Chemical Burdens in Fish from Alaskan Parks Compared to Human and Wildlife Health Consumption Thresholds

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November 2013

Introduction

This report is an addendum to the published paper, "Contaminants of Emerging Concern in Fish from Western U.S. and Alaskan National Parks–Spatial Distribution and Health Thresholds" (Flanagan *et al*. in press), with specific focus on contaminants in fish from Alaskan parks, including Lake Clark National Park & Preserve (LACL) and Katmai National Park & Preserve (KATM).

The importance of monitoring contaminants in fish has been discussed previously in Ackerman *et al.* 2008 and Flanagan *et al*. (in press). In brief, semi-volatile organic compounds (SOCs) including pesticides, industrial by-products such as polychlorinated biphenyls (PCBs), and combustion by-products like polycyclic aromatic hydrocarbons (PAHs) may negatively impact human and wildlife health. SOCs are known to persist in the environment, bioaccumulate in food chains, and cause reproductive abnormalities, cancer, or chronic disease (Ackerman *et al.* 2008, Schwindt *et al.* 2009). Some pesticides (DDTs, chlordanes, and endosulfans) and PCBs are endocrine disruptors causing impairment to the reproductive system and other bodily functions (Schwindt *et al.* 2009).

SOCs are deposited to terrestrial ecosystems from the atmosphere in cold, high elevation and high-latitude sites. SOCs in fish were measured at national parks in the western U.S. and Alaska during the Western Airborne Contaminants Assessment Project (WACAP). These results were compared with human and wildlife thresholds and some SOCs exceeded these limits in some individual fish (Ackerman *et al.* 2008, Landers *et al.* 2008, Landers *et al.* 2010, Schwindt *et al.* 2009).

This report summarizes the contaminant concentrations in fish from LACL collected from Lake Kontrashibuna and Kijik Lake in 2011 and fish from KATM collected from Idavain Lake and Lake Books also in 2011. These fish concentrations are compared to those from Denali National Park (DENA) (McLeod Lake and Wonder Lake), Gates of the Arctic NP & Preserve (GAAR) (Matcharak Lake), Noatak National Preserve (NOAT) (Burial Lake) that were collected in 2003-2007 during WACAP, and also those from Wrangell-St. Elias NP & Preserve (WRST) that were collected from Copper Lake in 2008 and Tanada Lake in 2009. Finally, the contaminant concentrations in fish from all of these parks are compared to human consumption and wildlife thresholds.

Study Design

The purpose of this study was to measure the concentration of airborne contaminants in 40 fish: 20 lake trout (*Salvelinus namaycush*) from LACL (Kijik Lake and Lake Kontrashibuna; Table 1), and 10 lake trout and 10 Arctic char (*Salvelinus alpinus*) from KATM (Lake Brooks and Idavain Lake, respectively; Table 2). This research stems from WACAP findings and was conducted to gain a better understanding of fish contaminant burdens at additional lakes located in Alaska. The parks included in the current study and WACAP are shown in Figure 1. Figure 2 is a map of Alaska depicting the locations of KATM and LACL. Figures 3 and 4 show the lakes that were sampled in LACL and KATM, respectively.

Water bodies within LACL and KATM parks were selected to compare anadromous (Kijik Lake in LACL and Lake Brooks in KATM) versus non-anadromous lakes (Lake Kontrashibuna in LACL and Idavain Lake). The lakes were remote and removed from anthropogenic influence (e.g., roads, latrines, developed areas) to isolate the contaminant loading by atmospheric deposition. Lake trout (Kijik Lake, Lake Kontrashibuna, and Lake Brooks) and Arctic char (Idavain Lake) were selected because they were available within these lakes and represent top level predators within the lake.

Measurement of SOCs in Fish

The 40 fish (Table 1 and 2) were analyzed for a wide-range of SOCs (Table 3). These SOCs (Table 3) were the same contaminants measured in fish collected for the WACAP study, excluding polybrominated diphenyl ethers (PBDEs) (Landers *et al*. 2008; Landers *et al*. 2010). Whole fish homogenate was prepared, extracted, and analyzed for a wide-range of pesticides, PAHs, and PCBs following the method described in Ackerman *et al*. 2008. Pesticides included both current-use pesticides (CUPs) and historic-use pesticides (HUPs, legacy contaminants now banned in North America). The concentrations of several pesticides that are structurally similar have been added together; including total chlordanes (termed "chlordanes" - sum of *oxy*-, *cis*,-, *trans*-chlordane, *cis*-, *trans*-nonachlor), total endosulfans (termed "endosulfans" - sum of endosulfan I, II and sulfate), and total PCBs (termed PCBs – sum of PCB 101, 118, 138, 153, 183, and 187). Only fish with pesticide concentrations above the estimated detection limits (consistent with Ackerman *et al.* 2008) are shown in the figures. Fish SOC concentrations are reported by wet weight of the whole fish (ng/g ww) (Figure 8 and 9) and by mass of lipid in the whole fish (ng/g lipid) (Figures 5-7). Normalizing concentrations to the lipid content of the individual fish helps to account for differences in individual fish, as well as fish species.

Contaminant specific human health thresholds were calculated based on contaminant consumption exceeding U.S. EPA guidance (see Ackerman *et al.* 2008). Wildlife health thresholds were calculated using fish contaminant consumption criteria for nonlethal reproductive and developmental wildlife health end points determined by the U.S. EPA (see Ackerman *et al.* 2008).

Results

SOC Concentrations in Fish, by Lake, in Lake Clark NP & Preserve

The lipid content and length of the individual fish in Kijik Lake and Lake Kontrashibuna are listed in Table 1. The average mg lipid/g extracted fish was significantly different (p-value = 0.011, paired, two-tailed t-test) between Kijik Lake fish (28.1 ± 15.2 mg lipid/g fish) and Lake Kontrashibuna fish (42.0 ± 5.12 mg lipid/g fish). However, the average fish length was not statistically different between Kijik Lake (466.6 ± 17.6 mm) and Lake Kontrashibuna (457.7 ± 30.1 mm).

Figure 5 shows the fish SOC concentrations, by lake, in Lake Clark NP & Preserve. The pesticides that were measured in >75% of the fish collected from Kijik Lake included p,p'- and o,p-dichlorodiphenylethene (p,p'-DDE), p,p'- dichlorodiphenyltrichloroethane (p,p'-DDT), hexachlorobenzene (HCB), *cis*-nonachlor, *trans*-nonachlor, *cis*-chlordane, *trans*-chlordane, oxy-chlordane, dieldrin, endosulfan I, endosulfan sulfate, chlorpyrifos, and mirex (Figure 5). These pesticides were also measured in >75% of the fish samples collected from Lake Kontrashibuna, with the exception of o,p-DDE and p,p'-DDT and the addition of heptachlor epoxide. The highest mean concentration of pesticide measured at Kijik Lake was p,p'-DDE (1626 ng/g lipid), however it was *cis*-nonachlor at Lake Kontrashibuna (58.10 ng/g lipid). On a wet weight basis, Kijik Lake had significantly higher concentrations of mirex (p-value = 0.0069) and p,p'-DDE (p-value <0.0001) compared to Lake Kontrashibuna. All other concentrations were not statistically different. On a lipid basis, Kijik Lake had significantly higher concentrations of HCB (p-value = 0.0015), heptachlor epoxide (p-value = 0.0106), mirex (p-value = 0.0058), p,p'-DDE (p-value <0.0001), and p,p'-DDD (p-value = 0.0238).

Kijik Lake fish had approximately 38 times higher mean concentration of p,p'-DDE on a ng/g lipid basis (3 times higher on a ng/g ww basis) compared to Lake Kontrashibuna. Although the same fish species (lake trout) were sampled at each lake, Kijik Lake is anadromous, meaning salmon from the ocean migrate into the lake providing an additional food source for the lake trout, and Lake Kontrashibuna is non-anadromous. The two lakes are only 40km from each other; therefore, the variation in food sources in the lakes may be contributing to the differences in lipid and contaminant concentration measured in the fish from each lake.

SOC Concentrations in Fish, by Lake, in Katmai NP & Preserve

The lipid content and length of the fish in Idavain Lake and Lake Brooks are listed in Table 2. The average mg lipid/g extracted fish was significantly different (p-value 0.0002, paired, two-tailed t-test) between Idavain Lake fish (Arctic char) (24.7 ± 12.4 mg lipid/g fish) and Lake Brooks fish (lake trout) (69.9 ± 23.9 mg lipid/g fish). The average fish length was also statistically different (p-value<0.0001) between Idavain Lake fish (Arctic char) (297.5 ± 36.2 mm) and Lake Brooks fish (lake trout) (528.4 ± 37.0 mm).

Figure 6 shows the fish SOC concentrations, by lake, in Katmai NP & Preserve. The pesticides that were measured in >75% of the fish samples, at both lakes, were fewer in number than those measured in Lake Clark NP and Preserve. At Idavain Lake, p,p'-DDE, HCB, *cis*-nonachlor, *trans*-nonachlor, *trans*-chlordane, endosulfan I, endosulfan sulfate, and chlorpyrifos were measured at >75% of the fish. The same pesticides were measured in Lake Brooks fish as Idavain Lake, with the addition of o,p-dichlorodiphenylethene (o,p-DDE), p,p'- dichlorodiphenydichloroethene (p,p'-DDD), p,p'-DDT, a-hexachlorocyclohexane (a-HCH), *cis*-chlordane, oxy-chlordane, dieldrin, and mirex, and heptachlor epoxide, but not endosulfan I. On a wet weight basis, Lake Brooks had statistically significantly higher concentrations of HCB (p-value = <0.0001), chlordanes (p-value = 0.0028) and p,p'-DDE (p-value < 0.0001). On a lipid basis, Lake Brooks had significantly higher concentrations of HCB (p-value = 0.0373) and p,p'-DDE (p-value = 0.0022).

Lake Brooks fish (lake trout) had approximately 13 times higher concentration of p,p'-DDE on a ng/g lipid basis (32 times higher on a ng/g ww basis) than at Idavain Lake (Arctic char). This may be because different fish species were collected and measured at the lakes (lake trout from Lake Brooks and Arctic char from Idavain Lake). Also, similar to higher concentrations of contaminants measured in anadromous fish from Kijik Lake compared to non-anadromous fish from Lake Kontrashibuna, anadromous fish from Lake Brooks may have a different food source than the non-anadromous fish from Idavain Lake.

Comparison to WACAP Fish SOC Concentrations

Figure 7 shows the fish pesticide concentrations in ng/g lipid measured in this study (Kijik Lake and Lake Kontrashibuna at LACL, and Lake Brooks and Idavain Lake at KATM), along with the fish pesticide concentrations measured in Alaskan parks as part of WACAP (Burial Lake at NOAT, Matcharak Lake at GAAR, McLeod Lake and Wonder Lake at DENA) (Ackerman *et al*. 2008, Landers et al 2008; Figure 1), and Tanada Lake and Copper Lake at WRST. Figure 8 shows the fish pesticide concentrations for these same lakes in ng/g wet weight (ww). In general, the pesticide profiles among the various lakes are similar on both a ng/g lipid and ng/g ww basis.

Average fish concentrations (ng/g lipid) of individual chlordanes (p-value <0.0006), total chlordanes (p-value < 0.0001) mirex (p-value = 0.0137), p,p'-DDE (p-value<0.0001, PCB 101 (p-value = 0.0165), PCB 118 (p-value = 0.0261), PCB 153 (p-value = 0.0119) and total PCBs (p-value = 0.0003) concentrations were significantly higher in fish from Kijik Lake (LACL) compared to Lake Kontrashibuna (LACL), Lake Brooks (KATM) and Idavain Lake (KATM) (Figure 7). Kijik Lake and Idavain Lake had similar concentrations of PCB 138, PCB 183, and PCB 187; however Kijik Lake had significantly higher concentration of these 3 individual PCBs compared to Lake Kontrashibuna (p-value = 0.0003, 0.0033, 0.0023, respectively) and and Lake Brooks (p-value = 0.0004, 0.0028, and 0.0032, respectively) .The concentrations of the pesticide p,p'-DDD were similar in fish collected from Kijik and Idavain Lakes, but were statistically lower between Kijik Lake and Lake Kontrashibunua (p-value = 0.0238) and Lake Brooks (p-value = 0.0002). The remaining individual pesticides, individual PCBs, and total endosulfans concentrations (termed “endosulfans” - sum of endosulfan I, II and sulfate), were not statistically different among the four lakes. The individual and total chlordane (p-value < 0.001), mirex (p-value = 0.0052), p,p’-DDE (p-value < 0.0001), and individual and total PCBs (p-value < 0.0008) concentrations in fish from Kijik Lake were also higher than their average concentrations in fish from WACAP and WRST. However, the other pesticide concentrations in Kijik Lake were not statistically different from WACAP and WRST fish (Figure 7). Gamma-HCH was not detected in any fish collected for this study and a-HCH was not detected in fish from Kijik Lake or Idavain Lake, but was detected fish from Lake Kontrashibuna and Lake Brooks. Mirex and heptachlor epoxide were not detected in fish from Idavain Lake, but were measured in fish from Lake Brooks, Kijik Lake, and Lake Kontrashibuna.

Comparison of Fish SOC Concentrations to Human Health Thresholds

Contaminant human health thresholds were adopted from the U.S. Environmental Protection Agency (EPA) to evaluate non-cancer and cancer causing contaminant health thresholds for recreational or subsistence fish consumption (see Ackerman *et al*. 2008). These data are shown in Figure 8 and Table 4 (subsistence fish consumption only). No fish in Kijik Lake, Lake Kontrashibuna, Lake Brooks, or Idavain Lake exceeded the pesticide concentration threshold for recreational fish consumption (Figure 8). Dieldrin concentrations exceeded the subsistence fish consumption threshold at all four lakes, and ranged from 1 out of 10 fish at Idavain Lake (the other 9 fish had dieldrin concentrations below the detection limit) up to 7 out of 10 fish at Lake Brooks (Table 4). Chlordane concentrations exceeded the subsistence consumption threshold in fish from both Kijik Lake (2 out of 10 fish) and Lake Kontrashibuna (1 out of 10 fish), but not at either lake in KATM. p,p’-DDE concentrations in all 10 fish from Kijik Lake and 4 out of 10 fish from Lake Brooks exceeded the threshold for subsistence fish consumption.

Comparison of Fish SOC Concentrations to Wildlife Health Thresholds

Contaminant health thresholds for piscivorous wildlife (kingfisher, mink, and river otter) were derived from EPA nonlethal reproductive and developmental wildlife health end points as indicators of a negative effect (see Ackerman *et al*. 2008). The data for chlordanes, dieldrin, and p,p'-DDE are shown in Figure 9 and Table 5. No individual fish from the four lakes exceeded the mink or river otter health thresholds (Figure 9). However, chlordane concentrations exceeded the threshold for kingfisher at Kijik Lake (8 out of 10 fish), Lake Kontrashibuna (2 out of 10), and Lake Brooks (7 out of 10) and p,p'-DDE at Kijik Lake (10 out of 10) and Lake Brooks (2 out of 10). No fish from other lakes in Alaska exceeded the kingfisher threshold in the WACAP study. Wildlife contaminant health thresholds for the remaining historic-use pesticides and for the current-use pesticides have not been established because of lack of data (Ackerman *et al*. 2008).

Figure 1. Map of national parks where fish were collected and subsequently analyzed for SOC concentrations by the Simonich Lab: WACAP and current study. WACAP fish samples were collected in 2003–2007. Fish samples analyzed in the current study were collected in 2008–2009 and 2011.

Figure 2: Map of southern Alaska to show the locations of LACL and KATM.

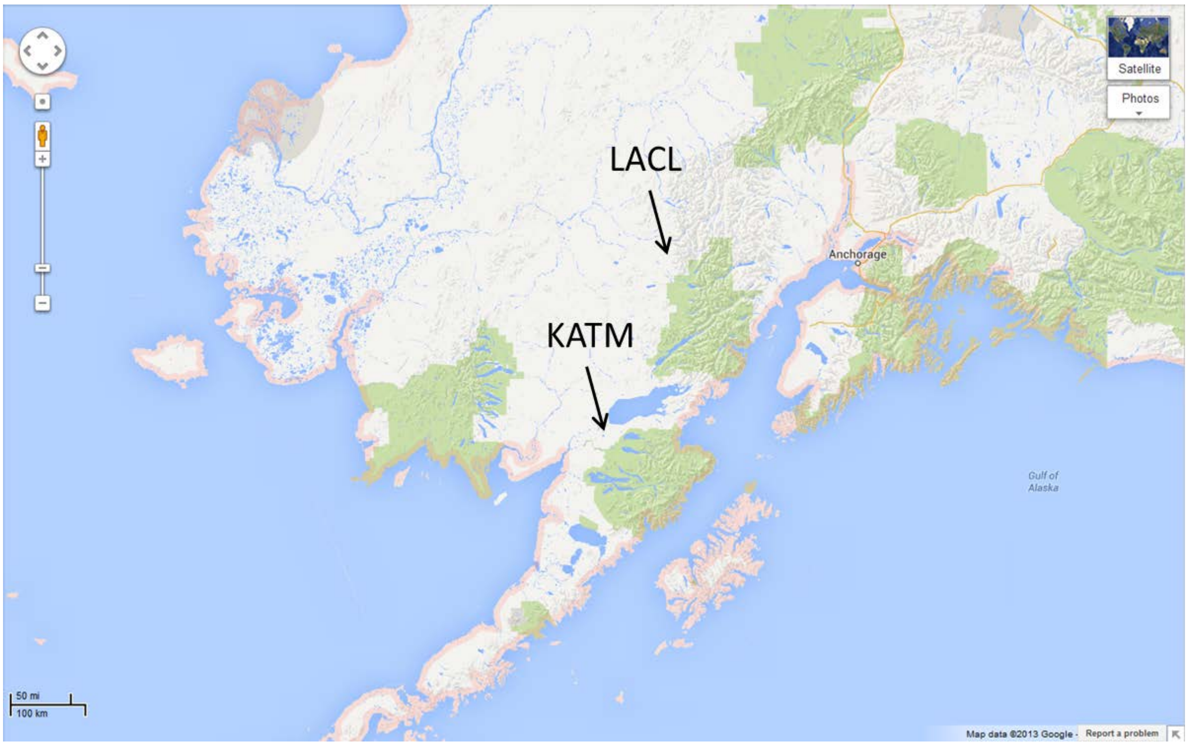


Figure 3. LACL with Kijik Lake and Lake Kontrashibuna.

Figure 4. KATM with Lake Brooks and Idavain Lake.

Table 1. Fish collected from LACL at Lake Kontrashibuna and Kijik Lake in 2011. Anadromous lakes are marked with "A" and non-anadromous lakes are marked with "NA".

Sample Name	Waterbody/Lake	Species	A or NA	Length (mm)	mg lipid/g fish
KONT 18	Lake Kontrashibuna	Lake trout	NA	459	38.74
KONT 19	Lake Kontrashibuna	Lake trout	NA	438	39.46
KONT 20	Lake Kontrashibuna	Lake trout	NA	528	38.91
KONT 22	Lake Kontrashibuna	Lake trout	NA	452	45.20
KONT 23	Lake Kontrashibuna	Lake trout	NA	466	50.34
KONT 24	Lake Kontrashibuna	Lake trout	NA	432	48.40
KONT 25	Lake Kontrashibuna	Lake trout	NA	415	38.22
KONT 26	Lake Kontrashibuna	Lake trout	NA	470	33.84
KONT 27	Lake Kontrashibuna	Lake trout	NA	453	41.87
KONT 28	Lake Kontrashibuna	Lake trout	NA	464	44.75
KIJIK 1	Kijik Lake	Lake trout	A	480	30.19
KIJIK 2	Kijik Lake	Lake trout	A	470	23.80
KIJIK 3	Kijik Lake	Lake trout	A	474	19.17
KIJIK 4	Kijik Lake	Lake trout	A	425	38.59
KIJIK 5	Kijik Lake	Lake trout	A	452	24.95
KIJIK 6	Kijik Lake	Lake trout	A	486	57.38
KIJIK 7	Kijik Lake	Lake trout	A	474	45.66
KIJIK 8	Kijik Lake	Lake trout	A	475	7.78
KIJIK 9	Kijik Lake	Lake trout	A	458	12.79
KIJIK 10	Kijik Lake	Lake trout	A	472	20.64

Table 2. KATM fish collected at Lake Brooks and Idavain Lake in 2011. Anadromous lakes are marked with "A" and non-anadromous lakes are marked with "NA".

Sample Name	Waterbody/Lake	Species	A or NA	Length (mm)	mg lipid/g fish
LBROO 1	Lake Brooks	Lake trout	A	475	104.1
LBROO 2	Lake Brooks	Lake trout	A	480	96.71
LBROO 3	Lake Brooks	Lake trout	A	533	30.13
LBROO 4	Lake Brooks	Lake trout	A	589	84.92
LBROO 5	Lake Brooks	Lake trout	A	572	76.10
LBROO 6	Lake Brooks	Lake trout	A	500	57.41
LBROO 7	Lake Brooks	Lake trout	A	540	73.29
LBROO 8	Lake Brooks	Lake trout	A	512	72.12
LBROO 9	Lake Brooks	Lake trout	A	538	34.60
LBROO 10	Lake Brooks	Lake trout	A	545	69.71
IDVAL 1	Idavain Lake	Arctic char	NA	355	33.45
IDVAL 2	Idavain Lake	Arctic char	NA	335	15.92
IDVAL 3	Idavain Lake	Arctic char	NA	286	51.73
IDVAL 4	Idavain Lake	Arctic char	NA	245	15.60
IDVAL 5	Idavain Lake	Arctic char	NA	307	23.79
IDVAL 6	Idavain Lake	Arctic char	NA	243	30.52
IDVAL 7	Idavain Lake	Arctic char	NA	279	25.87
IDVAL 8	Idavain Lake	Arctic char	NA	313	10.53
IDVAL 9	Idavain Lake	Arctic char	NA	292	27.60
IDVAL 10	Idavain Lake	Arctic char	NA	320	11.68

Table 3. SOCs measured in fish by GC/MS using two modes of ionization.

Electron Impact Ionization	**Negative Chemical Ionization**
Pesticides and degradation products: o,p'-DDT, p,p'-DDT, o,p'-DDD, p,p'-DDD, o,p'-DDE, p,p'-DDE, Methoxychlor, Acetochlor PAHs[1]: Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Retene, Benz[a]anthracene, Chrysene, Triphenylene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Benzo[e]pyrene, Benzo[a]pyrene, Indeno[1,2,3-cd]pyrene, Dibenz[a,h]anthracene, Benzo[ghi]perylene Surrogates: d_{10}-Fluorene, d_{10}-Phenanthrene, d_{10}-Pyrene, d_{12}-Triphenylene, d_{12}-Benzo[a]pyrene, d_{12}-Benzo[ghi]perylene, d_8-p,p'-DDE, d_8-p,p'-DDT, d_6-Methyl Parathion, Internal Standards: d_{10}-Acenaphthene, d_{10}-Fluoranthene, d_{12}-Benzo[k]fluoranthene	Pesticides and degradation products: Hexachlorocyclohexanes (HCH) (α, β, γ, δ) Chlordanes[2] (cis, trans, oxy), Nonachlor (cis, trans), Heptachlor, Heptachlor Epoxide, Endosulfans[3] (I, II, and sulfate), Dieldrin, Aldrin, Endrin, Endrin Aldehyde, Hexachlorobenzene (HCB), Dacthal, Chlorpyrifos, Chlorpyrifos oxon, Trifluralin, Metribuzin, Triallate, Mirex PCBs[4]: PCB 74, PCB 101, PCB 118, PCB 138, PCB 153, PCB 183, and PCB 187 Surrogates: $^{13}C_{12}$ PCB 101 (2,2',4,5,5'-Pentachlorobiphenyl), $^{13}C_{12}$ PCB 180 (2,2', 3,4,4',5,5'-Heptachlorobiphenyl), d_{10} -Chlorpyrifos, $^{13}C_6$-HCB, d_6-γ-HCH, d_4-Endosulfan I, d_4-Endosulfan II Internal Standards: d_{14}-Trifluralin

[1] ΣPAHs= Chrysene+ Triphenylene+ Fluorene+ Phenanthrene+ Anthracene+ Fluoranthene+ Pyrene+ Retene+ Benz[a]anthracene+ Benzo[b]fluoranthene+ Benzo[k]fluoranthene+ Benzo[e]pyrene+ Benzo[a]pyrene+ Indeno[1,2,3-cd]pyrene+ Dibenz[a,h]anthracene+ Benzo[ghi]perylene

[2] Σchlordanes= *oxy*-chlordane+ *trans*-chlordane+ *cis*-chlordane+ *cis*-nonachlor+ *trans*-nonachlor

[3] Σendosulfans= endosulfan I+ endosulfan II+ endosulfan sulfate

[4] ΣPCBs= PCBs 101+ 118+ 138+ 153+ 183+ 187

Figure 5. Mean SOC concentrations in fish (ng/g lipid) from Kijik Lake and Lake Kontrashibuna in LACL. Bars represent standard error.

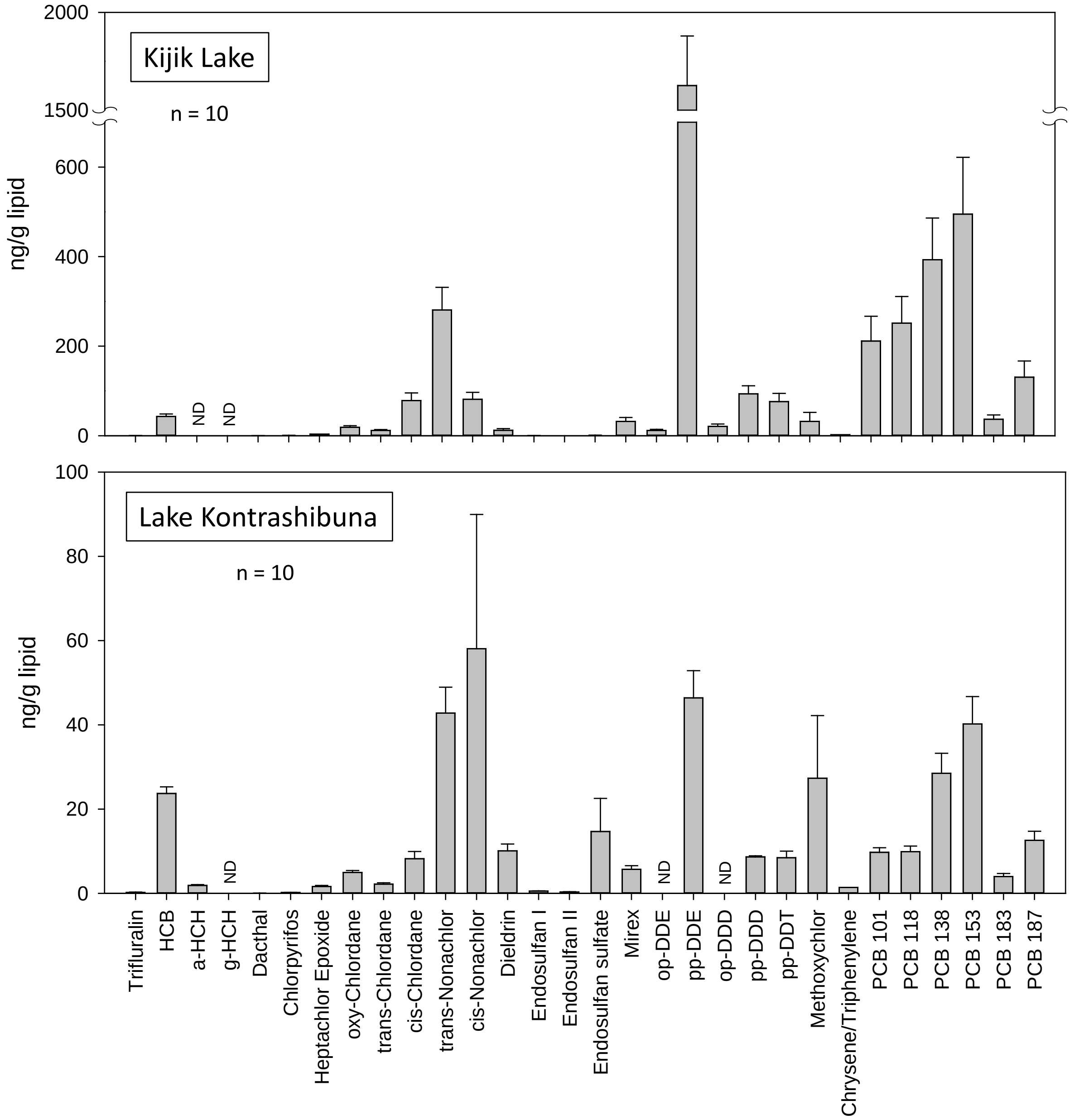


Figure 6. KATM mean SOC concentrations in fish (ng/g lipid) for Lake Brooks and Idavain Lake. Bars represent standard error.

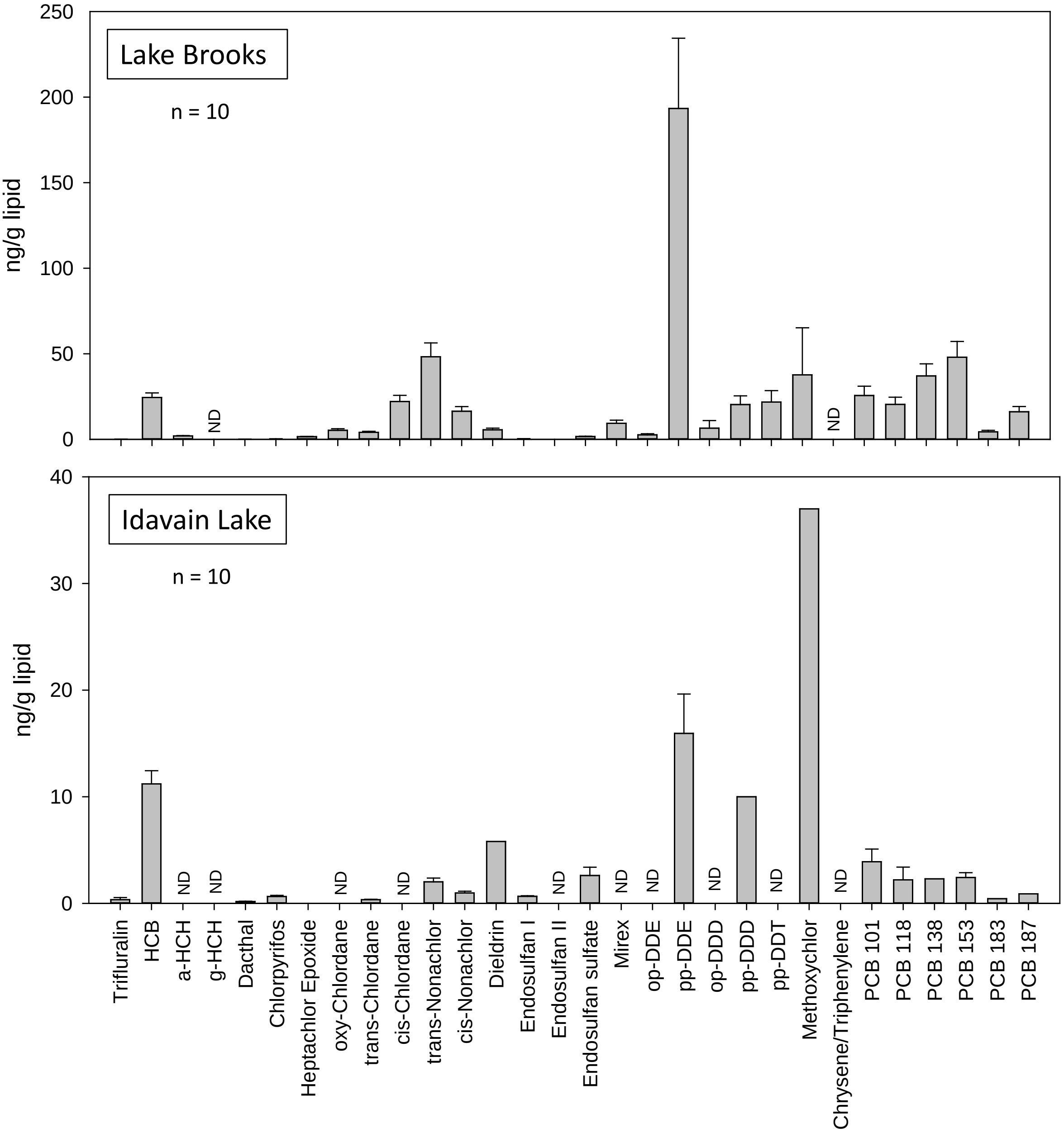


Figure 7 (A-M). Concentrations of the top 13 SOCs of concern in fish (ng/g lipid) Burial Lake (NOAT), Matcharak Lake (GAAR), McLeod Lake (DENA), Wonder Lake (DENA), Tanada Lake (WRST), Copper Lake (WRST), Kijik Lake (LACL), Lake Kontrashaibuna (LACL), Idavain Lake (KATM) and Lake Brooks (KATM). Top of bar indicates the mean concentration and the circles indicate concentrations of individual fish. Black bars depict data from current study; white bars depict previously published data from WACAP (Landers et al. 2010; Ackerman et al. 2008). ND, no detect; *, ND > 50% of lake fish.

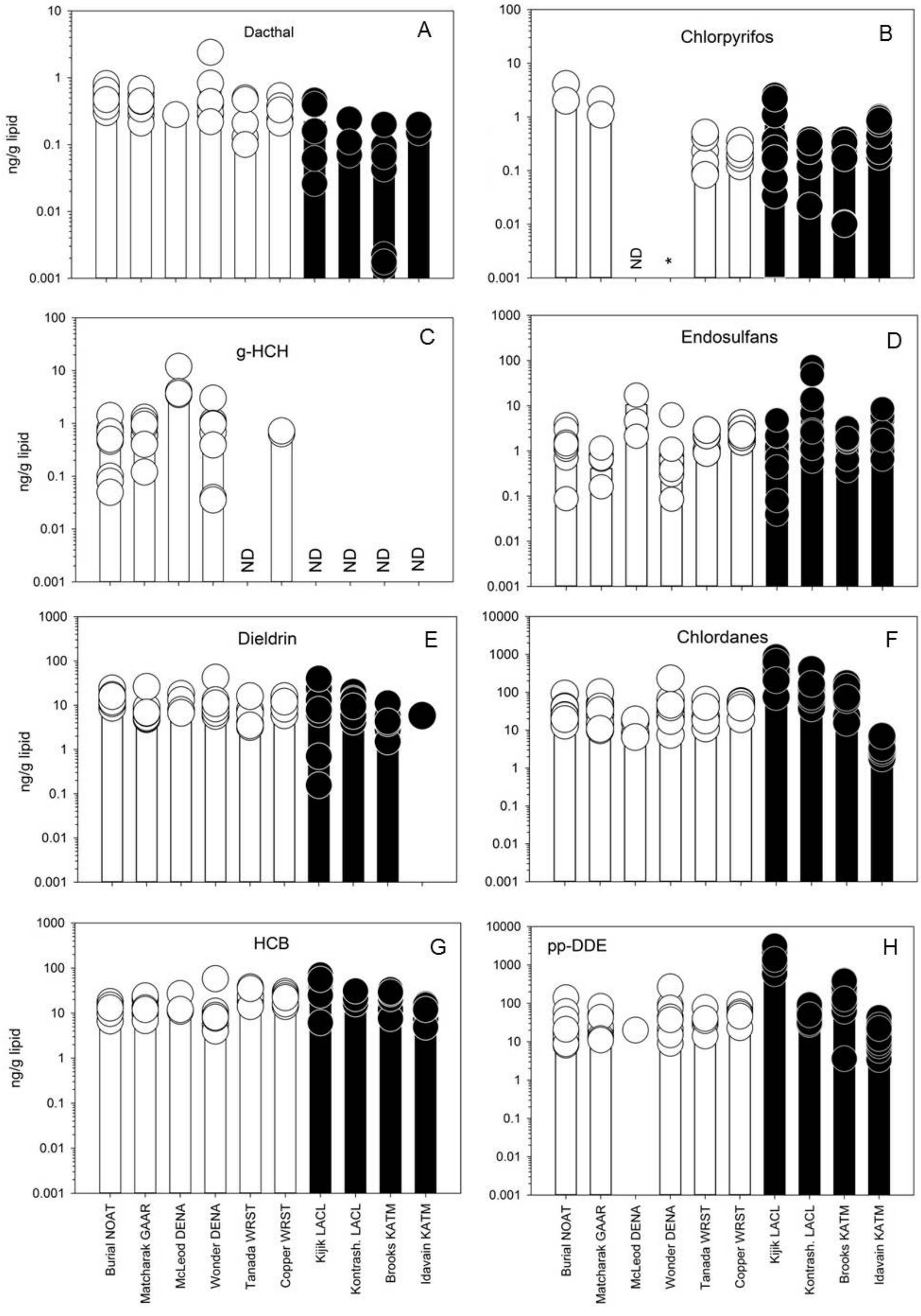


Figure 7 continued

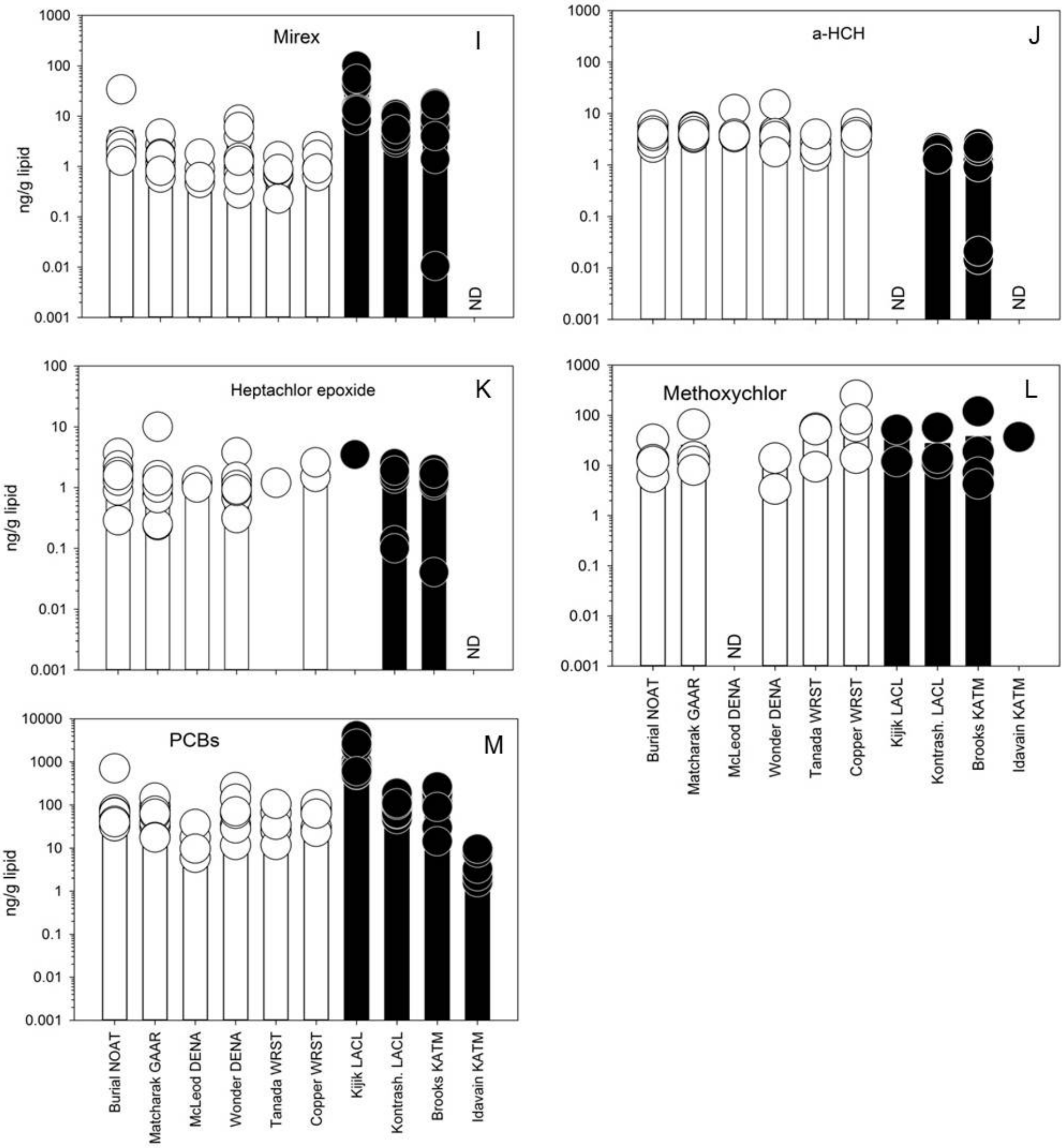


Figure 8 (A-L). Concentrations of SOCs in fish compared to human health consumption thresholds. Top of bar indicates the mean concentration and the circles represent the concentrations of individual fish. The solid line represents the threshold for recreational consumption and the dotted line represents subsistence consumption.

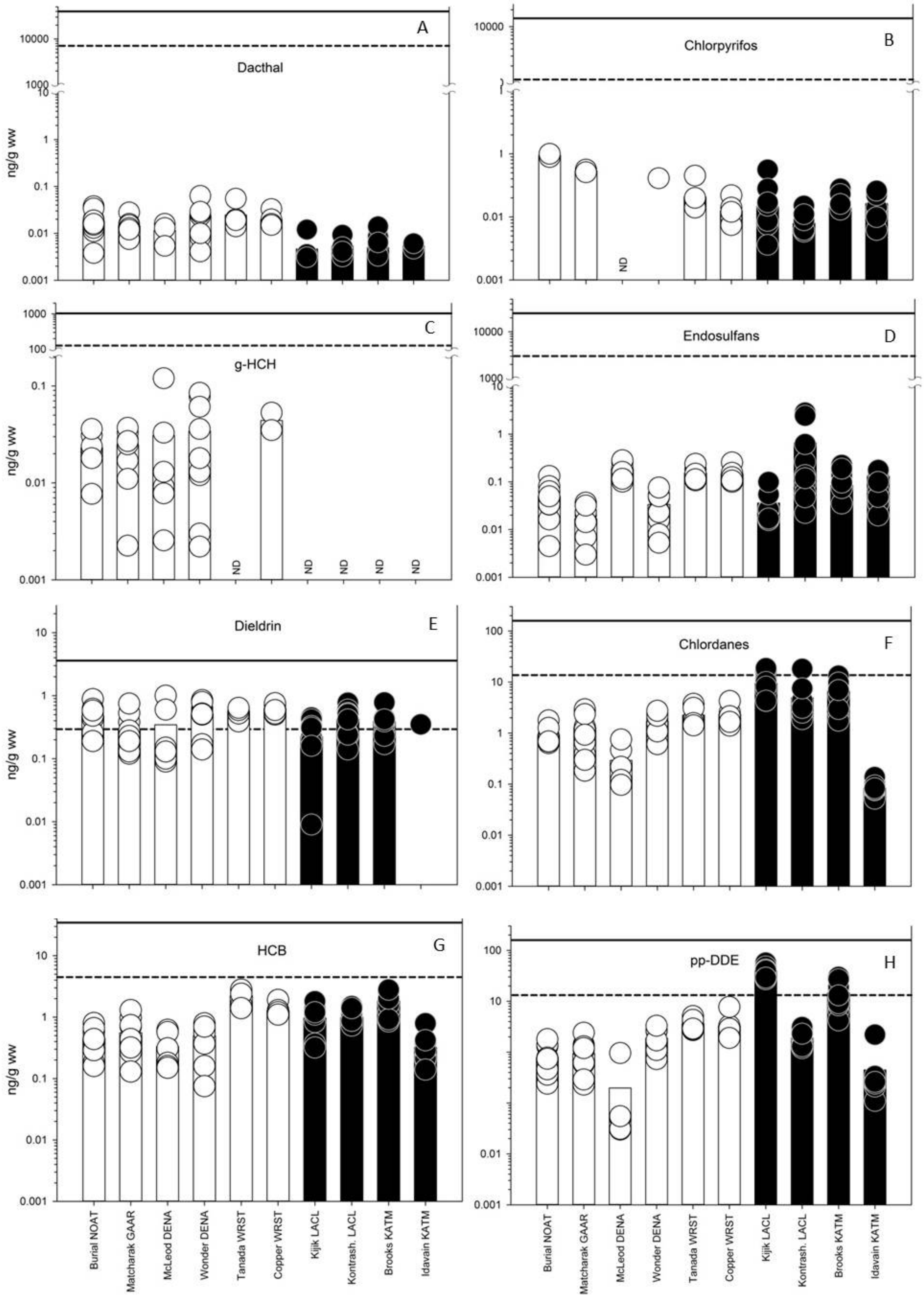
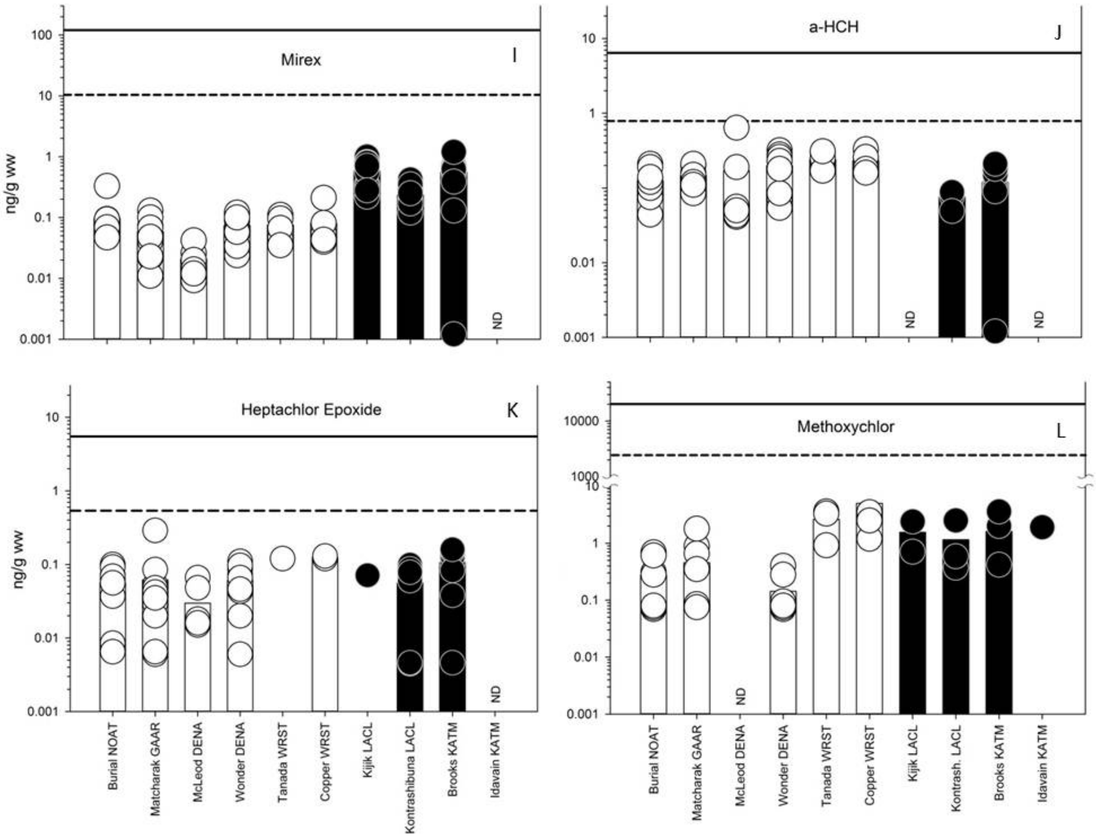


Figure 8 continued.



Figures 9A–C. Concentrations of historic-use pesticides chlordanes, *p’p*-DDE, and dieldrin in fish (ng/g ww) compared to piscivorous wildlife health thresholds for kingfisher (dotted line), mink (dashed line), and river otter (solid line). Top of bar indicates the mean concentration and the circles represent the concentrations of individual fish. Black bars depict data from current study; white bars depict previously published data from WACAP (Landers et al. 2010; Ackerman et al. 2008). ND, no detect; *, ND > 50% of lake fish.

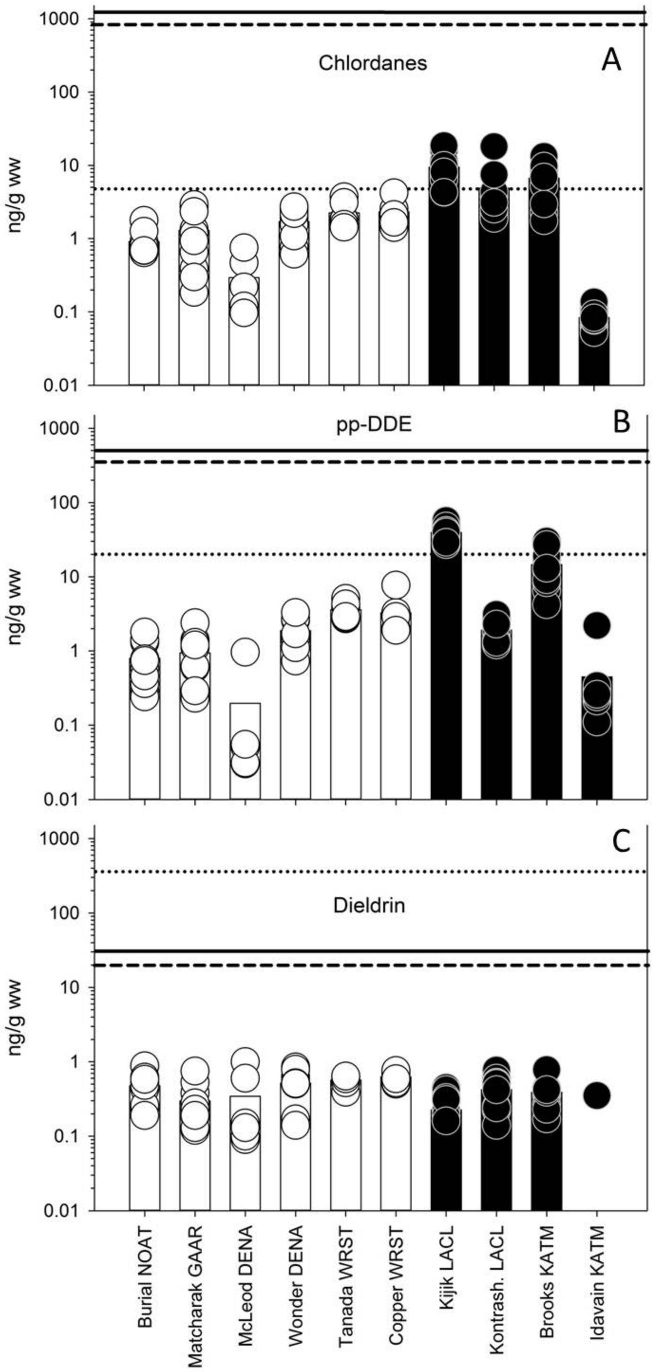


Table 4: Number of fish exceeding subsistence fish consumption threshold established for human health. Numerator indicates number of fish exceeding consumption limit and denominator indicates number of fish analyzed. Shaded cells depict an exceedance. No fish exceeded the recreational fish consumption threshold. Contaminant abbreviations as follows: DCPA, dacthal; CLPRY, chlorpyrifos; γ-HCH, gamma-hexachlorohexane; ENDO, endosulfans; DLDRN, dieldrin; CLDN, chlordanes; HCB, hexachlorobenzene; ppDDE, *p,p'*-dichlorodiphenylethene

Park	Water Body	SOC							
		DCPA	CLPYR	γ-HCH	ENDO	DLDRN	CLDN	HCB	ppDDE
Lake Clark NP & Preserve	Kijik	0/10	0/10	0/10	0/10	3/10	2/10	0/10	10/10
	Kontrashibuna	0/10	0/10	0/10	0/10	6/10	1/10	0/10	0/10
Katmai NP & Preserve	Brooks	0/10	0/10	0/10	0/10	7/10	0/10	0/10	4/10
	Idavain	0/10	0/10	0/10	0/10	1/10	0/10	0/10	0/10

Table 5: Number of fish exceeding kingfisher health thresholds. Numerator indicates number of fish exceeding consumption limit and denominator indicates number of fish analyzed. Shaded cells depict an exceedance. No fish exceeded the mink or river otter health thresholds. Contaminant abbreviations: DLDRN, dieldrin; CLDN, chlordanes; ppDDE, *p,p'*-dichlorodiphenylethene

Park	**Water Body**	**SOC**		
		DLDRN	**CLDN**	**ppDDE**
Lake Clark NP & Preserve	Kijik	0/10	8/10	10/10
	Kontrashibuna	0/10	2/10	0/10
Katmai NP & Preserve	Brooks	0/10	7/10	2/10
	Idavain	0/10	0/10	0/10

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Appendix

Appendix A. SOC concentrations (ng/g wet weight) in fish. Concentrations below the detection limit are represented by half of the estimated detection limits shown in blue. Blank cells represent SOC concentrations in laboratory blanks that were at least 30% the concentration in the sample.

Sample Name	TFLN ng/g ww	HCB ng/g ww	a-HCH ng/g ww	g-HCH ng/g ww	DCPA ng/g ww	CLPYR ng/g ww	HCLR E ng/g ww	o-CLDN ng/g ww	t-CLDN ng/g ww	c-CLDN ng/g ww
KIJIL 001	0.0091	1.1	0.0012	0.00165	0.0036	0.056	0.0045	0.68	0.41	1.9
KIJIL 002		1.40	0.00115	0.0016	0.000122	0.0083	0.0043	0.35	0.27	1.3
KIJIL 003		0.83	0.0012	0.00165	0.000127	0.0074	0.0045	0.48	0.24	2.3
KIJIL 004		1.2	0.0012	0.0017	0.000993	0.0086	0.0046	0.40	0.26	1.6
KIJIL 005		1.8	0.0012	0.00165	0.000126	0.00085	0.00445	0.94	0.56	4.2
KIJIL 006		0.35	0.0012	0.0017	0.0036	0.015	0.00455	0.087	0.032	0.50
KIJIL 007	0.012	1.1	0.00115	0.0016	0.012	0.028	0.00435	0.52	0.47	1.3
KIJIL 008		0.37	0.0012	0.0017	0.0031	0.017	0.00455	0.15	0.086	1.1
KIJIL 009		0.32	0.0012	0.0017	0.000129	0.00085	0.00455	0.23	0.11	1.3
KIJIL 010		1.2	0.0012	0.0017	0.000129	0.0036	0.0710	0.23	0.16	0.38
KONTL 018	0.020	0.81	0.078	0.0017	0.0093	0.015	0.0700	0.15	0.06	0.25
KONTL 019		1.1	0.088	0.0017	0.000131		0.0990	0.23	0.10	0.41
KONTL 020	0.012	0.82	0.00115	0.00165	0.000125	0.00085	0.00445	0.13	0.053	0.46
KONTL 022		0.89	0.088	0.0017	0.0032	0.0058	0.0850	0.29	0.088	0.47
KONTL 023	0.0036	0.83	0.0012	0.0017	0.000129	0.0062	0.0690	0.17	0.069	0.34
KONTL 024	0.0057	1.5	0.0012	0.0017	0.0051	0.015	0.0870	0.23	0.11	0.48
KONTL 025		1.0	0.049	0.00165	0.0041	0.0088	0.0600	0.15	0.068	0.30
KONTL 026	0.0021	0.73	0.0012	0.0017	0.00013	0.011	0.0046	0.17	0.073	0.008
KONTL 027		0.87	0.0012	0.0017	0.00013		0.0780	0.21	0.09	0.008
KONTL 028		1.4	0.0012	0.0017	0.00013	0.0009	0.0046	0.36	0.21	0.82
LBROO 001	0.010	1.2	0.11	0.0017	0.0088	0.016	0.1200	0.19	0.14	0.008
LBROO 003	0.011	0.85	0.10	0.0017	0.0084	0.028	0.0046	0.13	0.10	0.34
LBROO 004		1.8	0.0012	0.0017	0.0055	0.0009	0.1300	0.35	0.22	0.008
LBROO 005		2.7	0.19	0.0017	0.000129	0.0009	0.1500	0.51	0.45	2.1
LBROO 006		1.6	0.0012	0.0017	0.000129		0.1000	0.33	0.23	1.3
LBROO 007		2.0	0.16	0.0017	0.000129	0.014	0.1300	0.58	0.45	1.7
LBROO 008		2.6	0.15	0.0017	0.0033		0.1500	0.84	0.54	2.8
LBROO 009		0.92	0.09	0.0017	0.0033	0.013	0.0380	0.11	0.10	0.61
LBROO 010		2.0	0.18	0.0016	0.014	0.023	0.0830	0.46	0.40	2.3
LBROO 022	0.014	2.8	0.21	0.0017	0.0064	0.016	0.1600	0.49	0.45	1.8
IDVAL 001		0.20	0.00115	0.0016	0.000121	0.011	0.00425	0.00315	0.0060	0.0075
IDVAL 002		0.24	0.00115	0.0016	0.000121	0.0062	0.00425	0.00315	0.0071	0.0075
IDVAL 003		0.79	0.0012	0.0017	0.000129	0.013	0.00455	0.00335	0.014	0.008
IDVAL004		0.21	0.0012	0.0017	0.00013	0.011	0.0046	0.00335	0.0048	0.008
IDVAL005		0.37	0.0012	0.0017	0.00013	0.024	0.0046	0.0034	0.012	0.008
IDVAL 006	0.0049	0.42	0.00125	0.0017	0.0047	0.014	0.0046	0.0034	0.010	0.008
IDVAL007		0.29	0.0012	0.0017	0.000129	0.026	0.0046	0.00335	0.0094	0.008
IDVAL 008	0.016	0.14	0.00115	0.0016	0.0061	0.022	0.0043	0.00315	0.013	0.0075
IDVAL009		0.42	0.00125	0.0017	0.000131	0.026	0.0046	0.0034	0.011	0.008
IDVAL010		0.14	0.00125	0.00175	0.000132	0.0099	0.00465	0.0034	0.006	0.008

Sample Name	t-NCLR ng/g ww	c-NCLR ng/g ww	Dieldrin ng/g ww	ENDO I ng/g ww	ENDO II ng/g ww	ENDO S ng/g ww	Mirex ng/g ww	op-DDE ng/g ww	pp-DDE ng/g ww	op-DDD ng/g ww	pp-DDD ng/g ww	pp-DDT ng/g ww	MXCLR ng/g ww	CHR/TRI ng/g ww
KIJIL 001	11	2.1	0.22	0.00075	0.00115	0.015	0.35	0.22	37	0.33	0.055	2.6		0.007
KIJIL 002	4.5	1.100	0.19	0.0007	0.0011	0.024	0.32	0.20	27	0.39	1.6	1.2		0.0065
KIJIL 003	6.2	2.1	0.45	0.0044	0.00115	0.020	0.76	0.32	46	0.44	2.7	2.9		0.007
KIJIL 004	4.3	1.6	0.42	0.0083	0.00115	0.019	0.56	0.280	36	0.025	1.9	1.6		0.007
KIJIL 005	9.7	3.2	0.16	0.00075	0.00115	0.00024	1.0	0.80	57	1.1	4.3	4.4		0.007
KIJIL 006	2.8	0.84	0.009	0.014	0.00115	0.012	0.82	0.021	34	0.0245	0.055	0.045	0.71	0.007
KIJIL 007	6.5	1.2	0.33	0.0055	0.021	0.028	0.22	0.54	48	0.0495	0.11	3.3	2.4	0.014
KIJIL 008	3.9	1.3	0.31	0.005	0.00115	0.012	0.79	0.097	42	0.0245	1.4	0.34		0.007
KIJIL 009	4.8	1.7	0.009	0.00075	0.00115	0.000244	0.71	0.10	40	0.26	1.4	0.82		0.007
KIJIL 010	2.7	0.83	0.16	0.021	0.00115	0.078	0.28	0.10	29	0.16	0.92	0.44		0.041
KONTL 018	0.84	0.69	0.77	0.022	0.00115	0.24	0.16	0.021	1.2	0.0245	0.055	0.045		0.007
KONTL 019	1.5	0.0007	0.22	0.023	0.00115	2.8	0.12	0.0215	1.3	0.025	0.055	0.0455		0.057
KONTL 020	1.6	1.5	0.55	0.022	0.0011	0.000238	0.42	0.0205	2.5	0.024	0.055	0.0435		0.007
KONTL 022	2.2	15	0.6	0.017	0.022	0.58	0.31	0.021	2.8	0.0245	0.055	0.045		0.007
KONTL 023	1.3	0.0007	0.25	0.029	0.00115	2.4	0.17	0.021	1.4	0.0245	0.055	0.045		0.007
KONTL 024	1.7	1.2	0.53	0.025	0.003	0.11	0.20	0.021	1.8	0.0245	0.41	0.33		0.007
KONTL 025	1.1	0.89	0.51	0.017	0.0072	0.065	0.18	0.0205	1.4	0.024	0.055	0.044		0.007
KONTL 026	2.3	1.8	0.14	0.00075	0.00115	0.058	0.35	0.0215	3.1	0.025	0.055	0.0455	0.37	0.007
KONTL 027	1.6	1.2	0.24	0.028	0.019	0.000247	0.17	0.021	1.3	0.025	0.055	0.0455	0.59	0.007
KONTL 028	3.8	2.3	0.42	0.041	0.00115	0.078	0.25	0.0215	2.3	0.025	0.40	0.47	2.5	0.007
LBROO 001	1.5	0.42	0.27	0.0061	0.00115	0.029	0.13	0.12	6.5	0.22	0.11	0.09	2.0	0.014
LBROO 003	0.93	0.25	0.17	0.00075	0.00115	0.073	0.0012	0.12	4.2	0.0475	0.58	0.085	3.6	0.0135
LBROO 004	3.5	1.2	0.35	0.022	0.00115	0.11	0.59	0.021	8.3	0.025	0.64	0.72		0.007
LBROO 005	3.9	1.4	0.43	0.00075	0.00115	0.14	0.52	0.15	17	0.0245	2.3	1.9		0.007
LBROO 006	3.7	1.4	0.23	0.034	0.00115	0.12	0.70	0.021	12	0.0245	0.76	0.89	0.42	0.007
LBROO 007	5.1	1.6	0.42	0.024	0.00115	0.11	0.70	0.22	19	0.0245	1.5	1.9		0.007
LBROO 008	6.9	2.2	0.44		0.00115	0.14	0.67	0.43	30	0.86	3.9	4.9		0.007
LBROO 009	1.6	0.54	0.39	0.016	0.00115	0.08	0.62	0.076	9.1	0.025	0.8	0.56		0.007
LBROO 010	5	1.6	0.78	0.025	0.01	0.19	1.2	0.16	27	0.0235	0.19	2.0		0.007
LBROO 022	3.1	1.1	0.42	0.029	0.00115	0.16	0.39	0.27	13	0.0245	1.1	1.4	0.42	0.007
IDVAL 001	0.039	0.017	0.0085	0.02	0.0011	0.014	0.0011	0.0195	0.11	0.023	0.05	0.042		0.0065
IDVAL 002	0.042	0.017	0.0085	0.012	0.0011	0.15	0.0011	0.021	0.21	0.0245	0.055	0.045		0.007
IDVAL 003	0.062	0.032	0.35	0.029	0.00115	0.12	0.0012	0.021	2.2	0.0245	0.53	0.045	1.9	0.007
IDVAL004	0.032	0.015	0.009	0.014	0.00115	0.029	0.0012	0.021	0.27	0.025	0.055	0.0455		0.007
IDVAL005	0.084	0.041	0.009	0.016	0.00115	0.019	0.0012	0.0215	0.31	0.025	0.055	0.0455		0.007
IDVAL 006	0.0	0.022	0.009	0.027	0.00115	0.15	0.0012	0.0215	0.24	0.025	0.055	0.0455		0.007
IDVAL007	0.045	0.023	0.009	0.018	0.00115	0.049	0.0012	0.021	0.24	0.025	0.055	0.045		0.007
IDVAL 008	0.043	0.027	0.0085	0.0007	0.0011	0.019	0.0011	0.042	0.29	0.0495	0.11	0.09		0.014
IDVAL009	0.1	0.027	0.009	0.020	0.00115	0.028	0.0012	0.0215	0.34	0.025	0.055	0.0455		0.007
IDVAL010	0.053	0.024	0.009	0.0073	0.0012	0.092	0.0012	0.0215	0.26	0.0255	0.055	0.046		0.0075

Sample Name	PCB 101 ng/g ww	PCB 118 ng/g ww	PCB 138 ng/g ww	PCB 153 ng/g ww	PCB 183 ng/g ww	PCB 187 ng/g ww	FLO ng/g ww	PHE ng/g ww	ANT ng/g ww	FLA ng/g ww	PYR ng/g ww
KIJIL 001	1.3	4.5	6.70	8.0	0.63	2.2		0.55	0.021	0.084	0.0024
KIJIL 002	3	3.8	4.7	5.9	0.48	1.7			0.0205	0.12	
KIJIL 003	5.7	6.9	10	13	0.9	2.9			0.021	0.063	
KIJIL 004	4	4.4	9.9	9.1	0.6	2.1			0.0215		
KIJIL 005	9.8	9.5	13	16	1.1	3.8			0.021	0.11	
KIJIL 006	2.6	4	7.3	10	0.8	3.2	0.88	3.4	0.0215		0.15
KIJIL 007	2.2	2.30	3.3	4.1	0.3	1.1			0.043		0.00485
KIJIL 008	4.2	4.8	8.1	11	0.84	3.2			0.0215	0.061	
KIJIL 009	4.90	5.6	8.6	11	0.78	2.8			0.0215	0.14	
KIJIL 010	1.8	1.8	3.4	4.2	0.31	1.2			0.0215	0.24	0.13
KONTL 018	0.24	0.17	0.44	0.75		0.24			0.0215		
KONTL 019	0.38	0.34	0.89	1.2	0.11	0.34			0.022		
KONTL 020	0.6	0.66	2.0	3.0	0.27	0.87	0.0055		0.021		
KONTL 022	0.49	0.57	1.7	2.3	0.21	0.69	0.006		0.0215		
KONTL 023	0.33	0.37	0.96	1.4	0.12	0.37			0.0215		
KONTL 024	0.35	0.3	0.74	1.1	0.083	0.35	0.0055		0.0215		
KONTL 025	0.28	0.24	0.60	0.93	0.067	0.28			0.021		
KONTL 026	0.51	0.55	1.8	2.5	0.25	0.89			0.0215		
KONTL 027	0.32	0.41	1.1	1.7	0.16	0.49		17	0.0215	0.22	0.18
KONTL 028	0.53	0.44	1.4	1.7	0.2	0.64			0.0215	0.20	0.15
LBROO 001	0.47	0.38	0.73	0.91	0.084	0.3			0.0425	0.13	0.00485
LBROO 003	0.23	0.24	0.42	0.50	0.045	0.17			0.041	0.19	0.26
LBROO 004	1.3	1.1	2.4	3.1	0.32	1.1	0.006		0.0215		
LBROO 005	2	1.6	2.7	3.5	0.29	1.1	0.43	0.6	0.0215	0.07	0.073
LBROO 006	1.5	1.2	2.7	3.6	0.37	1.4	0.67		0.0215		
LBROO 007	2	1.6	3.1	4.0	0.38	1.4			0.0215		
LBROO 008	4.4	3.2	4.9	5.8	0.49	1.8	0.37		0.0215	0.06	0.058
LBROO 009	1.3	1.2	2.2	2.9	0.26	0.96			0.0215		
LBROO 010	3.1	2.5	4.5	6.0	0.53	2	0.0055		0.0205		
LBROO 022	1.7	1.3	2.1	2.6	0.22	0.83			0.0215		
IDVAL 001	0.0155							0.0125	0.02	0.00255	
IDVAL 002	0.0155			0.086				0.013	0.0215	0.0056	
IDVAL 003	0.0165			0.098				0.28	0.0215	0.076	0.11
IDVAL004	0.034							5.2	0.0215		
IDVAL005	0.079								0.0215		
IDVAL 006	0.0165								0.0215		
IDVAL007	0.0165								0.0215		
IDVAL 008	0.0155	0.03	0.067	0.092	0.013	0.027			0.043		0.14
IDVAL009	0.0165								0.0215		
IDVAL010	0.073	0.04						3.4	0.022		

Sample Name	Retene ng/g ww	B[a]A ng/g ww	B[b]F ng/g ww	B[k]F ng/g ww	B[e]P ng/g ww	B[a]P ng/g ww	I[1,2,3-cd]p ng/g ww	D[ah]A ng/g ww	B[ghi]P ng/g ww
KIJIL 001	0.0155	0.0095	0.0075	0.0085	0.038	0.006	0.0065	0.0065	0.00225
KIJIL 002	0.015	0.009		0.008	0.0365	0.0055	0.006	0.0065	0.00215
KIJIL 003	0.016	0.0095		0.0085	0.038	0.006	0.0065	0.007	0.00225
KIJIL 004	0.016	0.0095		0.0085	0.039	0.006	0.0065	0.007	0.0023
KIJIL 005	0.0155	0.0095	0.007	0.0085	0.038	0.006	0.0065	0.0065	0.0022
KIJIL 006	0.016	0.0095	0.0075	0.0085	0.039	0.006	0.0065	0.007	0.00225
KIJIL 007	0.032	0.019	0.015	0.017	0.08	0.012	0.013	0.0135	0.00455
KIJIL 008	0.016	0.0095		0.0085	0.0385	0.006	0.0065	0.007	0.00225
KIJIL 009	0.13	0.0095		0.0085	0.0385	0.006	0.0065	0.007	0.00225
KIJIL 010	0.32	0.073		0.0085	0.039	0.006	0.0065	0.007	0.052
KONTL 018	0.016	0.0095		0.0085	0.0385	0.006	0.0065	0.007	0.00225
KONTL 019		0.055	0.28	0.0085	0.0395	0.006	0.0065	0.007	0.028
KONTL 020	0.0155	0.0095		0.008	0.0375	0.006	0.0065	0.0065	0.0022
KONTL 022	0.016	0.0095		0.0085	0.039	0.006	0.0065	0.007	0.00225
KONTL 023		0.0095		0.0085	0.0385	0.006	0.0065	0.007	0.00225
KONTL 024	0.016	0.0095		0.0085	0.0385	0.006	0.0065	0.007	0.00225
KONTL 025	0.26	0.0095		0.008	0.038	0.006	0.0065	0.0065	0.0022
KONTL 026	0.016	0.0095		0.0085	0.039	0.006	0.0065	0.007	0.0023
KONTL 027	0.016	0.0095	0.0075	0.0085	0.039	0.006	0.0065	0.007	0.0023
KONTL 028	0.0165	0.0095		0.0085	0.0395	0.006	0.0065	0.007	0.0023
LBROO 001	0.032	0.019	0.0145	0.017	0.075	0.012	0.013	0.0135	0.0045
LBROO 003	0.031	0.0185	0.014	0.0165	0.075	0.0115	0.0125	0.013	0.00435
LBROO 004		0.0095	0.0075	0.0085	0.039	0.006	0.0065	0.007	0.0023
LBROO 005	0.016	0.0095	0.0075	0.0085	0.039	0.006	0.0065	0.007	0.00225
LBROO 006	0.016	0.0095	0.0075	0.0085	0.0385	0.006	0.0065	0.007	0.00225
LBROO 007		0.0095	0.0075	0.0085	0.0385	0.006	0.0065	0.007	0.00225
LBROO 008	0.016	0.0095	0.0075	0.0085	0.0385	0.006	0.0065	0.007	0.00225
LBROO 009	0.0165	0.0095		0.0085	0.0395	0.006	0.0065	0.007	0.0023
LBROO 010	0.0155	0.009		0.008	0.037	0.006	0.0065	0.0065	0.0022
LBROO 022	0.016	0.0095		0.0085	0.039	0.006	0.0065	0.007	0.00225
IDVAL 001		0.009	0.007	0.008	0.0365	0.0055	0.006	0.0065	0.0021
IDVAL 002		0.0095	0.0075	0.0085	0.0385	0.006	0.0065	0.007	0.00225
IDVAL 003	0.016	0.0095	0.0075	0.0085	0.039	0.006	0.0065	0.007	0.00225
IDVAL004	0.016	0.0095		0.0085	0.039	0.006	0.0065	0.007	0.0023
IDVAL005		0.0095	0.24	0.0085	0.039	0.006	0.0065	0.007	0.0023
IDVAL 006	0.0165	0.0095	0.0075	0.0085	0.0395	0.006	0.0065	0.007	0.0023
IDVAL007	0.016	0.0095	0.0075	0.0085	0.039	0.006	0.0065	0.007	0.0023
IDVAL 008	0.032	0.019	0.015	0.017	0.08	0.012	0.013	0.0135	0.00455
IDVAL009	0.0165	0.0095	0.0075	0.0085	0.0395	0.006	0.0065	0.007	0.0023
IDVAL010	0.0165	0.01		0.0085	0.0395	0.006	0.0065	0.007	0.0023

Appendix B. SOC concentrations (ng/g lipid) in fish. Concentrations below the detection limit are represented by half of the estimated detection limits shown in blue. Blank cells represent SOC concentrations in laboratory blanks that were at least 30% the concentration in the sample.

Sample Name	TFLN ng/g lipid	HCB ng/g lipid	a-HCH ng/g lipid	g-HCH ng/g lipid	DCPA ng/g lipid	CLPYR ng/g lipid	HCLR E ng/g lipid	o-CLDN ng/g lipid	t-CLDN ng/g lipid	c-CLDN ng/g lipid
KIJIL 001	0.40	50	0.055	0.075	0.16	2.5	0.2	30	18	85
KIJIL 002		57.00	0.048	0.065	0.005	0.35	0.18	15	11	53
KIJIL 003		43	0.06	0.085	0.0065	0.38	0.235	25	12	120
KIJIL 004		32	0.0315	0.044	0.026	0.22	0.12	10	6.7	43
KIJIL 005		70	0.0475	0.065	0.005	0.0345	0.18	38	23	170
KIJIL 006		6.1	0.021	0.0295	0.062	0.26	0.08	1.5	0.55	8.7
KIJIL 007	0.46	40	0.044	0.06	0.46	1.1	0.165	20	18	48
KIJIL 008		48	0.155	0.215	0.4	2.2	0.6	20	11	140
KIJIL 009		25	0.095	0.13	0.01	0.07	0.355	18	8.9	100.0
KIJIL 010		56	0.06	0.08	0.006	0.17	3.50	11	7.9	18
KONTL 018	0.53	21	2.0	0.0435	0.24	0.38	1.80	3.9	1.6	6.4
KONTL 019		27	2.2	0.0435	0.0033		2.50	5.9	2.6	10
KONTL 020	0.30	21	0.03	0.042	0.0032	0.022	0.115	3.4	1.4	12
KONTL 022		20	2.0	0.0375	0.07	0.13	1.90	6.3	2.0	11
KONTL 023	0.072	16	0.024	0.0335	0.00255	0.12	1.40	3.4	1.4	6.7
KONTL 024	0.12	31	0.025	0.0345	0.11	0.31	1.80	4.7	2.2	9.9
KONTL 025		27	1.3	0.043	0.11	0.23	1.60	3.8	1.8	7.8
KONTL 026	0.062	22	0.036	0.05	0.00385	0.34	0.135	5.1	2.2	0.235
KONTL 027		21	0.029	0.0405	0.0031		1.90	5.1	2.2	0.19
KONTL 028		31	0.027	0.038	0.0029	0.0195	0.1	7.9	4.6	18
LBROO 001	0.11	12	1.2	0.018	0.091	0.17	1.30	2.0	1.4	0.085
LBROO 003	0.1	7.6	0.92	0.015	0.075	0.25	0.0405	1.1	0.88	3.0
LBROO 004		21	0.0145	0.02	0.064	0.0105	1.50	4.2	2.6	0.095
LBROO 005		31	2.2	0.0195	0.0015	0.01	1.70	5.8	5.2	24
LBROO 006		28	0.021	0.0295	0.00225		1.80	5.8	4.1	22
LBROO 007		27	2.2	0.023	0.00175	0.2	1.70	7.9	6.1	23
LBROO 008		33	1.9	0.0215	0.043		2.00	11	6.9	36
LBROO 009		27	2.6	0.0495	0.095	0.38	1.10	3.2	3.0	18
LBROO 010		29	2.6	0.0235	0.2	0.33	1.20	6.5	5.7	33
LBROO 022	0.14	29	2.2	0.0175	0.066	0.17	1.70	5.1	4.6	18
IDVAL 001		5.9	0.034	0.0475	0.0036	0.34	0.13	0.095	0.18	0.22
IDVAL 002		7.3	0.034	0.0475	0.0036	0.18	0.13	0.095	0.21	0.22
IDVAL 003		13	0.0205	0.0285	0.00215	0.23	0.075	0.055	0.24	0.135
IDVAL004		13	0.08	0.11	0.0085	0.7	0.295	0.215	0.31	0.5
IDVAL005		16	0.05	0.07	0.0055	1	0.195	0.14	0.49	0.335
IDVAL 006	0.16	14	0.04	0.055	0.15	0.45	0.15	0.11	0.34	0.26
IDVAL007		11	0.047	0.065	0.005	0.99	0.175	0.13	0.36	0.305
IDVAL 008	0.54	4.9	0.0385	0.055	0.2	0.75	0.145	0.105	0.43	0.25
IDVAL009		15	0.0445	0.06	0.00475	0.94	0.17	0.125	0.39	0.29
IDVAL010		12	0.105	0.15	0.0115	0.85	0.4	0.295	0.51	0.7

Sample Name	t-NCLR ng/g lipid	c-NCLR ng/g lipid	Dieldrin ng/g lipid	ENDO I ng/g lipid	ENDO II ng/g lipid	ENDO S ng/g lipid	Mirex ng/g lipid	op-DDE ng/g lipid	pp-DDE ng/g lipid	op-DDD ng/g lipid	pp-DDD ng/g lipid	pp-DDT ng/g lipid	MXCLR ng/g lipid	CHR/TRI ng/g lipid
KIJIL 001	490	93	9.6	0.033	0.05	0.68	16	7.3	1230	11	1.8	85		0.23
KIJIL 002	190	46	7.8	0.0305	0.046	1.0	13	8.6	1140	17	67	51		0.285
KIJIL 003	320	110	24	0.23	0.06	1.0	40	17	2390	23	140	150		0.365
KIJIL 004	110	41	11	0.22	0.03	0.49	15	7.3	930	0.65	49	42		0.185
KIJIL 005	390	130	6.3	0.03	0.045	0.0095	42	32.0	2280	45	170	180		0.275
KIJIL 006	49	15	0.155	0.24	0.02	0.2	14	0.37	590	0.43	1	0.8	12	0.125
KIJIL 007	250	46	13	0.21	0.79	1.1	8.2	12	1050	1.1	2.45	72	52	0.31
KIJIL 008	500	160	40	0.64	0.145	1.5	100	5.0	2170	1.25	72	18.0		0.365
KIJIL 009	380	130	0.7	0.06	0.09	0.019	55	7.9	3090	21	110	64		0.55
KIJIL 010	130	40	7.9	1	0.055	3.8	13	5.1	1390	7.6	45	21		2
KONTL 018	22	18	20	0.56	0.0295	6.2	4.2	0.55	32	0.65	1.45	1.15		0.185
KONTL 019	37	0.018	5.6	0.59	0.0295	72	3.0	0.55	32	0.65	1.45	1.15		1.4
KONTL 020	42	39	14	0.58	0.029	0.006	11	0.5	65	0.6	1.4	1.1		0.175
KONTL 022	48	340	13	0.39	0.48	13	6.8	0.465	62	0.55	1.25	1		0.155
KONTL 023	26	0.0135	4.9	0.57	0.023	48	3.4	0.415	28	0.49	1.1	0.9		0.14
KONTL 024	34	25	11	0.51	0.063	2.3	4.1	0.43	37	0.5	8.4	6.9		0.145
KONTL 025	28	23	13	0.44	0.19	1.7	4.8	0.55	36	0.65	1.45	1.15		0.18
KONTL 026	68	55	4.2	0.0225	0.0345	1.7	10	0.65	91	0.75	1.65	1.35	11	0.21
KONTL 027	39	30	5.7	0.67	0.45	0.006	4.1	0.5	31	0.6	1.35	1.1	14	0.17
KONTL 028	84	51	9.4	0.91	0.026	1.7	5.5	0.475	50	0.55	8.9	10.0	57	0.16
LBROO 001	16	4.4	2.8	0.063	0.012	0.3	1.4	1.2	62	2.1	1.05	0.85	19	0.135
LBROO 003	8.3	2.2	1.5	0.007	0.0105	0.64	0.0105	4.1	140	1.6	19	2.85	120	0.455
LBROO 004	41	14	4.1	0.26	0.0135	1.3	7.0	0.25	98	0.295	7.5	8.5		0.085
LBROO 005	45	17	5.0	0.0085	0.0135	1.6	5.9	0.032	3.6	0.005	0.48	0.39		0.0015
LBROO 006	65	24	3.9	0.59	0.02	2.1	12	0.365	210	0.43	13	16	7.3	0.125
LBROO 007	70	22	5.8	0.33	0.0155	1.5	9.6	3.0	260	0.335	21	26		0.095
LBROO 008	89	29	5.7		0.0145	1.8	8.7	5.5	390	11	50	63		0.09
LBROO 009	45	16	11	0.45	0.034	2.3	18	2.2	260	0.7	23	16		0.205
LBROO 010	71	23	11	0.36	0.15	2.7	17	2.2	380	0.34	37	29		0.1
LBROO 022	32	12	4.3	0.3	0.012	1.6	4.0	2.8	130	0.255	12	15	4.3	0.075
IDVAL 001	1.2	0.5	0.25	0.6	0.032	0.43	0.033	0.6	3.4	0.7	1.55	1.25		0.2
IDVAL 002	1.3	0.5	0.25	0.4	0.032	4.6	0.033	0.6	5.9	0.7	1.55	1.25		0.195
IDVAL 003	1	0.54	5.8	0.49	0.0195	2.0	0.02	0.41	42	0.48	10	0.85	37	0.135
IDVAL004	2.1	0.99	0.6	0.9	0.075	1.9	0.075	1.35	17	1.6	3.65	2.9		0.46
IDVAL005	3.5	1.7	0.385	0.66	0.049	0.81	0.05	0.9	13	1.05	2.35	1.9		0.3
IDVAL 006	1.4	0.73	0.3	0.87	0.0385	5.0	0.039	0.7	7.8	0.8	1.85	1.5		0.235
IDVAL007	1.7	0.9	0.35	0.69	0.0445	1.9	0.046	0.8	9.3	0.95	2.2	1.75		0.275
IDVAL 008	1.5	0.9	0.29	0.0245	0.037	0.63	0.0375	4	27	4.7	10.5	8.5		1.35
IDVAL009	2	0.96	0.33	0.71	0.0425	1.0	0.0435	0.75	12	0.9	2.05	1.65		0.26
IDVAL010	4.5	2	0.8	0.62	0.1	7.9	0.105	1.85	22	2.15	4.85	3.9		0.6

Sample Name	PCB 101 ng/g lipid	PCB 118 ng/g lipid	PCB 138 ng/g lipid	PCB 153 ng/g lipid	PCB 183 ng/g lipid	PCB 187 ng/g lipid	FLO ng/g lipid	PHE ng/g lipid	ANT ng/g lipid	FLA ng/g lipid	PYR ng/g lipid
KIJIL 001	57	200	300	350	28	97		18	0.7	2.8	0.08
KIJIL 002	130	160	200	250	20.0	72			0.85	4.9	
KIJIL 003	300	360	530	700	47	150			1.1	3.3	
KIJIL 004	100	110	260	230	16	54			0.55		
KIJIL 005	390	380	510	630	44	150			0.85	4.4	
KIJIL 006	45	70	130	180	14.0	55	15	60	0.375		2.6
KIJIL 007	85	88	130	150	11	42			0.95		0.105
KIJIL 008	540	620	1040	1380	110	410			1.1	3.2	
KIJIL 009	380	440	670	880	61	220			1.65	11	
KIJIL 010	86	88	160	200	15	57.0			1.05	12	6.4
KONTL 018	6.2	4.3	11	19		6.2			0.55		
KONTL 019	9.6	8.7	23	30	2.8	8.7			0.55		
KONTL 020	15	17	52	78	7	22.0	0.145		0.55		
KONTL 022	11	13	38	51	4.7	15.0	0.13		0.475		
KONTL 023	6.6	7.4	19	27	2.3	7.3			0.42		
KONTL 024	7.1	6.2	15	23	1.7	7.2	0.12		0.44		
KONTL 025	7.3	6.3	16	24	1.8	7.4			0.55		
KONTL 026	15	16	53	72	7.5	26.0			0.65		
KONTL 027	7.6	9.9	27	40	3.7	12.0		400	0.5	5.3	4.4
KONTL 028	12	9.9	31	38	4.4	14.0			0.485	4.5	3.3
LBROO 001	4.9	4.0	7.6	9.5	0.87	3.1			0.41	1.2	0.0465
LBROO 003	2.1	2.2	3.7	4.4	0.4	1.5			1.35	6.4	8.8
LBROO 004	15	12	28	37	3.7	13.0	0.07		0.255		
LBROO 005	23	19	31	40	3.4	13.0	0.09	0.13	0.0045	0.014	0.015
LBROO 006	26	21	47	63	6.5	24.0	12		0.37		
LBROO 007	28	22	43	55	5.1	19.0			0.29		
LBROO 008	57	42	63	75	6.4	23.0	4.7		0.275	0.77	0.74
LBROO 009	38	33	62	83	7.6	28.0			0.65		
LBROO 010	44	36	64	86	7.6	28.0	0.08		0.295		
LBROO 022	18	13	21	27	2.3	8.5			0.22		
IDVAL 001	0.46							0.365	0.6	0.075	
IDVAL 002	0.46			2.6				0.365	0.6	0.16	
IDVAL 003	0.28			1.6				5.3	0.415	1.5	2
IDVAL004	2.2							330	1.4		
IDVAL005	3.3								0.9		
IDVAL 006	0.55								0.7		
IDVAL007	0.65								0.85		
IDVAL 008	0.55	1.0	2.3	3.1	0.44	0.9			4.05		13
IDVAL009	0.6								0.8		
IDVAL010	6.2	3.4						290	1.85		

Sample Name	Retene ng/g lipid	B[a]A ng/g lipid	B[b]F ng/g lipid	B[k]F ng/g lipid	B[e]P ng/g lipid	B[a]P ng/g lipid	I[1,2,3-cd]p ng/g	D[ah]A ng/g lipid	B[ghi]P ng/g lipid
KIJIL 001	0.5	0.31	0.24	0.275	1.25	0.195	0.21	0.225	0.075
KIJIL 002	0.65	0.38		0.34	1.55	0.24	0.26	0.275	0.09
KIJIL 003	0.8	0.49		0.435	2	0.31	0.335	0.35	0.115
KIJIL 004	0.415	0.25		0.22	1	0.155	0.17	0.18	0.06
KIJIL 005	0.65	0.37	0.29	0.33	1.5	0.235	0.255	0.27	0.09
KIJIL 006	0.28	0.165	0.13	0.15	0.7	0.105	0.115	0.12	0.0395
KIJIL 007	0.7	0.42	0.325	0.37	1.7	0.265	0.285	0.3	0.1
KIJIL 008	0.85	0.49		0.435	2	0.31	0.335	0.355	0.115
KIJIL 009	10	0.75		0.65	3	0.47	0.5	0.55	0.175
KIJIL 010	16	3.5		0.41	1.85	0.29	0.315	0.33	2.5
KONTL 018	0.415	0.245		0.22	1	0.155	0.17	0.175	0.06
KONTL 019		1.4	7.1	0.22	1	0.155	0.17	0.175	0.71
KONTL 020	0.4	0.24		0.21	0.95	0.15	0.165	0.17	0.055
KONTL 022	0.355	0.21		0.19	0.85	0.135	0.145	0.15	0.05
KONTL 023		0.19		0.165	0.75	0.12	0.13	0.135	0.045
KONTL 024	0.33	0.195		0.175	0.8	0.125	0.135	0.14	0.0465
KONTL 025	6.9	0.245		0.215	1	0.155	0.165	0.175	0.06
KONTL 026	0.48	0.285		0.25	1.15	0.18	0.195	0.205	0.07
KONTL 027	0.385	0.23	0.18	0.205	0.95	0.145	0.155	0.165	0.055
KONTL 028	0.365	0.215		0.19	0.9	0.135	0.15	0.155	0.05
LBROO 001	0.305	0.18	0.14	0.16	0.75	0.115	0.125	0.13	0.0435
LBROO 003	1	0.6	0.475	0.55	2.5	0.385	0.415	0.44	0.145
LBROO 004		0.115	0.09	0.1	0.46	0.07	0.075	0.08	0.027
LBROO 005	0.0034	0.002	0.00155	0.0018	0.008	0.0013	0.0014	0.00145	0.000479
LBROO 006	0.28	0.165	0.13	0.145	0.65	0.105	0.115	0.12	0.0395
LBROO 007		0.13	0.1	0.115	0.55	0.08	0.09	0.095	0.031
LBROO 008	0.205	0.12	0.095	0.11	0.495	0.075	0.085	0.09	0.029
LBROO 009	0.47	0.28		0.245	1.15	0.175	0.19	0.2	0.065
LBROO 010	0.22	0.13		0.115	0.55	0.085	0.09	0.095	0.031
LBROO 022	0.165	0.1		0.085	0.4	0.065	0.065	0.07	0.0235
IDVAL 001		0.265	0.205	0.235	1.1	0.17	0.18	0.19	0.065
IDVAL 002		0.265	0.205	0.235	1.05	0.165	0.18	0.19	0.065
IDVAL 003	0.31	0.185	0.145	0.165	0.75	0.115	0.125	0.135	0.044
IDVAL004	1.05	0.6		0.55	2.5	0.39	0.42	0.445	0.145
IDVAL005		0.405	10.0	0.355	1.65	0.255	0.275	0.29	0.095
IDVAL 006	0.55	0.315	0.245	0.28	1.3	0.2	0.215	0.225	0.075
IDVAL007	0.65	0.37	0.29	0.33	1.5	0.235	0.255	0.27	0.09
IDVAL 008	3.05	1.8	1.4	1.6	7.5	1.15	1.25	1.3	0.43
IDVAL009	0.6	0.35	0.27	0.31	1.4	0.22	0.24	0.25	0.085
IDVAL010	1.4	0.85		0.75	3.35	0.55	0.55	0.6	0.195