.1	2.0	0.3	2.3	0.3	2.9	0.3
			61 to 63.5 cm	2.5	2.6	2.3	2.3	2.5	2.4	2.4	0.1	2.8	0.2	3.7	0.2
			70 to 72.5 cm	3.7	2.9	3.7	3.6			3.5	0.4	3.9	0.3	5.0	0.3

Table 15 continued...

Chemical Parameter	Method Detection Limit	Estimated Quantitation Limit	Length Group*	Composite Number				Replicate**		Length Group Average	Length Group STDEV	Skin-on Trimmed (SOT) Fillet Average	Skin-on Trimmed (SOT) Fillet STDEV	Skin-on Untrimmed (SOUT) Fillet Average	Skin-on Untrimmed (SOUT) Fillet STDEV
				1	2	3	4	1	2						
Methoxychlor	2.8***	25	43 to 48.0 cm	3.6	ND	3.9	ND			3.8	0.2	4.7	0.1	5.7	0.4
			52 to 54.5 cm	4.2	3.3	ND	ND	3.3	ND	3.8	0.6	4.3	0.8	5.6	1.3
			61 to 63.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			70 to 72.5 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
Mirex	0.99***	5.0	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
			52 to 54.5 cm	ND	1.5	ND	ND	ND	1.5	1.5	.	1.7	.	2.1	.
			61 to 63.5 cm	2.9	ND	2.3	5.1	ND	2.9	3.4	1.5	4.1	2.0	5.3	2.5
			70 to 72.5 cm	3.9	3.5	7.4	8.6			5.9	2.5	6.5	2.7	8.2	3.1
Oxychlordane	0.72	5.0	43 to 48.0 cm	0.9	0.8	1.2	2.8			1.4	0.9	1.7	1.0	2.1	1.3
			52 to 54.5 cm	1.8	1.7	3.1	3.1	1.6	1.8	2.4	0.8	2.8	0.8	3.5	1.1
			61 to 63.5 cm	3.0	3.5	2.4	3.4	3.1	2.8	3.1	0.5	3.6	0.7	4.7	0.9
			70 to 72.5 cm	5.4	4.1	4.8	7.4			5.4	1.4	6.1	1.5	7.7	1.8
Pentachloroanisole	0.36	2.5	43 to 48.0 cm	ND	ND	ND	ND			ND	.	ND	.	ND	.
			52 to 54.5 cm	0.71	0.79	ND	0.66	0.79	ND	0.72	0.07	0.83	0.08	1.1	0.09
			61 to 63.5 cm	ND	ND	ND	ND	ND	ND	ND	.	ND	.	ND	.
			70 to 72.5 cm	ND	ND	ND	0.84			0.84	.	0.93	.	1.2	.
Total Chlordane	sum of - cis-chlordane, trans-chlordane, cis-nonachlor, trans nonachlor, oxychlordane		43 to 48.0 cm	11	9	12	39			18	14	21	15	26	19
			52 to 54.5 cm	17	18	27	36	18	18	25	8.9	28	10	36	12
			61 to 63.5 cm	25	28	27	40	26	23	30	6.9	35	10	46	12
			70 to 72.5 cm	48	39	76	100			66	28	74	30	92	35
Total DDT	sum of - 2,4'-DDD, 2,4'-DDE, 2,4'-DDT, 4,4'-DDD, 4,4'-DDE, 4,4'DDT		43 to 48.0 cm	13	9.3	13	43			20	16	24	17	29	21
			52 to 54.5 cm	23	22	39	54	24	20	35	15	39	17	50	21
			61 to 63.5 cm	32	41	42	72	37	27	47	17	55	24	72	30
			70 to 72.5 cm	78	69	160	190			120	60	140	65	170	75
Total Mercury****	1.30		43 to 48.0 cm	99.0	82.0	188	170			135	52	.	.	.	.
			52 to 54.5 cm	142	133	305	247	133	133	207	83	.	.	.	.
			61 to 63.5 cm	227	168	244	280	230	224	230	47	.	.	.	.
			70 to 72.5 cm	320	292	422	534			392	110	.	.	.	.

Table 15 continued...

Chemical Parameter	Method Detection Limit	Estimated Quantitation Limit	Length Group*	Composite Number				Replicate**		Length Group Average	Length Group STDEV	Skin-on Trimmed (SOT) Fillet Average	Skin-on Trimmed (SOT) Fillet STDEV	Skin-on Untrimmed (SOUT) Fillet Average	Skin-on Untrimmed (SOUT) Fillet STDEV
				1	2	3	4	1	2						
Total PCBs	12	50	43 to 48.0 cm	28	23	28	86			41	30	50	31	61	40
			52 to 54.5 cm	35	39	64	93	38	40	58	27	65	30	84	37
			61 to 63.5 cm	54	69	79	110	54	53	78	24	92	34	120	41
			70 to 72.5 cm	110	95	200	530			230	200	260	220	330	270
Toxaphene	46	250	43 to 48.0 cm	57	53	54	170			84	58	100	60	130	77
			52 to 54.5 cm	77	97	86	160	84	110	110	38	120	42	150	51
			61 to 63.5 cm	115	140	130	170	110	120	140	23	160	37	210	44
			70 to 72.5 cm	230	180	350	390			290	99	320	110	410	120
Trans-nonachlor	0.8	5.0	43 to 48.0 cm	5.3	4.2	5.6	19			8.5	7.0	10	7.5	13	9.5
			52 to 54.5 cm	7.7	8.6	12	18	8.2	9.0	12	4.7	13	5.1	17	6.5
			61 to 63.5 cm	12	14	14	21	11	12	15	4.1	18	6.0	23	7.2
			70 to 72.5 cm	24	20	44	54			36	16	40	18	50	20

ND = Not detected. "ND" values were treated as "0" and were not included in length group average calculations.

* Length groups in centimeters correspond to inches as follows: 43 to 48 cm = 17 to 19 inches; 52 to 54.5 cm = 20.5 to 21.5 inches; 61 to 63.5 cm = 24 to 25 inches; and 70 to 72.5 cm = 27.5 to 28.5 inches.

** For the 52 to 54.5 cm length group, the values for composite 2 represent the average of two replicates. For the 61 to 63.5 cm length group, the values for composite 1 represent the average of two replicates.

*** The method detection limit and estimated quantitation limit values vary for each compound depending on sample dilutions and the presence of interferences that affect how a compound is quantitated. The values displayed for these analytes are the lowest reported values from En Chem based on no dilutions or interferences.

**** Total mercury concentrations were not calculated for SOT and SOUT fillets because mercury binds to muscle tissue and concentrations is not reduced by trimming fillets.

Table 16. Average relative percent difference (RPD) between measured and predicted chemical concentrations in Lake Superior lake trout (*Salvelinus namaycush namaycush*) fat and skin tissues. Only chemicals with both a predicted and measured observation are included.

Tissue	Chemical Parameter	Observations*	RPD	Tissue	Chemical Parameter	Observations*	RPD
FAT	4,4'-DDD	1	116%	SKIN	4,4'-DDD	1	68.6%
FAT	4,4'-DDE	3	22.5%	SKIN	4,4'-DDE	3	-17.4%
FAT	4,4'-DDT	3	-4.14%	SKIN	4,4'-DDT	3	-9.84%
FAT	Aroclor 1260	3	11.1%	SKIN	Aroclor 1260	3	-28.9%
FAT	Dieldrin	3	1.80%	SKIN	Dieldrin	3	-21.3%
FAT	Endrin Aldehyde	1	-28.4%	SKIN	Endrin Aldehyde	1	-46.0%
FAT	Heptachlor Epoxide	3	2.82%	SKIN	Heptachlor Epoxide	3	-31.4%
FAT	Hexachlorobenzene	3	41.5%	SKIN	Hexachlorobenzene	3	-3.83%
FAT	Mirex	1	210%	SKIN	Mirex	2	134%
FAT	Oxychlordane	3	-1.01%	SKIN	Oxychlordane	3	-28.6%
FAT	Total Chlordane	3	-7.60%	SKIN	Total Chlordane	3	-37.1%
FAT	Total DDT	3	17.7%	SKIN	Total DDT	3	-17.2%
FAT	Total PCBs	3	-41.3%	SKIN	Total PCBs	3	-62.6%
FAT	Toxaphene	3	-26.0%	SKIN	Toxaphene	3	-48.2%
FAT	Trans-nonachlor	3	10.2%	SKIN	Trans-nonachlor	3	-25.9%
FAT	alpha-BHC	1	-5.54%	SKIN	alpha-BHC	1	-31.1%
FAT	alpha-Chlordane	3	6.81%	SKIN	alpha-Chlordane	3	-40.1%
FAT	cis-nonachlor	3	-21.1%	SKIN	cis-nonachlor	3	-45.3%
FAT	gamma-BHC (Lindane)	1	39.5%	SKIN	gamma-Chlordane	1	-50.5%
FAT	gamma-Chlordane	1	-37.7%			Mean	-18.0%
		Mean	15.3%			StDev	44.6%
		StDev	55.7%				

* Observations – Number of composites represented in the RPD calculation. A total of three composites each of fat and skin were analyzed.

Table 17. Lake Superior lake trout (*Salvelinus namaycush namaycush*) mean, standard deviation, and range of chemical concentrations (ug/kg) in muscle tissue, skin-on trimmed fillet (SOT) and skin-on, untrimmed fillet (SOUT) for each composite size group. Results for SOT and SOUT fillets are estimated values based on the wet weight of tissues in the composites and percent lipid in those tissues. United States Food and Drug Administration (FDA) action levels regulating the commercial sale of fish are given for each chemical or chemical group.

Chemical Parameter	Tissue*	Lake Trout Size Group (cm)	Mean Conc. (ug/kg)	St. Dev. (ug/kg)	Range** (ug/kg)	FDA Level (ug/kg)
Total Mercury	M	46	135	52	82-188	1000***
	M	54	207	83	133-305	
	M	62	230	47	168-280	
	M	71	392	110	292-534	
Total PCBs	M	46	41	30	23-86	2000
	M	54	58	27	35-93	
	M	62	78	24	54-110	
	M	71	230	200	95-530	
	SOT	46	50	31	34-98	
	SOT	54	65	30	41-100	
	SOT	62	92	34	59-140	
	SOT	71	260	220	110-590	
	SOUT	46	61	40	39-120	
	SOUT	54	84	37	54-130	
	SOUT	62	120	41	78-180	
	SOUT	71	330	270	150-730	
Total Chlordane	M	46	18	14	8.7-39	300
	M	54	25	8.9	17-36	
	M	62	30	6.9	25-40	
	M	71	66	28	39-100	
	SOT	46	21	15	13-44	
	SOT	54	28	10	20-41	
	SOT	62	35	10	27-50	
	SOT	71	74	30	47-110	
	SOUT	46	26	19	15-55	
	SOUT	54	36	12	25-51	
	SOUT	62	46	12	35-64	
	SOUT	71	92	35	61-140	
Total DDT	M	46	20	16	9.3-43	5000
	M	54	35	15	22-54	
	M	62	47	17	32-72	
	M	71	120	60	69-190	
	SOT	46	24	17	14-49	
	SOT	54	39	17	25-61	
	SOT	62	55	24	35-91	
	SOT	71	140	65	83-210	
	SOUT	46	29	21	16-61	
	SOUT	54	50	21	31-77	
	SOUT	62	72	30	46-110	
	SOUT	71	170	75	110-260	
Aldrin/Dieldrin	M	46	6.8	4.2	4.2-13	300
	M	54	8.0	2.1	6.6-11	
	M	62	7.9	1.6	6.5-9.9	
	M	71	12	2.3	9.8-15	
	SOT	46	8.4	4.3	5.2-15	
	SOT	54	9.1	2.3	7.4-12	
	SOT	62	9.2	1.6	7.7-11	
	SOT	71	14	2.1	12-16	
	SOUT	46	10	5.5	6.4-18	
	SOUT	54	12	2.8	9.7-16	
	SOUT	62	12	2.4	10-15	
	SOUT	71	17	3.2	15-22	

Table 17 Continued...

Chemical Parameter	Tissue*	Lake Trout Size Group (cm)	Mean Conc. (ug/kg)	St. Dev. (ug/kg)	Range** (ug/kg)	FDA Level (ug/kg)
Heptachlor/Heptachlor Epoxide	M	46	1.6	0.9	1.1-2.9	300
	M	54	1.9	0.4	1.6-2.4	
	M	62	1.8	0.5	1.3-2.3	
	M	71	2.3	0.6	1.8-3.1	
	SOT	46	2.0	0.9	1.4-3.3	
	SOT	54	2.1	0.4	1.8-2.7	
	SOT	62	2.1	0.5	1.6-2.6	
	SOT	71	2.6	0.6	2.0-3.4	
	SOUT	46	2.4	1.1	1.7-4.1	
	SOUT	54	2.7	0.5	2.4-3.4	
	SOUT	62	2.7	0.7	2.1-3.6	
	SOUT	71	3.3	0.9	2.4-4.5	
	Mirex	M	46	ND	.	.	100
M		54	1.5****	.	.	
M		62	3.4	1.5	ND-5.1	
M		71	5.9	2.5	3.5-8.6	
SOT		46	ND	.	.	
SOT		54	1.7****	.	.	
SOT		62	4.1	2.0	ND-6.4	
SOT		71	6.5	2.7	4.2-9.5	
SOUT		46	ND	.	.	
SOUT		54	2.1****	.	.	
SOUT		62	5.3	2.5	ND-8.1	
SOUT		71	8.2	3.1	5.5-12	

ND = Not Detected

* M = Muscle tissue (skin-off, trimmed fillet), SOT = Skin-on trimmed fillet, SOUT = Skin-on untrimmed fillet.

** The 54 and 62 cm size group ranges include the mean of duplicate samples, i.e. duplicates were not treated as separate samples for inclusion in the concentration ranges.

*** The FDA action level for mercury is for methylmercury. Generally >95% of mercury in top predator fish such as lake trout is methylmercury (GLIFWC data, unpublished).

**** Not a mean value because it was the only detected concentration in the group.

Table 18. Comparison of Lake Superior lake trout (*Salvelinus namaycush namaycush*) contaminant data collected by the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) between 1999 and 2003. Lake trout composite size group, mean chemical concentration, and concentration range are given for three chemicals/chemical groups.

Chemical Parameter	2003 Data			1999 Data		
	Lake Trout Size Group (cm)	Mean Conc.	Range	Lake Trout Size Group (cm)	Mean Conc.	Range
Total Mercury	43-48	135	82-188			
	52-54.5*	207	133-305			
	61-63.5*	230	168-280	64	163	133-193
	70-72.5	392	292-534	70	355	227-484
Total PCBs	43-48	41	23-86			
	52-54.5*	58	35-93			
	61-63.5*	78	54-110	64	229	178-280
	70-72.5	230	95-530	70	391	274-509
Total Chlordane	43-48	18	8.7-39			
	52-54.5*	25	17-36			
	61-63.5*	30	25-40	64	58	43-72
	70-72.5	66	39-100	70	99	72-127

* These ranges include the mean of duplicate samples, i.e. duplicates were not treated as separate samples for inclusion in the concentration ranges.

FIGURES

Figure 1. Lake Superior lake trout (*Salvelinus namaycush namaycush*) management units in the 1842 treaty-ceded area from which lake trout samples were collected.

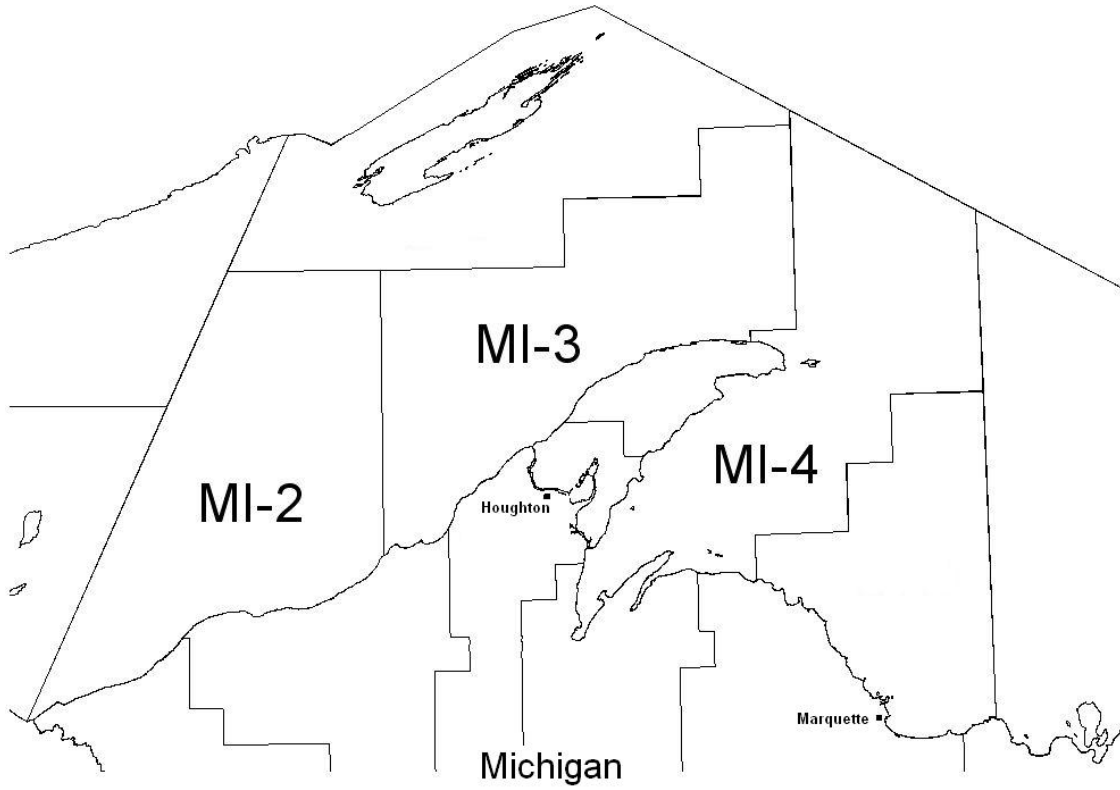


Figure 2. Great Lakes Indian Fish and Wildlife Commission (GLIFWC) lake trout (*Salvelinus namaycush namaycush*) monitoring data from Lake Superior lake trout management units MI-2, 3, and 4 from the years 1999-2003.

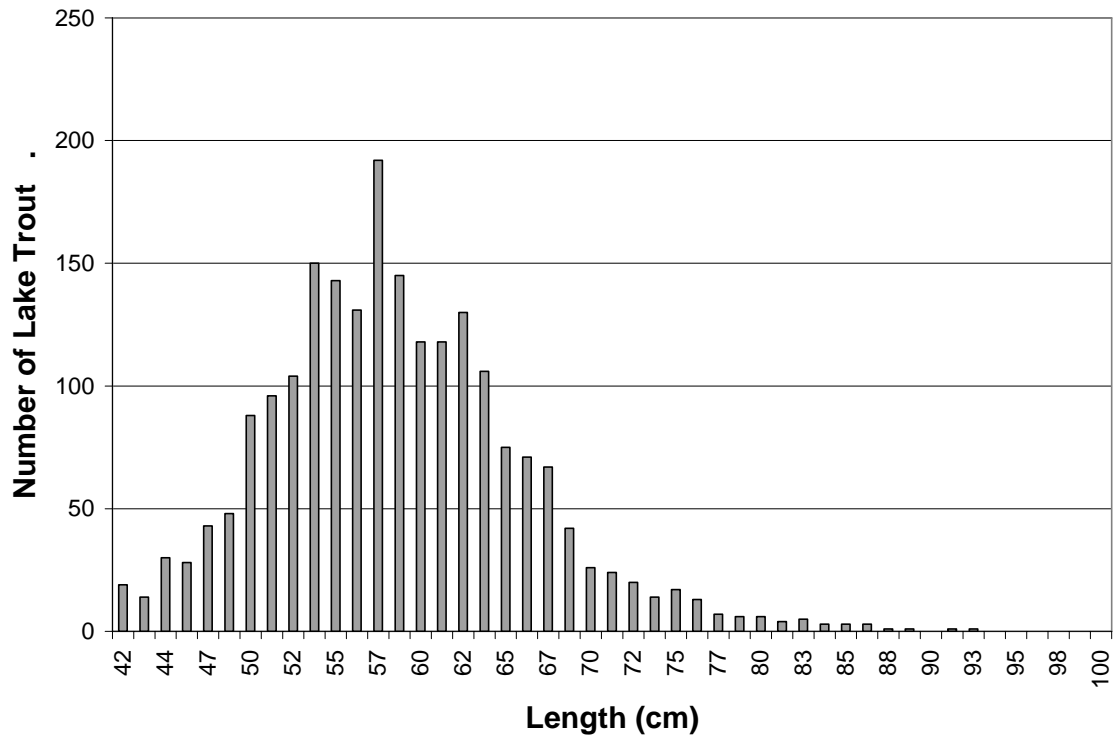


Figure 3. Mean \pm one standard deviation of total mercury concentrations in Lake Superior lake trout (*Salvelinus namaycush namaycush*) muscle tissue (i.e. trimmed, skin-off fillet) composites.

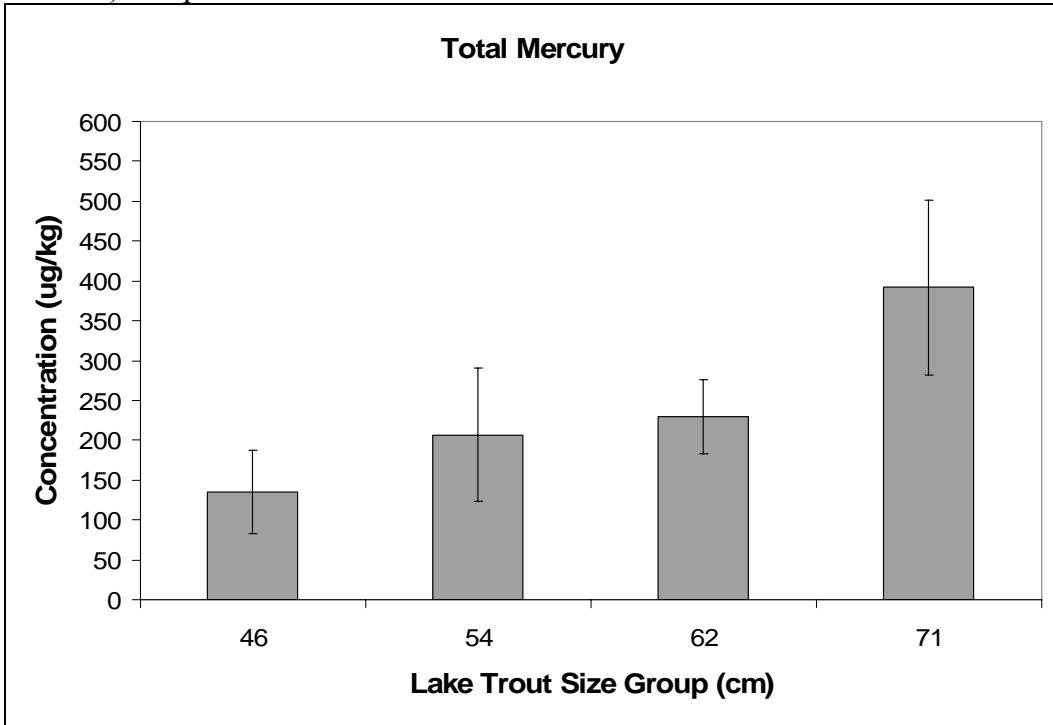


Figure 4. Mean \pm one standard deviation of total PCB concentrations in Lake Superior lake trout (*Salvelinus namaycush namaycush*) muscle tissue (i.e. trimmed, skin-off fillet) composites.

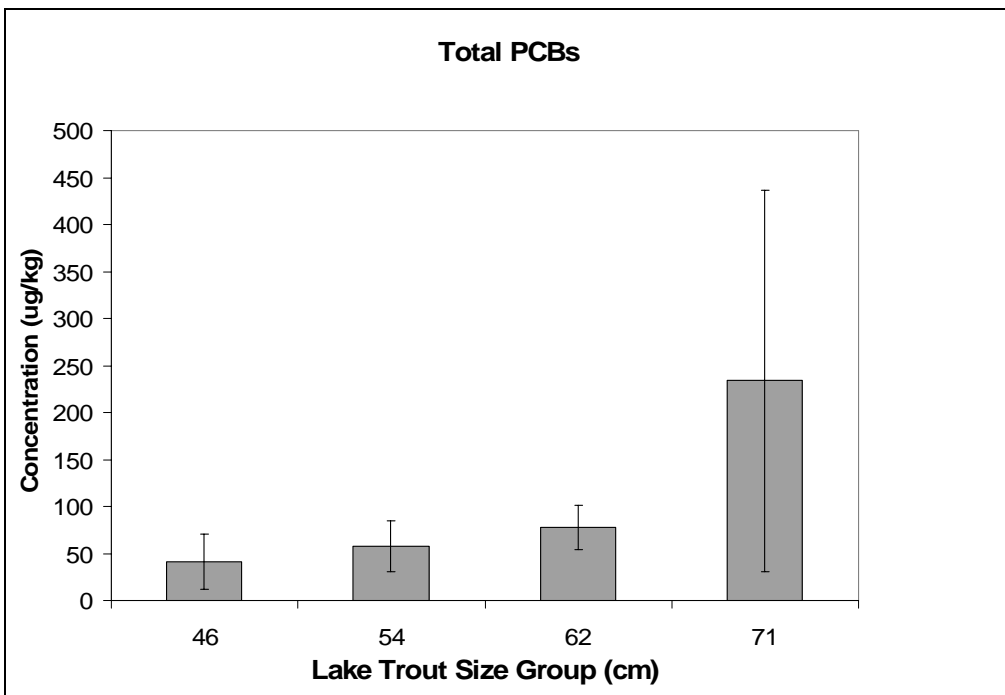


Figure 5. Mean \pm one standard deviation of total chlordane concentrations in Lake Superior lake trout (*Salvelinus namaycush namaycush*) muscle tissue (i.e. trimmed, skin-off fillet) composites.

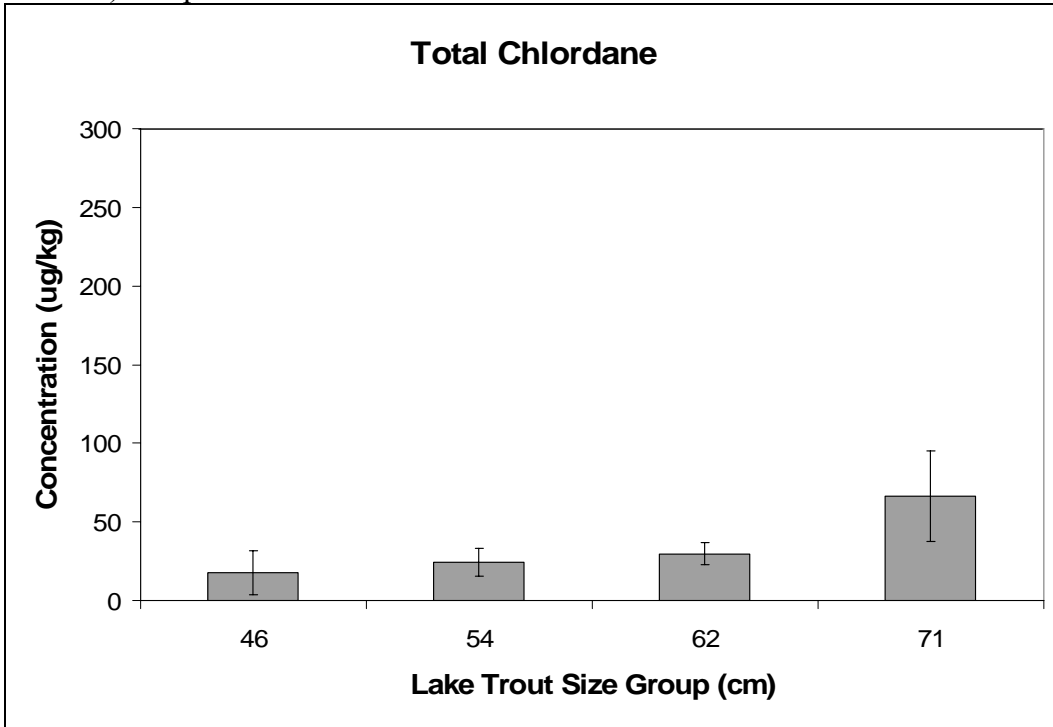


Figure 6. Mean \pm one standard deviation of total DDT concentrations in Lake Superior lake trout (*Salvelinus namaycush namaycush*) muscle tissue (i.e. trimmed, skin-off fillet) composites.

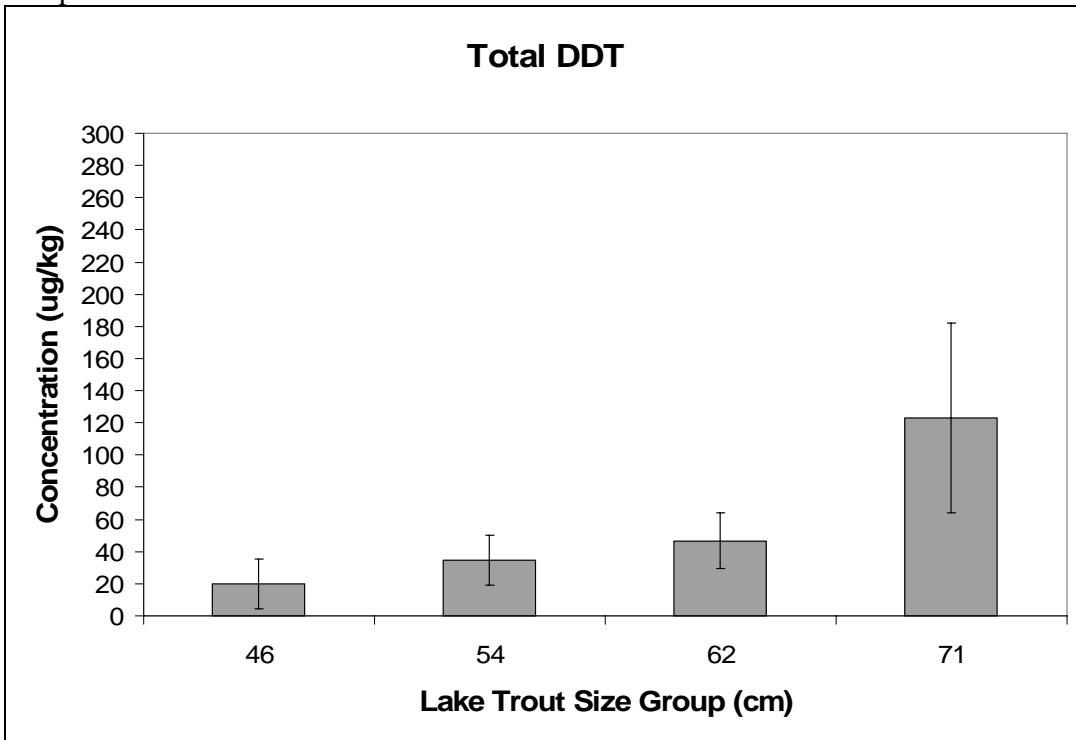


Figure 7. Mean \pm one standard deviation of toxaphene concentrations in Lake Superior lake trout (*Salvelinus namaycush namaycush*) muscle tissue (i.e. trimmed, skin-off fillet) composites.

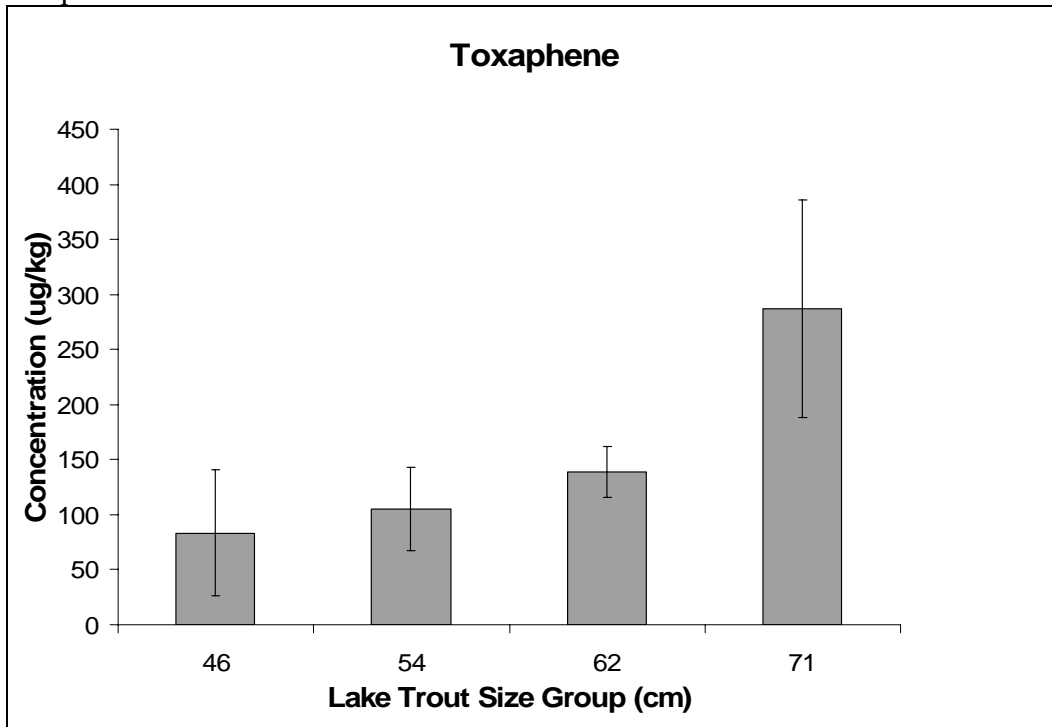


Figure 8. Mean \pm one standard deviation of dieldrin concentrations in Lake Superior lake trout (*Salvelinus namaycush namaycush*) muscle tissue (i.e. trimmed, skin-off fillet) composites.

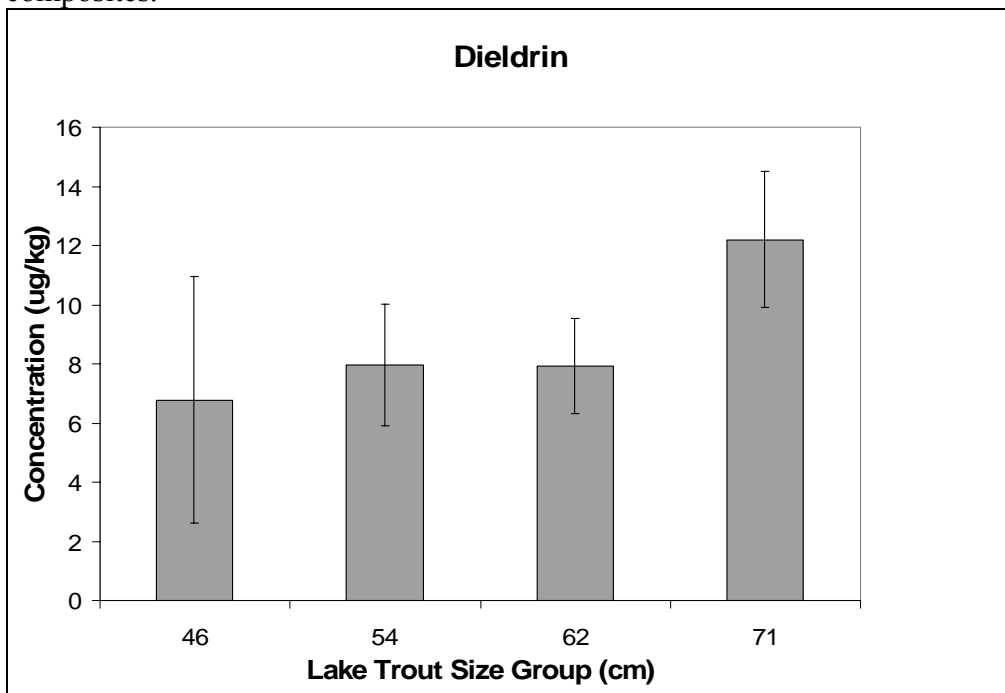


Figure 9. Mean \pm one standard deviation of hexachlorobenzene concentrations in Lake Superior lake trout (*Salvelinus namaycush namaycush*) muscle tissue (i.e. trimmed, skin-off fillet) composites.

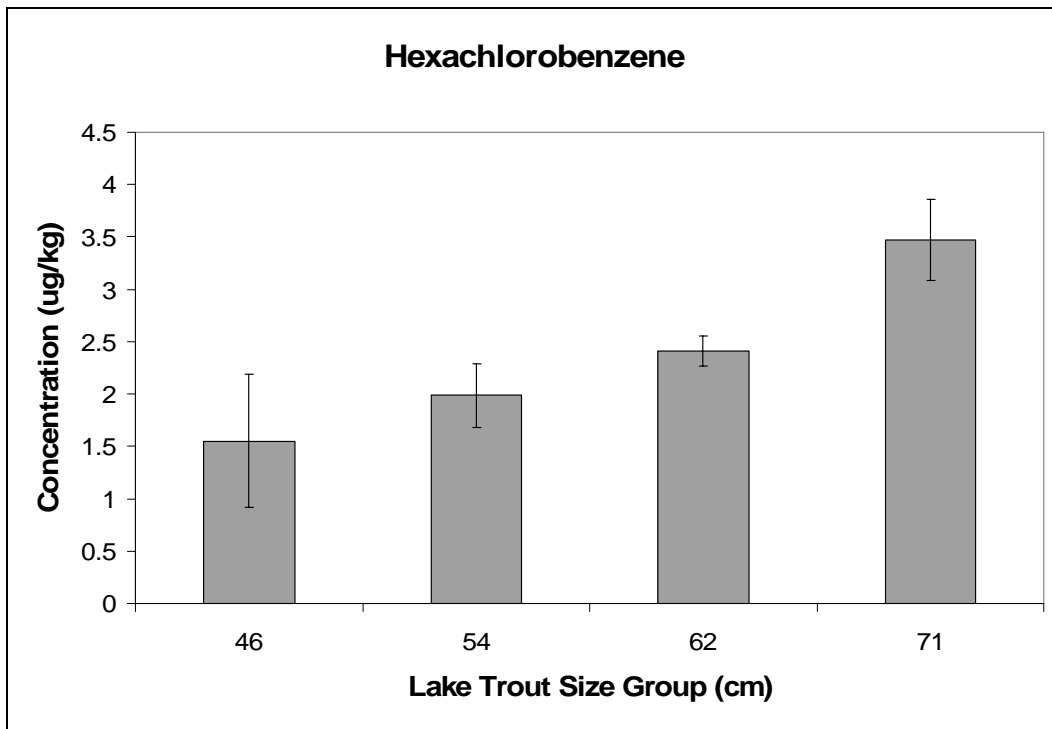


Figure 10. Mean \pm one standard deviation of mirex concentrations in Lake Superior lake trout (*Salvelinus namaycush namaycush*) muscle tissue (i.e. trimmed, skin-off fillet) composites.

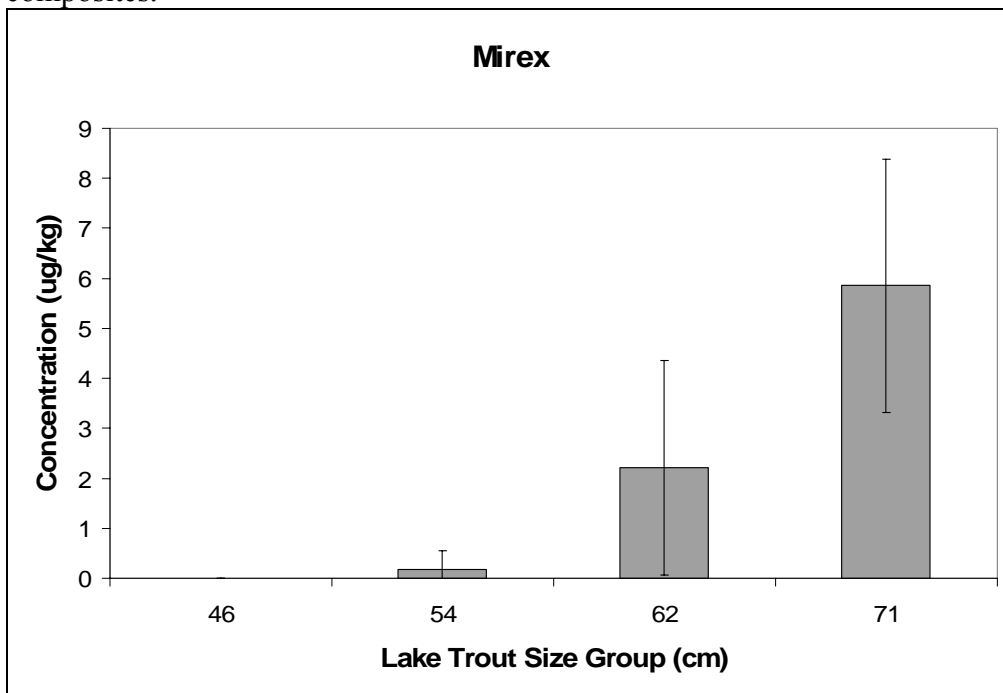


Figure 11. Mean \pm one standard deviation of heptachlor epoxide concentrations in Lake Superior lake trout (*Salvelinus namaycush namaycush*) muscle tissue (i.e. trimmed, skin-off fillet) composites.

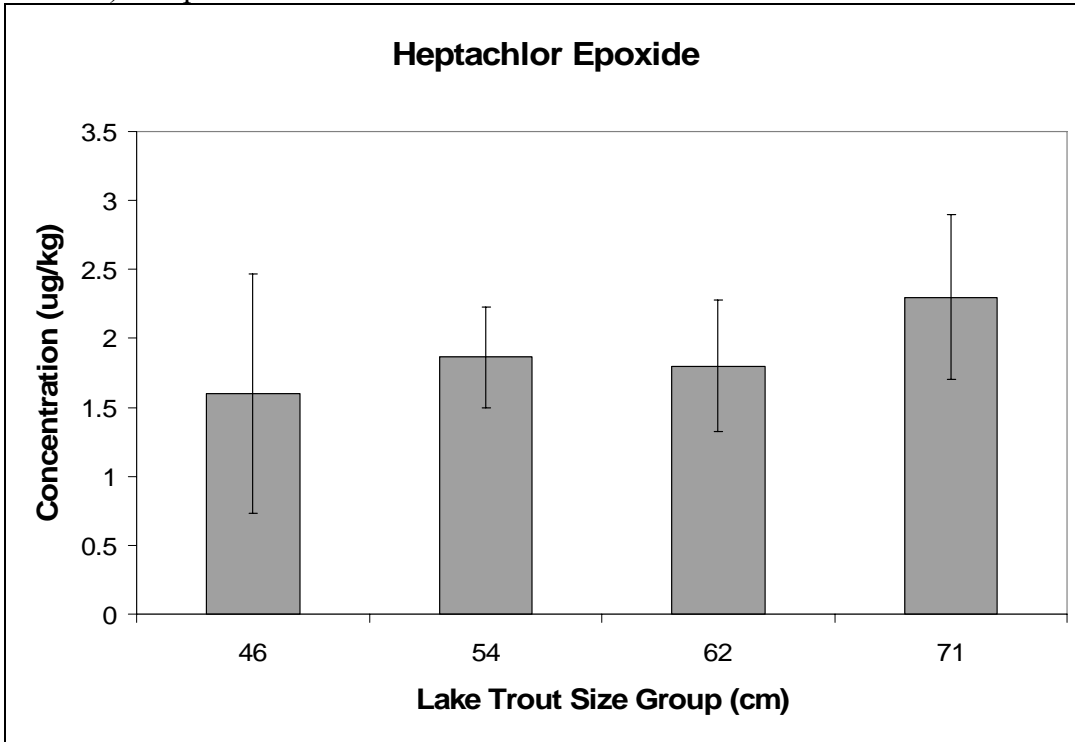


Figure 12. Plot of predicted versus measured organic chemical concentrations in three lake trout fat composite samples. Both the linear regression (solid line) and a line with a slope of one (dashed line) are given.

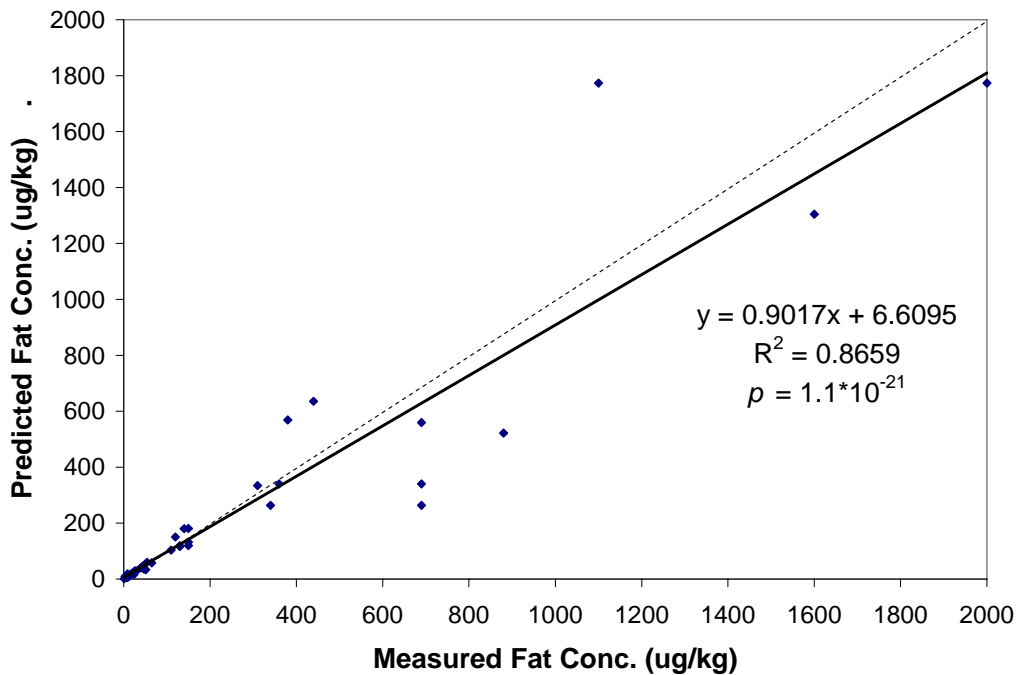


Figure 13. Plot of predicted versus measured organic chemical concentrations in three lake trout skin composite samples. Both the linear regression (solid line) and a line with a slope of one (dashed line) are given.

