



## **Environmental Contaminants in Brook Trout from Aroostook National Wildlife Refuge**

**Fish and Wildlife Service**

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**U.S. Department of the Interior**

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U.S. Fish and Wildlife Service

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**Environmental Contaminants in  
Brook Trout from Aroostook National Wildlife Refuge**

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## Executive Summary

In June 2012, four brook trout (*Salvelinus fontinalis*) were collected by angling from Chapman Pond and East Loring Lake at Aroostook NWR in northeast Maine. Two skin-on fillet samples from each pond were analyzed to determine if body burdens of polychlorinated biphenyl (PCB) and other organochlorine compounds or trace elements would pose a potential risk to refuge anglers.

The 2012 fish tissue analyses were similar to results reported in earlier collections (2003, 2008) executed by the Air Force. The 2012 analyses indicate that:

- Due to PCB contamination, brook trout from Chapman Pond and East Loring Lake should not be consumed by anglers. The fish consumption advisory by the Maine Division of Environmental Health in place since 1997 should not be lifted.
- In both ponds, Total DDT levels in brook trout would require very restrictive consumption limits of only one-half a meal per month.
- Mercury levels in trout tissue from Chapman Pond would also trigger consumption limits of only 3 fish meals per month. In East Loring Lake, 4 to 8 fish meals per month would be allowed due to mercury burdens in brook trout.

Although the Air Force conducted extensive remedial actions to remove soil and sediments from the portions of the former installation that now comprise Aroostook NWR, persistent organochlorine contamination continues to impact biota on the refuge. Fish tissue contamination in Chapman Pond and East Loring Lake continues to prevent the establishment of any type of consumptive recreational angling program in these two areas.

**Keywords:** brook trout, PCB, Aroostook NWR, Maine

## **PREFACE**

This report provides documentation of environmental contaminants in skin-on fillets from brook trout collected at Aroostook National Wildlife Refuge in Maine. Analytical work was completed under USFWS Analytical Control Facility Catalog 5100049. Purchase orders numbers were AR#055 (Organics) and AR#056 (Inorganics).

Questions, comments, and suggestions related to this report are encouraged. Written inquiries should refer to Report Number FY13-MEFO-1-EC and be directed to:

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This report complies with the peer review and certification provisions of the Information Quality Act (Public Law 106-554, Section 515).

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## 1. Background

The Aroostook National Wildlife Refuge (ARONWR) in northeast Aroostook County was established in 1998 on the site of the former Loring Air Force Base (LAFB), a cold war era Strategic Air Command base. Throughout the course of its 40+ year operational history, Department of Defense activities at LAFB resulted in widespread contamination of soil, sediment, surface water, groundwater and biotic resources of the former Air Force base and present day wildlife refuge. In addition to the release of large volumes of petroleum products, cleaning solvents, heavy metals, and other toxic chemicals, leaking underground transformers contributed to the chronic release of polychlorinated biphenyls (PCBs) that contaminated sediments along several miles of the refuge's brooks and streams and receiving water bodies. Use and disposal of organochlorine pesticides (i.e., DDT and chlordane) in the course of military support activities and by pesticide applications in adjacent agricultural areas resulted in additional contamination to the refuge's watersheds.

Under the Superfund law, intensive remedial and restoration activities occurred at LAFB throughout much of the 1990s. These actions resulted in the partial removal and mitigation of some of the most serious environmental contamination issues at the installation. Remedial activities included a massive PCB-contaminated sediment removal project in Greenlaw Brook that resulted in the excavation and disposal of over 100,000 cubic yards of surficial sediments and floodplain soils. PCB-contaminated sediments located at depths greater than two feet were not excavated, but were covered with a geo-textile fabric and clean sediment cover to prevent mobilization of contaminants at depth. Pesticide contamination in the remediated area was determined to be co-located with PCB-contaminated sediment during the removal action. Similar PCB-related remedial actions and removal activities occurred in other portions of the installation including an Underground Transformer Site near East Loring Lake and the former Weapons Storage Area.

Following a fish tissue investigation in 1994, the Maine Bureau of Health enacted a fish consumption advisory for several LAFB surface waters. The state's guidelines recommended no consumption of fish from Chapman Pond and Greenlaw Brook (Maine CDC 2012a). PCB remedial actions at the installation were completed by the Air Force in 1998. Subsequent biota monitoring conducted by the Air Force, however, indicates that PCB concentrations in fish tissue remains elevated at some sampling locations (AFCEE 2004, 2009).

Despite the extensive remedial actions and removal activities, levels of PCBs in excess of Maine's fish tissue action levels (FTALs, Maine CDC 2012b) persist in brook trout and the consumption advisory remains in place. The Air Force, Environmental Protection Agency, and Maine Department of Environmental Protection had predicted that subsequent to the removal or containment of PCB-contaminated sediments, PCB concentrations in fish would steadily decrease and that the consumption advisory would likely be rescinded within five to ten years (ATSDR 1999). The expected decrease in biota PCB concentrations to "safe" levels, however,



has not occurred. Except for an annual fishing derby for children, ARONWR currently is closed to recreational angling. The derby is held at a recently created impoundment, which is stocked with trout just prior to the derby.

## 2. Study Purpose

Brook trout (*Salvelinus fontinalis*) were collected from Chapman Pond and East Loring Lake at ARONWR to determine if body burdens of polychlorinated biphenyl (PCB) pose a potential risk to refuge anglers. A secondary aspect of the screening-level study was to compare contaminant concentrations in trout from the two areas to contaminant levels previously reported by the US Air Force and its contractors.

## 3. Methods

### 3.1 Sampling Locations and Sample Collections.

3.1.1 East Loring Lake – East Loring Lake (Maine Information Display and Analysis System, (MIDAS # 6358) is a shallow 14.6 hectare (36 acre) pond in the northeast portion of the refuge in the township of Caswell ([Figure 1](#)). Lake coordinates are 46.967411° / -067.874242° (Map datum WGS84). The lake is located adjacent to the former Weapons Storage Area and is within the Butterfield Brook drainage.

3.1.2 Chapman Pond - Chapman Pond (also referred to locally as Chapman Pit and Chapman Pit Pond, MIDAS #1851) is a shallow 4.8 hectare (12 acre) pond located in the southwest portion of the refuge in the township of Limestone ([Figure 1](#)). Pond coordinates are 46.926012° / -067.923734°. The pond receives drainage from Malabeam Pond, which is within the drainage of the West Branch of Greenlaw Brook. A refuge water control structure is located along the southeast edge of the Chapman Pond. A natural outflow along the southwest edge of the pond continues the West Branch drainage into Greenlaw Brook.

3.1.3 Sample Collections and Processing – Between June 6 and 7, 2012, similar-size brook trout from each pond were caught by angling using small artificial lures and light spinning tackle. After being dispatched with a blow to the head, individual fish were measured for length and weight ([Table 1](#)), wrapped in aluminum foil, placed in a labeled zip-loc bag, and placed in a cooler filled with wet ice. Fish were processed at the USFWS Maine Field Office in Orono within four hours of collection. Fish were processed on stainless steel trays that were decontaminated by a wash of low residue, biodegradable soap (e.g., Alconox) and tap water followed by a tap water rinse, and a de-ionized water rinse. Fillet knives were similarly decontaminated. Fillet samples were removed in the manner traditionally used by Maine anglers for consumption (i.e., the head, tail, fins, and viscera were removed). Each skin-on fillet was weighed ([Table 1](#)), wrapped in aluminum foil (dull side towards sample), placed in labeled zip-loc bags, and frozen.

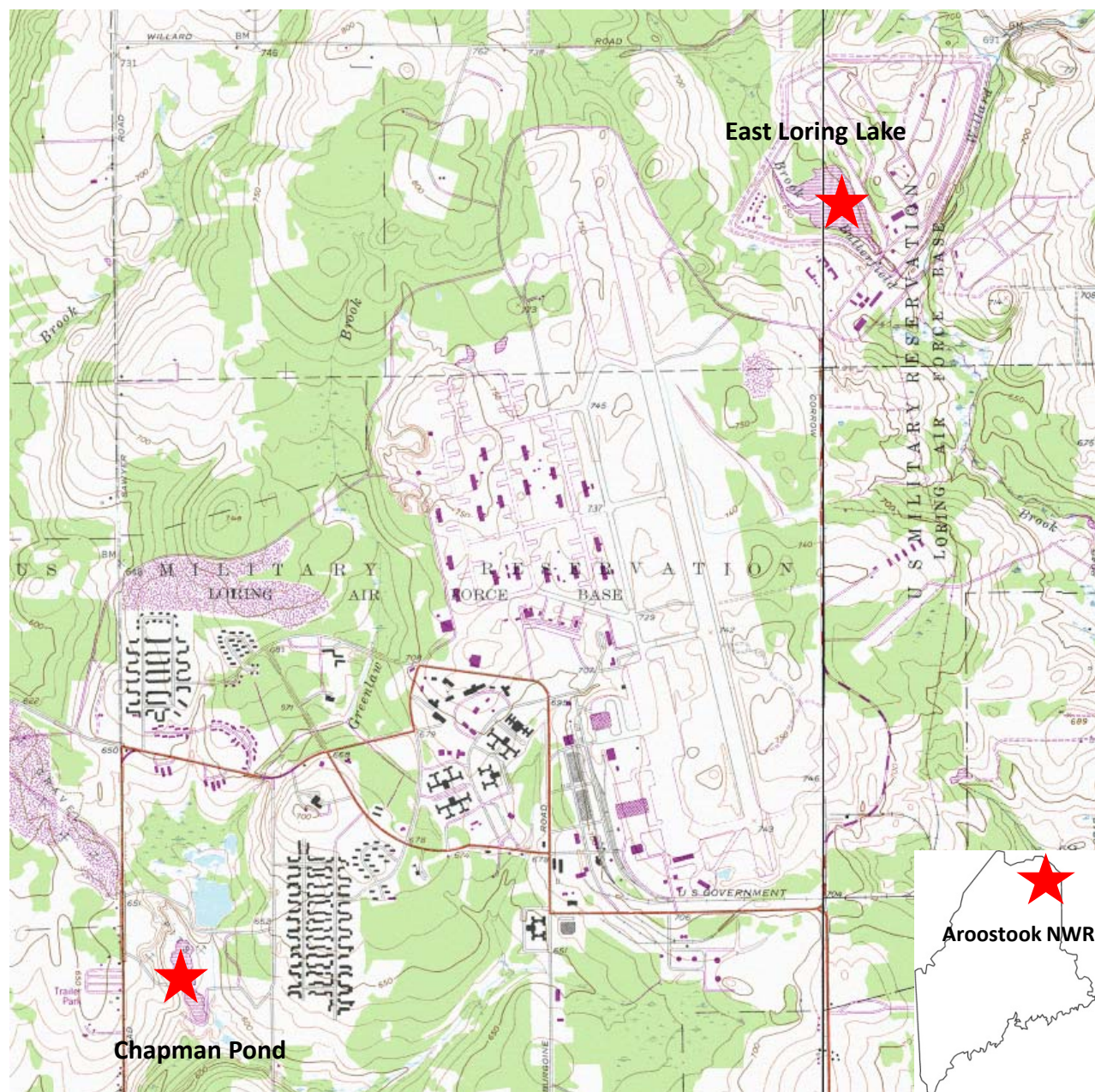
**3.2 Analytical.** Fillet samples were analyzed for Aroclors 1242, 1248, 1254, 1260 and 1268; Aroclor is one of the most commonly known trade names for PCB mixtures. The first two digits in an Aroclor refer to the number of carbon atoms in the phenyl rings - for PCBs this is 12 – while the last two digits indicate the degree of chlorination by mass in the mixture (EPA 2013). For example, the name Aroclor 1254 means that the PCB mixture contains approximately 54% chlorine by weight (EPA 2013). Note: Aroclor 1260 is the PCB formulation associated with LAFB contamination. Funds were not available to analyze for PCB congeners or polybrominated diphenyl ether.

Total PCB, DDT (dichlorodiphenyltrichloroethane) metabolites and isomers, and other organochlorine compounds including benzene hexachlorides (BHC), chlordane compounds, aldrin, endrin, dieldrin, endosulfan II, hexachlorobenzene (HCB), mirex, pentachloro-anisole, and toxaphene (Table 2a and 2b) were also included in the organochlorine analyses conducted by the Geochemical and Environmental Research Group (GERG) in College Station, Texas.

Inorganic determinations were made by Trace Element and Research Laboratory (TERL) in College Station, Texas. Inorganics included aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, phosphorus, potassium, selenium, silicon, silver, sodium, strontium, sulphur, thallium, tin, vanadium, and zinc (Table 3a and 3b). Percent lipid (Table 2a and 2b) and percent moisture (Table 3b) were also measured in each sample.

**3.3 Quality Assurance and Quality Control (QA/QC).** QA/QC procedures at GERG and TERL followed USFWS guidelines (USFWS 2007) and included procedural blanks, duplicates, spike recoveries, and certified reference material. The USFWS Analytical Control Facility reviewed QA/QC results and accepted all organic and inorganic data packages from GERG and TERL.

**Figure 1.** Brook trout collection locations at Aroostook NWR



**Table 1.** Fish and sample metrics

	Total Length mm. (in.)	Total Weight g. (oz.)	Sex	Sample No.	Sample Fillet Weight g. (oz.)	Sample Lipids (%)	Carcass Weight g. (oz.)
<b><u>Chapman Pond</u></b>							
Brook Trout #1	274 (10.8)	209.2 (7.4)	F	CP1201F	127.6 (4.5)	2.60	79.5 (2.8)
Brook Trout #2	275 (10.8)	175.1 (6.2)	M	CP1202F	96.0 (3.4)	3.10	71.3 (2.5)
<b><u>East Loring Lake</u></b>							
Brook Trout #1	356 (14.0)	376.9 (13.3)	F	EL1201F	239.5 (8.4)	3.11	134.0 (4.7)
Brook Trout #2	343 (13.5)	366.5 (12.0)	M	EL1202F	237.8 (8.4)	3.00	121.2 (4.3)

Fillet samples are skin-on portion of the body minus the tail, head, viscera, and fins of individual fish.

Carcasses (not analyzed) included tail, head, viscera, and fins of individual fish.

#### 4. Analytical Results

Analytical results are presented in [Table 2a](#) (organochlorines, µg/g wet weight), [Table 2b](#) (organochlorines, ng/g wet weight), [Table 3a](#) (inorganics, µg/g wet weight), and [Table 3b](#) (inorganics µg/g dry weight).

In this report, Total DDT ( $\Sigma$ DDT) is the sum of o,p'-DDD, o,p'-DDE, o,p'-DDT, p,p'-DDD, p,p'-DDE, and p,p'-DDT. Total Chlordane ( $\Sigma$ Chlordane) is the sum of alpha chlordane, gamma chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane.

Discussions of analytical results in the text are presented in ng/g (parts per billion) for organochlorines and µg/g (parts per million) for inorganics on a wet weight basis to facilitate comparisons with state Fish Tissue Action Levels (FTALs), EPA risk-based consumption limits, previous LAFB investigations, Maine studies and concentrations reported in regional and national bio-monitoring programs.

## WET WEIGHT

**Table 2a.** Organochlorines in brook trout fillets from Aroostook NWR, µg/g wet weight

Location	Chapman Pond			East Loring Lake		
Sample Number	CP1201F	CP1202F	Average	EL1201F	EL1202F	Average
Percent Lipid	2.60	3.10	2.85	3.11	3.00	3.06
<b>Polychlorinated Biphenyl</b>						
PCB-1242	< 0.000896	< 0.000959		< 0.000995	< 0.000863	
PCB-1248	< 0.000896	< 0.000959		< 0.000995	< 0.000863	
PCB-1254	< 0.000896	< 0.000959		0.022700	0.028900	0.025800
PCB-1260	0.336000	0.352000	0.344000	0.056700	0.096300	0.076500
PCB-1268	< 0.000896	< 0.000959		< 0.000995	< 0.000863	
PCB-TOTAL	0.336000	0.352000	0.344000	0.079400	0.125000	0.102200
<b>DDT Metabolites</b>						
o,p'-DDD	0.003940	0.001560	0.002750	0.004890	0.007860	0.006375
o,p'-DDE	0.000287	< 0.0000479		0.000510	0.000950	0.000730
o,p'-DDT	0.001700	0.001440	0.001570	0.005120	0.009500	0.007310
p,p'-DDD	0.024600	0.012200	0.018400	0.040400	0.076800	0.058600
p,p'-DDE	0.126000	0.125000	0.125500	0.351000	0.435000	0.393000
p,p'-DDT	0.001290	0.000888	0.001089	0.024800	0.045500	0.035150
ΣDDT	0.157817	0.141088	0.149453	0.426720	0.575610	0.501165
<b>Benzene Hexachlorides</b>						
alpha BHC	< 0.0000448	< 0.0000479		< 0.0000498	< 0.0000431	
beta BHC	0.000230	0.000261	0.000246	0.000152	< 0.0000431	
gamma BHC	< 0.0000448	< 0.0000479		< 0.0000498	< 0.0000431	
delta BHC	< 0.0000448	< 0.0000479		< 0.0000498	< 0.0000431	

fillets were skin-on

µg/g = parts per million

Values in red preceded by < symbol indicate non-detects and sample detection limit

Average not calculated if one sample was below the detection limit

ΣDDT is the sum of all isomers and metabolites



## WET WEIGHT

**Table 2a (continued).** Organochlorines in brook trout fillets from Aroostook NWR, µg/g wet weight

Location	Chapman Pond			East Loring Lake		
Sample Number	CP1201F	CP1202F	Average	EL1201F	EL1202F	Average
Percent Lipid	2.60	3.10	2.85	3.11	3.00	3.06
<b>Chlordane Compounds</b>						
alpha chlordane	0.000455	0.000059	0.000257	0.000120	0.001310	0.000715
gamma chlordane	< 0.0000448	< 0.0000479		< 0.0000498	0.000121	
cis-nonachlor	0.000381	0.000375	0.000378	0.000258	0.001440	0.000849
trans-nonachlor	0.000996	0.000930	0.000963	0.000988	0.003280	0.002134
oxychlordane	0.000352	0.000206	0.000279	0.003220	0.000748	0.001984
ΣChlordane	0.002184	0.001570	0.001877	0.004586	0.006899	0.005743
Heptachlor	< 0.0000448	< 0.0000479		< 0.0000498	< 0.0000431	
heptachlor epoxide	0.000116	0.000064	0.000090	< 0.0000498	< 0.0000431	
<b>Other Organochlorine Compounds</b>						
aldrin	< 0.0000448	< 0.0000479		< 0.0000498	0.000102	
endrin	< 0.0000448	< 0.0000479		< 0.0000498	< 0.0000431	
dieldrin	0.000169	< 0.0000479		0.000119	0.000124	0.000122
endosulfan II	< 0.0000448	< 0.0000479		< 0.0000498	< 0.0000431	
HCB	0.000123	< 0.0000479	0.000123	0.000186	0.000207	0.000197
mirex	< 0.0000448	< 0.0000479		< 0.0000498	< 0.0000431	
pentachloro-anisole	0.000289	< 0.0000479		0.000467	0.000506	0.000487
toxaphene	< 0.000896	< 0.000959		< 0.000995	< 0.000863	

fillets were skin-on

µg/g = parts per million

Values in red preceded by < symbol indicate non-detects and sample detection limit

Average not calculated if one sample was below the detection limit

ΣChlordane is the sum of alpha chlordane, gamma chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane

## WET WEIGHT

**Table 2b.** Organochlorines in brook trout fillets from Aroostook NWR, ng/g wet weight

Location	Chapman Pond			East Loring Lake		
Sample Number	CP1201F	CP1202F	Average	EL1201F	EL1202F	Average
Percent Lipid	2.60	3.10	2.85	3.11	3.00	3.06
<b>Polychlorinated Biphenyl</b>						
Aroclor 1242	< 0.896	< 0.959		< 0.995	< 0.863	
Aroclor 1248	< 0.896	< 0.959		< 0.995	< 0.863	
Aroclor 1254	< 0.896	< 0.959		22.7	28.9	25.8
Aroclor 1260	336.0	352.0	344.0	56.7	96.3	76.5
Aroclor 1268	< 0.896	< 0.959		< 0.995	< 0.863	
ΣPCB	336.0	352.0	344.0	79.4	125.0	102.2
<b>DDT Metabolites</b>						
o,p'-DDD	3.9	1.6	2.8	4.9	7.9	6.4
o,p'-DDE	0.3	< 0.0479		0.5	1.0	0.7
o,p'-DDT	1.7	1.4	1.6	5.1	9.5	7.3
p,p'-DDD	24.6	12.2	18.4	40.4	76.8	58.6
p,p'-DDE	126.0	125.0	125.5	351.0	435.0	393.0
p,p'-DDT	<u>1.3</u>	<u>0.9</u>	1.1	<u>24.8</u>	<u>45.5</u>	<u>35.2</u>
ΣDDT	157.8	141.1	149.5	426.7	575.6	501.2
<b>Benzene Hexachlorides</b>						
alpha BHC	< 0.0448	< 0.0479		< 0.0498	< 0.0431	
beta BHC	0.230	0.261	0.246	0.152	< 0.0431	
gamma BHC	< 0.0448	< 0.0479		< 0.0498	< 0.0431	
delta BHC	< 0.0448	< 0.0479		< 0.0498	< 0.0431	

fillets were skin-on

ng/g = parts per billion

Values in red preceded by < symbol indicate non-detects and sample detection limit

Average not calculated if one sample was below the detection limit

ΣDDT is the sum of all isomers and metabolites



## WET WEIGHT

**Table 2b (continued).** Organochlorines in brook trout fillets from Aroostook NWR, ng/g wet weight

Location	Chapman Pond			East Loring Lake		
Sample Number	CP1201F	CP1202F	Average	EL1201F	EL1202F	Average
Percent Lipid	2.60	3.10	2.85	3.11	3.00	3.06
<b>Chlordane Compounds</b>						
alpha chlordane	0.455	0.059	0.257	0.120	1.310	0.715
gamma chlordane	< 0.0448	< 0.0479		< 0.0498	0.121	
cis-nonachlor	0.381	0.375	0.378	0.258	1.440	0.849
trans-nonachlor	0.996	0.930	0.963	0.988	3.280	2.134
oxychlordane	<u>0.352</u>	<u>0.206</u>	0.279	<u>3.220</u>	<u>0.748</u>	<u>1.984</u>
ΣChlordane	2.184	1.570	1.877	4.586	6.899	5.743
heptachlor	< 0.0448	< 0.0479		< 0.0498	< 0.0431	
heptachlor epoxide	0.116	0.064	0.090	< 0.0498	< 0.0431	
<b>Other Organochlorine Compounds</b>						
aldrin	< 0.0448	< 0.0479		< 0.0498	0.102	
endrin	< 0.0448	< 0.0479		< 0.0498	< 0.0431	
dieldrin	0.169	< 0.0479		0.119	0.124	0.122
endosulfan II	< 0.0448	< 0.0479		< 0.0498	< 0.0431	
HCB	0.123	< 0.0479		0.186	0.207	0.197
mirex	< 0.0448	< 0.0479		< 0.0498	< 0.0431	
pentachloro-anisole	0.289	< 0.0479		0.467	0.506	0.487
toxaphene	< 0.896	< 0.959		< 0.995	< 0.863	

fillets were skin-on

ng/g = parts per billion

Values in red preceded by < symbol indicate non-detects and sample detection limit

Average not calculated if one sample was below the detection limit

ΣChlordane is the sum of alpha chlordane, gamma chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane

## WET WEIGHT

**Table 3a.** Inorganics in brook trout fillets from Aroostook NWR, µg/g wet weight

	Chapman Pond			East Loring Lake		
	CP1201F	CP1202F	Average	EL1201F	EL1202F	Average
Aluminum (Al)	2.12	14.80	8.46	1.01	1.43	1.22
Antimony (Sb)	< 0.00252	< 0.00230		< 0.00278	< 0.00282	
Arsenic (As)	< 0.0126	< 0.0115		0.0240	< 0.0141	
Barium (Ba)	0.12	0.22	0.17	0.08	0.17	0.12
Beryllium (Be)	< 0.0126	< 0.0115		< 0.0139	< 0.0141	
Boron (B)	< 0.126	< 0.115		< 0.139	< 0.141	
Cadmium (Cd)	< 0.00252	0.0024		< 0.00278	< 0.00282	
Chromium (Cr)	0.03	0.08	0.05	0.03	0.05	0.04
Cobalt (Co)	0.01	0.02	0.01	0.01	0.01	0.01
Copper (Cu)	0.40	0.31	0.36	0.37	0.35	0.36
Iron (Fe)	5.41	9.66	7.53	4.42	5.52	4.97
Lead (Pb)	< 0.0126	0.0139		< 0.0139	< 0.0141	
Magnesium (Mg)	294.00	321.00	307.50	295.00	298.00	296.50
Manganese (Mn)	1.06	1.73	1.40	0.84	0.78	0.81
Mercury (Hg)	0.226	0.234	0.230	0.131	0.091	0.111
Molybdenum (Mo)	< 0.0252	< 0.0230		< 0.0278	< 0.0282	
Nickel (Ni)	0.08	0.26	0.17	0.05	0.08	0.06
Phosphorus (P)	3930.00	5190.00	4560.00	3000.00	3420.00	3210.00
Potassium (K)	3950.00	3670.00	3810.00	3780.00	3780.00	3780.00
Selenium (Se)	0.09	0.08	0.08	0.14	0.11	0.12
Silicon (Si)	0.56	0.89	0.73	0.69	0.68	0.69
Silver (Ag)	< 0.00252	< 0.00230		< 0.00278	< 0.00282	

fillets were skin-on

µg/g = parts per million

Values in red preceded by < symbol indicate non-detects and sample detection limit

Average not calculated if one sample was below the detection limit

## WET WEIGHT

**Table 3a (continued).** Inorganics in brook trout fillets from Aroostook NWR, µg/g wet weight

	Chapman Pond			East Loring Lake		
	CP1201F	CP1202F	Average	EL1201F	EL1202F	Average
Sodium (Na)	452.00	647.00	549.50	395.00	433.00	414.00
Strontium (Sr)	6.32	10.80	8.56	2.86	4.39	3.63
Sulphur (S)	1870.00	1840.00	1855.00	2080.00	2060.00	2070.00
Thallium (Tl)	0.0033	< 0.00230		< 0.00278	< 0.00282	
Tin (Sn)	< 0.00506	< 0.00460		< 0.00556	< 0.00563	
Vanadium (V)	< 0.126	< 0.115		< 0.139	< 0.141	
Zinc (Zn)	8.72	10.20	9.46	7.23	7.87	7.55

fillets were skin-on

µg/g = parts per million

Values in red preceded by < symbol indicate non-detects and sample detection limit

Average not calculated if one sample was below the detection limit

## DRY WEIGHT

**Table 3b.** Inorganics in brook trout fillets from Aroostook NWR, µg/g dry weight

Location	Chapman Pond			East Loring Lake		
Sample Number	CP1201F	CP1202F	Average	EL1201F	EL1202F	Average
Moisture (%)	75.3	78.3	76.8	72.2	72.4	72.3
Aluminum (Al)	8.59	68.20	38.40	3.62	5.17	4.40
Antimony (Sb)	<0.0102	<0.0106		<0.0100	<0.0102	
Arsenic (As)	<0.0512	<0.0529		0.09	<0.0510	
Barium (Ba)	0.49	1.00	0.74	0.28	0.61	0.45
Beryllium (Be)	<0.0512	<0.0529		<0.0501	<0.0510	
Boron (B)	<0.512	<0.529		<0.501	<0.510	
Cadmium (Cd)	<0.0102	0.01		<0.0100	<0.0102	
Chromium (Cr)	0.11	0.36	0.23	0.12	0.19	0.15
Cobalt (Co)	0.04	0.08	0.06	0.03	0.04	0.03
Copper (Cu)	1.63	1.44	1.54	1.34	1.25	1.30
Iron (Fe)	21.90	44.50	33.20	15.90	20.00	17.95
Lead (Pb)	<0.0512	0.06		<0.0501	<0.0510	
Magnesium (Mg)	1190.00	1480.00	1335.00	1060.00	1080.00	1070.00
Manganese (Mn)	4.31	7.99	6.15	3.01	2.82	2.92
Mercury (Hg)	0.91	1.08	1.00	0.47	0.33	0.40
Molybdenum (Mo)	<0.102	<0.106		<0.100	<0.102	
Nickel (Ni)	0.34	1.20	0.77	0.17	0.28	0.23
Phosphorus (P)	15900.00	23900.00	19900.00	10800.00	12400.00	11600.00
Potassium (K)	16000.00	16900.00	16450.00	13600.00	13700.00	13650.00
Selenium (Se)	0.35	0.38	0.37	0.49	0.39	0.44
Silicon (Si)	2.26	4.12	3.19	2.49	2.48	2.49
Silver (Ag)	<0.0102	<0.0106		<0.0100	<0.0102	

fillets were skin-on

µg/g = parts per million

Values in red preceded by < symbol indicate non-detects and sample detection limit

Average not calculated if one sample was below the detection limit

## DRY WEIGHT

**Table 3b (continued).** Inorganics in brook trout fillets from Aroostook NWR, µg/g dry weight

Location	Chapman Pond			East Loring Lake		
Sample Number	CP1201F	CP1202F	Average	EL1201F	EL1202F	Average
Moisture (%)	75.3	78.3	76.8	72.2	72.4	72.3
Sodium (Na)	1830.00	2980.00	2405.00	1420.00	1570.00	1495.00
Strontium (Sr)	25.60	49.70	37.65	10.30	15.90	13.10
Sulphur (S)	7590.00	8480.00	8035.00	7490.00	7450.00	7470.00
Thallium (Tl)	0.01	<0.0106		<0.0100	<0.0102	
Tin (Sn)	<0.0205	<0.0212		<0.0200	<0.0204	
Vanadium (V)	<0.512	<0.529		<0.501	<0.510	
Zinc (Zn)	35.30	46.90	41.10	26.00	28.50	27.25

fillets were skin-on

µg/g = parts per million

Values in red preceded by < symbol indicate non-detects and sample detection limit

Average not calculated if one sample was below the detection limit

## 5. Discussion

The primary concern of ARONWR staff was whether body burdens of PCB in brook trout from the two ponds may pose a potential risk to refuge anglers. A secondary interest was whether contaminant levels in the two ponds were similar to data previously collected by the Air Force and its contractors. Lastly, the ARONWR staff wanted to know how contaminant concentrations in brook trout on the refuge compare to state, regional, or national studies.

Although only a screening study, this investigation potentially fulfills broader needs of the U.S. Fish and Wildlife Service and its partners. The brook trout is one of the Highest Priority Species for the North Atlantic Landscape Conservation Cooperative (NALCC, USFWS 2009). NALCC science capacity desires include the need to test the adaptability and resiliency of high priority species such as the brook trout and their habitats and landscapes that are particularly at risk of climate change impacts. The NALCC also seeks to improve understanding of the underlying environmental and ecological factors that determine current distributions of high priority species and how they may be altered by climate change (USFWS 2009). Since contaminant uptake may be affected by climate change (Noyes *et al.* 2009), the Aroostook NWR brook trout dataset should provide useful information to future researchers. In addition, among the states in the northeastern U.S., the Eastern Brook Trout Joint Venture (EBTJV) has identified Maine as the largest remaining native eastern brook trout habitat. The EBTJV (2011) was established in 2005 out of concern for the health of the many populations of the only native eastern trout species. Within this context, brook trout contaminant body burdens are a data gap that requires additional information such as the data provided in this study.

To assess potential risk to refuge anglers, brook trout fillet contaminant concentrations were compared against Maine Fish Tissue Action Levels (FTALs, Maine CDC 2012b) and EPA risk-based consumption limits (EPA 2000). To qualitatively assess data comparability, current PCB data were compared to previous LAFB brook trout investigations by the Air Force in 1994, 2001, 2003, and 2008 (Figures 2 and 3, AFCEE 2004, 2009).

Data from this study were also broadly compared to Maine studies using brook trout (Stafford and Haines 1997, Mierzykowski *et al.* 1997, Mierzykowski *et al.* 2008, EPA 2008) and to mean contaminant concentrations of other fish species reported in regional (Yeardley *et al.* 1998, Kamman *et al.* 2005) and national bio-monitoring programs (Hinck *et al.* 2009, Stahl *et al.* 2009). These comparisons to state, regional, and national bio-monitoring programs are of limited use, however, since other species (e.g., bass or perch) were analyzed or other sample types may have been processed (e.g., boneless, skinless fillets or whole-body), but they do provide some information regarding what may be considered “high” or “low” contaminant body burdens.

**5.1 Total Polychlorinated Biphenyl ( $\Sigma$ PCB).** Average  $\Sigma$ PCB concentration in brook trout fillet samples from Chapman Pond was 344.0 ng/g (Table 2b). The average  $\Sigma$ PCB concentration in

the fillet samples from East Loring Lake were 3 fold lower (102.2 ng/g) than Chapman Pond. Among the five Aroclors in the analyses, Aroclor 1260 was the only one detected in Chapman Pond. Aroclor 1254 and 1260 were detected brook trout tissue from East Loring Lake (Table 2b).

$\Sigma$ PCB concentrations in brook trout fillets from the two ponds on Aroostook NWR were higher than levels reported in other investigations. In Cove Brook in the Penobscot River watershed and Finn and Weaver Brooks in the Sheepscot River watershed,  $\Sigma$ PCB was below detection limits ( $< 10$  ng/g) in 36 whole-body brook trout samples (Mierzykowski *et al.* 2008). At the Brunswick Naval Air Station in Brunswick, Maine, another Federal Superfund site, six brook trout whole-body samples (individual and composites) from Mere Brook did not have detectable levels of seven Aroclors, but the detection limit was high (200 ng/g, Mierzykowski *et al.* 1997). In two samples of skinless brook trout fillets collected in 2012 from Gilead on the Androscoggin River in Maine, mean  $\Sigma$ PCB was 6.4 ng/g (Maine DEP, unpublished data). Stahl *et al.* (2009) examined  $\Sigma$ PCB in fillets of predator fish species from 500 lakes in the lower 48 states of the U.S. and found a median concentration of 2.16 ng/g. In multiple freshwater species analyzed whole-body in the national Biomonitoring of Environmental Status and Trends Project, the mean  $\Sigma$ PCB concentration was 84 ng/g (Hinck *et al.* 2009).

$\Sigma$ PCB concentrations in brook trout fillets from Chapman Pond and East Loring Lake exceed consumption guidelines and trigger restrictive federal and state consumption limits (Table A-1). Three of the four fillet samples had  $\Sigma$ PCB concentrations high enough ( $> 94$  ng/g or  $> 0.094$   $\mu$ g/g EPA Cancer Health Endpoint as noted Table A-1) to preclude any consumption by anglers.

Figures 2 and 3 depict  $\Sigma$ PCB in brook trout fillets collected at Chapman Pond and East Loring Lake, respectively, since 1994. Brook trout fillets for the present study were processed in the same manner as the previous U.S. Air Force collections. In Chapman Pond (Figure 2), brook trout fillet  $\Sigma$ PCB concentrations in 2008 (average 361.7 ng/g in three samples) and 2012 (average 344.0 ng/g in two samples) appear to slightly decrease since the high point recorded in the 2003 collections (average 564.3 ng/g in four samples). In East Loring Lake (Figure 3), the  $\Sigma$ PCB level in trout fillets slightly increases from 2003 (average 73.2 ng/g in 4 samples), to 2008 (78.9 ng/g in three samples), to 2012 (102.2 ng/g in two samples). Too few samples were collected in any of the collections, however, to determine if the suggested increasing or decreasing trends are statistically significant.

**5.2 Dichlorodiphenyldichloroethylene (p,p'-DDE) and Total DDT ( $\Sigma$ DDT).** In contrast to the  $\Sigma$ PCB concentration found in Chapman Pond and East Loring Lake, p,p'-DDE and  $\Sigma$ DDT were considerably higher in brook trout fillets from East Loring Lake than Chapman Pond (Table 2b). Average p,p'-DDE concentrations were 393.0 ng/g at East Loring Lake and 125.5 ng/g at Chapman Pond. Average  $\Sigma$ DDT concentrations were 501.2 ng/g at East Loring Lake and 149.5 ng/g at Chapman Pond.

DDE concentrations in brook trout fillets from the two ponds on Aroostook NWR were higher than levels reported in other investigations. In 36 whole-body brook trout samples collected from Cove Brook in the Penobscot River watershed and Finn and Weaver Brooks in the Sheepscot River watershed, *p,p'*-DDE was below detection limits ( $< 2$  ng/g) in all except two fish (Mierzykowski *et al.* 2008). In brook trout (skinless fillets) collected from 11 Aroostook County locations in 2009,  $\Sigma$ DDT ranged from 67.0 ng/g to 402.1 ng/g (Maine DEP 2010). Stahl *et al.* (2009) examined  $\Sigma$ DDT in fillets of predator fish species from 500 lakes in the lower 48 states of the U.S. and found a median concentration of 1.47 ng/g. Levels of *p,p'*-DDE and  $\Sigma$ DDT in brook trout fillets at Aroostook NWR were also elevated compared to multiple freshwater species analyzed whole-body in the national Biomonitoring of Environmental Status and Trends Project (44.7 ng/g *p,p'*-DDE, 80.9 ng/g  $\Sigma$ DDT, Hinck *et al.* 2009).

$\Sigma$ DDT concentrations in brook trout fillets from the two ponds on Aroostook NWR would trigger more restrictive federal and state consumption limits (Table A-2). One fillet sample from East Loring Lake (575.6 ng/g in EL1202F) had a  $\Sigma$ DDT concentration high enough ( $> 550$  ng/g or  $> 0.55$   $\mu$ g/g EPA Cancer Health Endpoint as noted in Table A-2) to preclude any consumption by anglers.

### 5.3 Other Organochlorine compounds.

**5.3.1 Total Chlordane ( $\Sigma$ Chlordane)** –  $\Sigma$ Chlordane is the sum of alpha chlordane, gamma chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane.  $\Sigma$ Chlordane ranged from 1.57 ng/g to 6.89 ng/g in brook trout fillet samples with higher levels occurring in East Loring Lake than Chapman Pond (Table 2b). Levels of  $\Sigma$ Chlordane were not high enough to warrant a consumption limit or advisory recommendation (Table A-3).

**5.3.2 Heptachlor Epoxide** – Heptachlor epoxide is a chlordane-related compound. The compound was detected in both fillet samples from Chapman Pond (average 0.09 ng/g), but not in the samples from East Loring Lake (Table 2b). The concentrations detected in Chapman Pond brook trout fillets would not trigger consumption limits or advisory recommendations (Table A-4).

**5.3.3 Aldrin** – Aldrin was only found above detection limits in one fillet sample from East Loring Lake (0.102 ng/g, Table 2b). The concentration would not trigger consumption limits or advisory recommendations (Table A-5).

**5.3.4 Dieldrin** – Dieldrin was detected in three of the four fillet samples with the highest concentration found in one of the samples from Chapman Pond (0.169 ng/g, Table 2b). None of the concentrations detected, however, would trigger consumption limits or advisory recommendations (Table A-6).

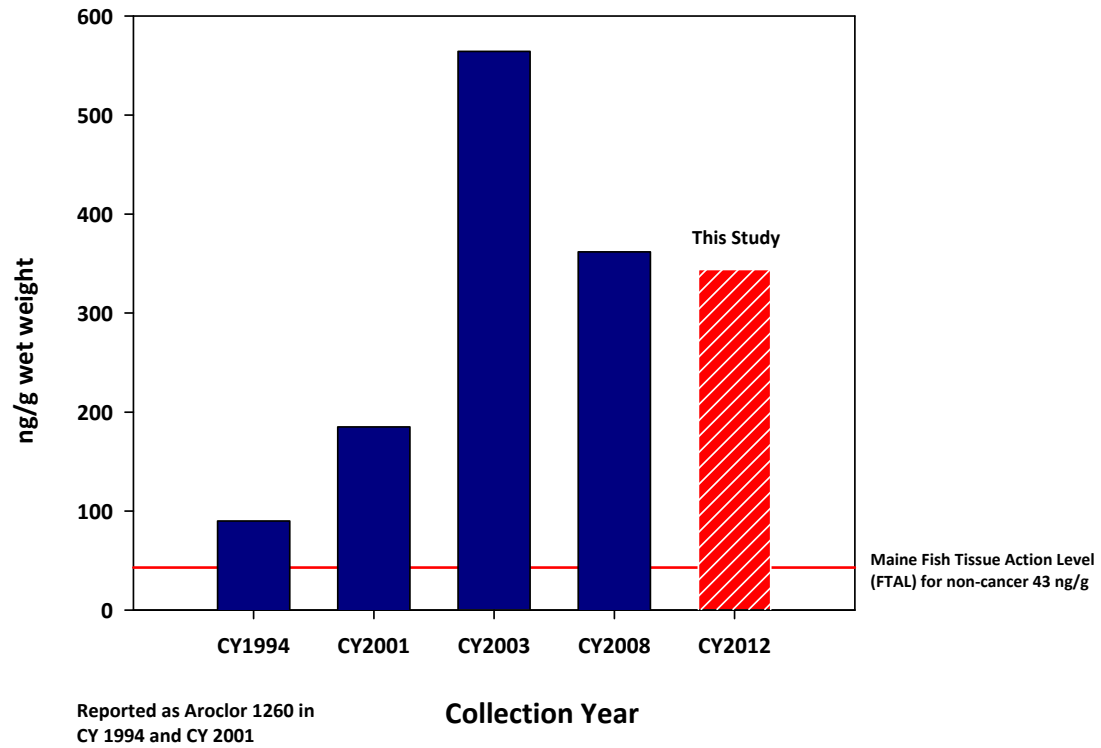
**5.3.5 Hexachlorobenzene (HCB)** – Similar to dieldrin, three of four fillet samples had



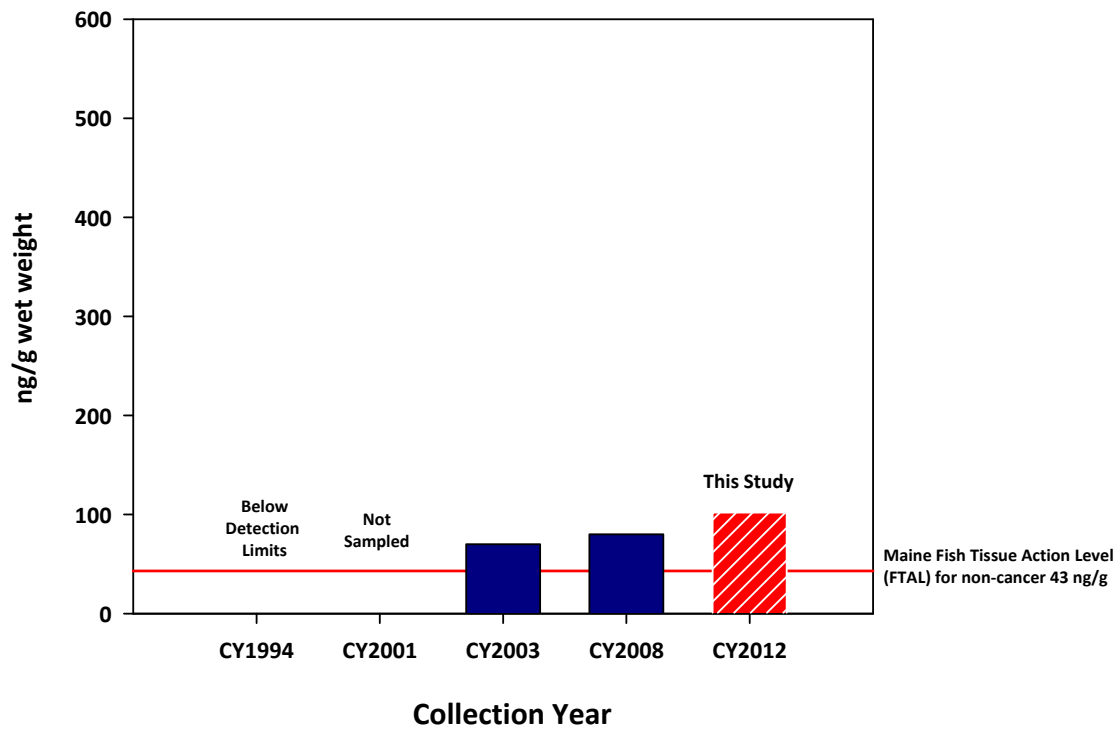
detectable levels of HCB. The highest concentration was found in a fillet sample from East Loring Lake, but none of the concentrations would trigger consumption limits or advisory recommendations ([Table A-7](#)).

5.3.6 Compounds below analytical detection limits – Aroclor 1242, Aroclor 1248, Aroclor 1268, alpha BHC, gamma BHC (Lindane), delta BHC, heptachlor, endrin, endosulfan II, mirex, and toxaphene were below analytical detection limits in all four fillet samples ([Table 2b](#)).

**Figure 2.** Total PCB in brook trout fillets from Chapman Pond by collection year, ng/g wet weight



**Figure 3.** Total PCB in brook trout fillets from East Loring Lake by collection year, ng/g wet weight



**5.4 Total Mercury (Hg).** Mercury concentrations in brook trout fillets from Chapman Pond averaged 0.23 µg/g, while the fillets from East Loring Lake averaged 0.11 µg/g ([Table 3a](#)). The TERL inorganic analyses for fillets were for total mercury, but it is safe to assume that nearly all the mercury in brook trout fillets would be comprised of methylmercury (MeHg). Kelly *et al.* (2008) found 97.1% of the total mercury in salmonid flesh was in the organometallic (i.e., MeHg) form; a finding consistent with Westoo (1973, average 93%, range: 82 – 102%).

Mercury levels in brook trout fillets from the two Aroostook NWR ponds were elevated or lower compared to other Maine trout collections. In seven samples of whole-body brook trout (individuals and composites) from Brunswick Naval Air Station, the mean mercury concentration was 0.09 µg/g (Mierzykowski *et al.* 1997). In a later collection at Brunswick Naval Air Station, six whole-body brook trout samples (individuals and composites) had a mean mercury level of 0.08 µg/g (EPA 2008). In 36 whole-body brook trout samples from Cove Brook, Finn Brook, and Weaver Brook, the mean mercury concentration was 0.06 µg/g (Mierzykowski *et al.* 2008). Stafford and Haines (1997) reported higher mercury concentrations in skinless, boneless fillets of 31 brook trout collected from Maine lakes (mean 0.31 µg/g, range: 0.03 – 0.79 µg/g).

In regional and national studies, higher and lower fish mercury concentrations than the levels found in Aroostook NWR brook trout have been reported. Kamman *et al.* (2005) summarized fish mercury in the northeastern U.S. and reported a mean mercury concentration of 0.215 µg/g in 1,104 brook trout fillets. Yeardley *et al.* (1998) examined mercury in multiple species of whole-body fish from 167 northeastern U.S. lakes and reported a mean mercury level of 0.17 µg/g. Stahl *et al.* (2009) examined mercury in fillets of predator fish species from 500 lakes in the lower 48 states of the U.S. and found a mean concentration of 0.352 µg/g. Hinck *et al.* (2009) reported a mean mercury level of 0.13 µg/g in multiple species of whole-body piscivorous and benthivorous fish collected from 111 large U.S. river sites.

Mercury levels in brook trout fillets from Chapman Pond and East Loring Lake would exceed Maine consumption advisories and also result in more restricted consumption levels under EPA's mercury endpoints ([Table B-2](#)).

## **5.5 Other Inorganics.**

**5.5.1 Arsenic (As)** – Arsenic was detected in only one sample, a fillet from East Loring Lake (0.024 µg/g, [Table 3a](#)). Arsenic concentrations in brook trout fillet samples are reported by TERL as total arsenic. EPA Health Endpoints and Maine BOH Action levels, however, are for inorganic arsenic. In [Table B-1](#), the reported trout fillet arsenic concentration was multiplied by 0.1 under the assumption that 10% of the total arsenic in fish is inorganic arsenic (FDA 1993, Maine CDC 2012b). The arsenic level detected in the single fillet would have a small effect on consumption limits under the EPA Cancer Health Endpoint. Instead of unlimited consumption

of more than 16 meals per month, the arsenic concentration in the East Loring Lake trout fillet would reduce the consumption limit to 16 meals per month ([Table B-1](#)).

5.5.2 Cadmium (Cd) – Cadmium was detected in only one sample, a fillet from Chapman Pond (0.0024 µg/g, [Table 3a](#)). The Maine Action level for cadmium is 2.20 µg/g, so the consumption of brook trout fillets from the two Aroostook NWR ponds would be unrestricted ([Table B-3](#)).

5.5.3 Lead (Pb) - Lead was detected in only one sample from Chapman Pond at 0.0139 µg/g; a concentration at the detection limit ([Table 3a](#)).

5.5.4 Manganese (Mn) – Manganese was detected in all four samples with a range from 0.78 µg/g to 1.73 µg/g. The Maine Action level for manganese is 302.00 µg/g, so the consumption of brook trout fillets from the two Aroostook NWR ponds would be unrestricted ([Table B-4](#)).

5.5.5 Nickel (Ni) – Nickel was detected in all four samples with a range from 0.05 µg/g to 0.26 µg/g. The Maine Action level for nickel is 43.00 µg/g, so the consumption of brook trout fillets from the two Aroostook NWR ponds would be unrestricted ([Table B-5](#)).

5.5.6 Selenium (Se) – Selenium was detected in all four samples with a range from 0.08 µg/g to 0.14 µg/g. The Maine Action level for selenium is 11.00 µg/g, so the consumption of brook trout fillets from the two Aroostook NWR ponds would be unrestricted ([Table B-6](#)).

5.5.7 Zinc (Zn) - Zinc was detected in all four samples with a range from 7.23 µg/g to 10.20 µg/g. The Maine Action level for zinc is 648.00 µg/g, so the consumption of brook trout fillets from the two Aroostook NWR ponds would be unrestricted ([Table B-7](#)).

5.5.8 Inorganics below analytical detection limits, essential elements, and elements with limited toxicological information – Antimony, beryllium, boron, molybdenum, silver, tin, and vanadium were below detection limits in all fillet samples ([Table 3a](#)). Essential elements for fish are not discussed. Essential macro-elements for fish nutrition include magnesium, sodium, potassium, phosphorus, and sulphur, while essential trace or micro-elements include iron, copper, cobalt, chromium, molybdenum, tin, and silicon (FAO 1987). Aluminum was detected in all four fillet samples (range 1.01 – 14.80 µg/g, [Table 3a](#)). However, all fillet samples were wrapped in aluminum foil so the reported aluminum concentrations have little value in this assessment. Toxicological information regarding residue concentrations in fish tissue are lacking for barium, strontium, and thallium (John Peter and Viraraghavan 2005).

## 6. Summary and Management Recommendation

In June 2012, four brook trout were collected by angling from Chapman Pond and East Loring Lake at Aroostook NWR in northeast Maine. Two fillet samples from each pond were analyzed to determine if body burdens of polychlorinated biphenyl (PCB) and other organochlorine compounds or trace elements would pose a potential risk to refuge anglers.

The 2012 fish tissue analyses were similar to results reported in earlier collections (2003, 2008) executed by the Air Force. The 2012 analyses indicate that:

- Due to PCB contamination, brook trout from Chapman Pond (max. 352.0 ng/g) and East Loring Lake (max. 125.0 ng/g) should not be consumed by anglers. Maximum  $\Sigma$ PCB levels in brook trout from the two ponds exceed the state Fish Tissue Action level (43 ng/g) by factors of 8 and 3, respectively. The consumption advisory by the Maine Division of Environmental Health in place since 1997 should not be lifted.
- In both ponds,  $\Sigma$ DDT levels in brook trout would require very restrictive consumption limits of only one-half a meal per month.
- Mercury levels in trout tissue from Chapman Pond (max. 0.234  $\mu$ g/g) would also trigger consumption limits of only 3 fish meals per month. In East Loring Lake, 4 to 8 fish meals per month would be allowed due to mercury burdens in brook trout.

Although the Air Force conducted extensive remedial actions to remove soil and sediments from the portions of the former installation that now comprise Aroostook NWR, persistent organochlorine contamination continues to impact biota on the refuge. Mercury contamination in trout tissue, most likely from atmospheric deposition, also presents a potential risk to human and ecological receptors. Fish tissue contamination in Chapman Pond and East Loring Lake continues to prevent the establishment of any type of consumptive recreational angling program in these two areas.

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## Appendix Tables

Comparisons to EPA Fish Consumption Limits and Maine Bureau of Health Action Levels

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**Table A-1.** Total Polychlorinated Biphenyl ( $\Sigma$ PCB)

FWS Sample Number	Total PCB $\mu\text{g/g ww}$	EPA Cancer Health Endpoint $\mu\text{g/g ww}$	EPA Risk-Based Consumption Limit Fish Meals / Month
CP1201F	0.336	> 0.094	None (< 0.5 meal / month)
CP1202F	0.352	> 0.094	None (< 0.5 meal / month)
EL1201F	0.079	> 0.047 – 0.094	0.5
EL1202F	0.125	> 0.094	None (< 0.5 meal / month)
FWS Sample Number	Total PCB $\mu\text{g/g ww}$	EPA Non Cancer Health Endpoint $\mu\text{g/g ww}$	EPA Risk-Based Consumption Limit Fish Meals / Month
CP1201F	0.336	> 0.19 – 0.38	0.5
CP1202F	0.352	> 0.19 – 0.38	0.5
EL1201F	0.079	> 0.063 – 0.094	2
EL1202F	0.125	> 0.094 – 0.19	1
FWS Sample Number	Total PCB $\mu\text{g/g ww}$	Maine Cancer Action Level $\mu\text{g/g ww}$	Maine Consumption Advisory Recommendation
CP1201F	0.336	> 0.011	Threshold exceeded by one fish meal / week
CP1202F	0.352	> 0.011	Threshold exceeded by one fish meal / week
EL1201F	0.079	> 0.011	Threshold exceeded by one fish meal / week
EL1202F	0.125	> 0.011	Threshold exceeded by one fish meal / week
FWS Sample Number	Total PCB $\mu\text{g/g ww}$	Maine Non Cancer Action Level $\mu\text{g/g ww}$	Maine Consumption Advisory Recommendation
CP1201F	0.336	> 0.043	Threshold exceeded by one fish meal / week
CP1202F	0.352	> 0.043	Threshold exceeded by one fish meal / week
EL1201F	0.079	> 0.043	Threshold exceeded by one fish meal / week
EL1202F	0.125	> 0.043	Threshold exceeded by one fish meal / week

**Table A-2.** Total DDT ( $\Sigma$ DDT = sum of *o,p'*-DDD, *o,p'*-DDE, *o,p'*-DDT, *p,p'*-DDD, *p,p'*-DDE, *p,p'*-DDT)

FWS Sample Number	Total DDT $\mu\text{g/g ww}$	EPA Cancer Health Endpoint $\mu\text{g/g ww}$	EPA Risk-Based Consumption Limit Fish Meals / Month
CP1201F	0.1578	> 0.14 – 0.28	1
CP1202F	0.1411	> 0.14 – 0.28	1
EL1201F	0.4267	> 0.28 – 0.55	0.5
EL1202F	0.5756	> 0.55	None (< 0.5 meal / month)
FWS Sample Number	Total DDT $\mu\text{g/g ww}$	EPA Non Cancer Health Endpoint $\mu\text{g/g ww}$	EPA Risk-Based Consumption Limit Fish Meals / Month
CP1201F	0.1578	> 0.12 – 0.16	3
CP1202F	0.1411	> 0.12 – 0.16	3
EL1201F	0.4267	> 0.23 – 0.47	1
EL1202F	0.5756	> 0.47 – 0.94	0.5
FWS Sample Number	Total DDT $\mu\text{g/g ww}$	Maine Cancer Action Level $\mu\text{g/g ww}$	Maine Consumption Advisory Recommendation
CP1201F	0.1578	> 0.0014	Threshold exceeded by one fish meal / week
CP1202F	0.1411	> 0.0014	Threshold exceeded by one fish meal / week
EL1201F	0.4267	> 0.0014	Threshold exceeded by one fish meal / week
EL1202F	0.5756	> 0.0014	Threshold exceeded by one fish meal / week
FWS Sample Number	Total DDT $\mu\text{g/g ww}$	Maine Non Cancer Action Level $\mu\text{g/g ww}$	Maine Consumption Advisory Recommendation
CP1201F	0.1578	> 0.108	Threshold exceeded by one fish meal / week
CP1202F	0.1411	> 0.108	Threshold exceeded by one fish meal / week
EL1201F	0.4267	> 0.108	Threshold exceeded by one fish meal / week
EL1202F	0.5756	> 0.108	Threshold exceeded by one fish meal / week

**Table A-3.** Total Chlordane ( $\Sigma$ Chlordane = sum of *alpha* chlordane, *gamma* chlordane, *cis*-nonachlor, *trans*-nonachlor and oxychlordane)

FWS Sample Number	$\Sigma$ Chlordane $\mu\text{g/g ww}$	EPA Cancer Health Endpoint $\mu\text{g/g ww}$	EPA Risk-Based Consumption Limit Fish Meals / Month
CP1201F	0.0022	0 – 0.0084	Unrestricted (>16)
CP1202F	0.0016	0 – 0.0084	Unrestricted (>16)
EL1201F	0.0046	0 – 0.0084	Unrestricted (>16)
EL1202F	0.0069	0 – 0.0084	Unrestricted (>16)
FWS Sample Number	$\Sigma$ Chlordane $\mu\text{g/g ww}$	EPA Non Cancer Health Endpoint $\mu\text{g/g ww}$	EPA Risk-Based Consumption Limit Fish Meals / Month
CP1201F	0.0022	0 – 0.15	Unrestricted (> 16)
CP1202F	0.0016	0 – 0.15	Unrestricted (> 16)
EL1201F	0.0046	0 – 0.15	Unrestricted (> 16)
EL1202F	0.0069	0 – 0.15	Unrestricted (> 16)
FWS Sample Number	$\Sigma$ Chlordane $\mu\text{g/g ww}$	Maine Cancer Action Level $\mu\text{g/g ww}$	Maine Consumption Advisory Recommendation
CP1201F	0.0022	> 0.017	One fish meal / week will not exceed threshold
CP1202F	0.0016	> 0.017	One fish meal / week will not exceed threshold
EL1201F	0.0046	> 0.017	One fish meal / week will not exceed threshold
EL1202F	0.0069	> 0.017	One fish meal / week will not exceed threshold
FWS Sample Number	$\Sigma$ Chlordane $\mu\text{g/g ww}$	Maine Non Cancer Action Level $\mu\text{g/g ww}$	Maine Consumption Advisory Recommendation
CP1201F	0.0022	> 0.130	One fish meal / week will not exceed threshold
CP1202F	0.0016	> 0.130	One fish meal / week will not exceed threshold
EL1201F	0.0046	> 0.130	One fish meal / week will not exceed threshold
EL1202F	0.0069	> 0.130	One fish meal / week will not exceed threshold

**Table A-4.** Heptachlor epoxide

FWS Sample Number	Heptachlor epoxide µg/g ww	EPA Cancer Health Endpoint µg/g ww	EPA Risk-Based Consumption Limit Fish Meals / Month
CP1201F	0.000116	> 0 – 0.00032	Unrestricted (>16)
CP1202F	0.000064	> 0 – 0.00032	Unrestricted (>16)
EL1201F	< 0.0000498	> 0 – 0.00032	Unrestricted (>16)
EL1202F	< 0.0000431	> 0 – 0.00032	Unrestricted (>16)
FWS Sample Number	Heptachlor epoxide µg/g ww	EPA Non Cancer Health Endpoint µg/g ww	EPA Risk-Based Consumption Limit Fish Meals / Month
CP1201F	0.000116	0 – 0.0038	Unrestricted (> 16)
CP1202F	0.000064	0 – 0.0038	Unrestricted (> 16)
EL1201F	< 0.0000498	0 – 0.0038	Unrestricted (> 16)
EL1202F	< 0.0000431	0 – 0.0038	Unrestricted (> 16)
FWS Sample Number	Heptachlor epoxide µg/g ww	Maine Cancer Action Level µg/g ww	Maine Consumption Advisory Recommendation
CP1201F	0.000116	> 0.0024	One fish meal / week will not exceed threshold
CP1202F	0.000064	> 0.0024	One fish meal / week will not exceed threshold
EL1201F	< 0.0000498	> 0.0024	One fish meal / week will not exceed threshold
EL1202F	< 0.0000431	> 0.0024	One fish meal / week will not exceed threshold
FWS Sample Number	Heptachlor epoxide µg/g ww	Maine Non Cancer Action Level µg/g ww	Maine Consumption Advisory Recommendation
CP1201F	0.000116	> 0.028	One fish meal / week will not exceed threshold
CP1202F	0.000064	> 0.028	One fish meal / week will not exceed threshold
EL1201F	< 0.0000498	> 0.028	One fish meal / week will not exceed threshold
EL1202F	< 0.0000431	> 0.028	One fish meal / week will not exceed threshold

Concentrations in green preceded by the < symbol indicate non-detects and the sample detection limit

**Table A-5. Aldrin**

FWS Sample Number	Aldrin µg/g ww	Maine Cancer Action Level µg/g ww	Maine Consumption Advisory Recommendation
CP1201F	< 0.0000448	> 0.0013	One fish meal / week will not exceed threshold
CP1202F	< 0.0000479	> 0.0013	One fish meal / week will not exceed threshold
EL1201F	< 0.0000498	> 0.0013	One fish meal / week will not exceed threshold
EL1202F	0.000102	> 0.0013	One fish meal / week will not exceed threshold
FWS Sample Number	Aldrin µg/g ww	Maine Non Cancer Action Level µg/g ww	Maine Consumption Advisory Recommendation
CP1201F	< 0.0000448	> 0.065	One fish meal / week will not exceed threshold
CP1202F	< 0.0000479	> 0.065	One fish meal / week will not exceed threshold
EL1201F	< 0.0000498	> 0.065	One fish meal / week will not exceed threshold
EL1202F	0.000102	> 0.065	One fish meal / week will not exceed threshold

**Table A-6. Dieldrin**

FWS Sample Number	Dieldrin µg/g ww	EPA Cancer Health Endpoint µg/g ww	EPA Risk-Based Consumption Limit Fish Meals / Month
CP1201F	0.000169	0 - 0.00018	Unrestricted (> 16)
CP1202F	< 0.0000479	0 - 0.00018	Unrestricted (> 16)
EL1201F	0.000119	0 - 0.00018	Unrestricted (> 16)
EL1202F	0.000124	0 - 0.00018	Unrestricted (> 16)
FWS Sample Number	Dieldrin µg/g ww	EPA Non Cancer Health Endpoint µg/g ww	EPA Risk-Based Consumption Limit Fish Meals / Month
CP1201F	0.000169	0 – 0.015	Unrestricted (> 16)
CP1202F	< 0.0000479	0 – 0.015	Unrestricted (> 16)
EL1201F	0.000119	0 – 0.015	Unrestricted (> 16)
EL1202F	0.000124	0 – 0.015	Unrestricted (> 16)
FWS Sample Number	Dieldrin µg/g ww	Maine Cancer Action Level µg/g ww	Maine Consumption Advisory Recommendation
CP1201F	0.000169	> 0.0014	One fish meal / week will not exceed threshold
CP1202F	< 0.0000479	> 0.0014	One fish meal / week will not exceed threshold
EL1201F	0.000119	> 0.0014	One fish meal / week will not exceed threshold
EL1202F	0.000124	> 0.0014	One fish meal / week will not exceed threshold
FWS Sample Number	Dieldrin µg/g ww	Maine Non Cancer Action Level µg/g ww	Maine Consumption Advisory Recommendation
CP1201F	0.000169	> 0.108	One fish meal / week will not exceed threshold
CP1202F	< 0.0000479	> 0.108	One fish meal / week will not exceed threshold
EL1201F	0.000119	> 0.108	One fish meal / week will not exceed threshold
EL1202F	0.000124	> 0.108	One fish meal / week will not exceed threshold

Concentrations in green preceded by the < symbol indicate non-detects and the sample detection limit

**Table A-7. Hexachlorobenzene (HCB)**

FWS Sample Number	HCB µg/g ww	EPA Cancer Health Endpoint µg/g ww	EPA Risk-Based Consumption Limit Fish Meals / Month
CP1201F	0.000123	0 – 0.0018	Unrestricted (>16)
CP1202F	< 0.0000479	0 – 0.0018	Unrestricted (>16)
EL1201F	0.000186	0 – 0.0018	Unrestricted (>16)
EL1202F	0.000207	0 – 0.0018	Unrestricted (>16)
FWS Sample Number	HCB µg/g ww	EPA Non Cancer Health Endpoint µg/g ww	EPA Risk-Based Consumption Limit Fish Meals / Month
CP1201F	0.000123	0 – 0.23	Unrestricted (> 16)
CP1202F	< 0.0000479	0 – 0.23	Unrestricted (> 16)
EL1201F	0.000186	0 – 0.23	Unrestricted (> 16)
EL1202F	0.000207	0 – 0.23	Unrestricted (> 16)
FWS Sample Number	HCB µg/g ww	Maine Cancer Action Level µg/g ww	Maine Consumption Advisory Recommendation
CP1201F	0.000123	> 0.014	One fish meal / week will not exceed threshold
CP1202F	< 0.0000479	> 0.014	One fish meal / week will not exceed threshold
EL1201F	0.000186	> 0.014	One fish meal / week will not exceed threshold
EL1202F	0.000207	> 0.014	One fish meal / week will not exceed threshold
FWS Sample Number	HCB µg/g ww	Maine Non Cancer Action Level µg/g ww	Maine Consumption Advisory Recommendation
CP1201F	0.000123	> 1.728	One fish meal / week will not exceed threshold
CP1202F	< 0.0000479	> 1.728	One fish meal / week will not exceed threshold
EL1201F	0.000186	> 1.728	One fish meal / week will not exceed threshold
EL1202F	0.000207	> 1.728	One fish meal / week will not exceed threshold

Concentrations in green preceded by the < symbol indicate non-detects and the sample detection limit

**Table B-1. Arsenic (As)**

FWS Sample Number	As µg/g ww	EPA Cancer Health Endpoint µg/g ww	EPA Risk-Based Consumption Limit Fish Meals / Month
CP1201F	BDL	0 – 0.002	Unrestricted (> 16)
CP1202F	BDL	0 – 0.002	Unrestricted (> 16)
EL1201F	0.0024	> 0.002 – 0.0039	16
EL1202F	BDL	0 – 0.002	Unrestricted (> 16)
FWS Sample Number	As µg/g ww	EPA Non Cancer Health Endpoint µg/g ww	EPA Risk-Based Consumption Limit Fish Meals / Month
CP1201F	BDL	0 – 0.088	Unrestricted (> 16)
CP1202F	BDL	0 – 0.088	Unrestricted (> 16)
EL1201F	0.0024	0 – 0.088	Unrestricted (> 16)
EL1202F	BDL	0 – 0.088	Unrestricted (> 16)
FWS Sample Number	As µg/g ww	Maine Cancer Action Level µg/g ww	Maine Consumption Advisory Recommendation
CP1201F	BDL	0.014	One fish meal / week will not exceed threshold
CP1202F	BDL	0.014	One fish meal / week will not exceed threshold
EL1201F	0.0024	0.014	One fish meal / week will not exceed threshold
EL1202F	BDL	0.014	One fish meal / week will not exceed threshold
FWS Sample Number	As µg/g ww	Maine Non Cancer Action Level µg/g ww	Maine Consumption Advisory Recommendation
CP1201F	BDL	0.6	One fish meal / week will not exceed threshold
CP1202F	BDL	0.6	One fish meal / week will not exceed threshold
EL1201F	0.0024	0.6	One fish meal / week will not exceed threshold
EL1202F	BDL	0.6	One fish meal / week will not exceed threshold

Original brook trout fillet sample concentrations reported as total arsenic. EPA Health Endpoints and Maine BOH Action levels are for inorganic arsenic. Reported trout fillet arsenic concentrations below were multiplied by 0.1 under the assumption that 10% of the total arsenic in fish is inorganic arsenic (FDA 1993, Maine BOH 2009). BDL = below detection limit. Sample detection limits (i.e., samples without detectable arsenic concentrations) were not converted to inorganic arsenic.

**Table B-2. Cadmium (Cd)**

FWS Sample Number	Cd µg/g ww	EPA Non Cancer Health Endpoint µg/g ww	EPA Risk-Based Consumption Limit Fish Meals / Month
CP1201F	< 0.00252	0 – 0.088	Unrestricted (> 16)
CP1202F	0.0024	0 – 0.088	Unrestricted (> 16)
EL1201F	< 0.00278	0 – 0.088	Unrestricted (> 16)
EL1202F	< 0.00282	0 – 0.088	Unrestricted (> 16)
FWS Sample Number	Cd µg/g ww	Maine Non Cancer Action Level µg/g ww	Maine Consumption Advisory Recommendation
CP1201F	< 0.00252	2.20	One fish meal / week will not exceed threshold
CP1202F	0.0024	2.20	One fish meal / week will not exceed threshold
EL1201F	< 0.00278	2.20	One fish meal / week will not exceed threshold
EL1202F	< 0.00282	2.20	One fish meal / week will not exceed threshold

**Table B-3. Manganese (Mn)**

FWS Sample Number	Mn μg/g ww	Maine Non Cancer Action Level μg/g ww	Maine Consumption Advisory Recommendation
CP1201F	1.06	302.00	One fish meal / week will not exceed threshold
CP1202F	1.73	302.00	One fish meal / week will not exceed threshold
EL1201F	0.84	302.00	One fish meal / week will not exceed threshold
EL1202F	0.78	302.00	One fish meal / week will not exceed threshold

**Table B-4. Mercury (Hg)**

FWS Sample Number	Hg μg/g ww	EPA Non Cancer Health Endpoint μg/g ww	EPA Risk-Based Consumption Limit Fish Meals / Month
CP1201F	0.226	> 0.23 – 0.31	3
CP1202F	0.234	> 0.23 – 0.31	3
EL1201F	0.131	> 0.12 – 0.23	4
EL1202F	0.091	> 0.078 – 0.12	8
FWS Sample Number	Hg μg/g ww	Maine Non Cancer Action Level μg/g ww	Maine Consumption Advisory Recommendation
CP1201F	0.226	0.20	Threshold exceeded by one fish meal / week
CP1202F	0.234	0.20	Threshold exceeded by one fish meal / week
EL1201F	0.131	0.20	One fish meal / week will not exceed threshold
EL1202F	0.091	0.20	One fish meal / week will not exceed threshold

EPA Health Endpoints and Maine BOH Action levels are for methylmercury. Over 90% of the total mercury in fish tissue is comprised of methylmercury.

**Table B-5. Nickel (Ni)**

FWS Sample Number	Ni μg/g ww	Maine Non Cancer Action Level μg/g ww	Maine Consumption Advisory Recommendation
CP1201F	0.08	43.00	One fish meal / week will not exceed threshold
CP1202F	0.26	43.00	One fish meal / week will not exceed threshold
EL1201F	0.05	43.00	One fish meal / week will not exceed threshold
EL1202F	0.08	43.00	One fish meal / week will not exceed threshold



**Table B-6. Selenium (Se)**

<b>FWS Sample Number</b>	<b>Se µg/g ww</b>	<b>EPA Non Cancer Health Endpoint µg/g ww</b>	<b>EPA Risk-Based Consumption Limit Fish Meals / Month</b>
CP1201F	0.09	0 – 1.5	Unrestricted (> 16)
CP1202F	0.08	0 – 1.5	Unrestricted (> 16)
EL1201F	0.14	0 – 1.5	Unrestricted (> 16)
EL1202F	0.11	0 – 1.5	Unrestricted (> 16)
<b>FWS Sample Number</b>	<b>Se µg/g ww</b>	<b>Maine Non Cancer Action Level µg/g ww</b>	<b>Maine Consumption Advisory Recommendation</b>
CP1201F	0.09	> 11.00	One fish meal / week will not exceed threshold
CP1202F	0.08	> 11.00	One fish meal / week will not exceed threshold
EL1201F	0.14	> 11.00	One fish meal / week will not exceed threshold
EL1202F	0.11	> 11.00	One fish meal / week will not exceed threshold

**Table B-7. Zinc (Zn)**

<b>FWS Sample Number</b>	<b>Zn µg/g ww</b>	<b>Maine Non Cancer Action Level µg/g ww</b>	<b>Maine Consumption Advisory Recommendation</b>
CP1201F	8.72	> 648.00	One fish meal / week will not exceed threshold
CP1202F	10.20	> 648.00	One fish meal / week will not exceed threshold
EL1201F	7.23	> 648.00	One fish meal / week will not exceed threshold
EL1202F	7.87	> 648.00	One fish meal / week will not exceed threshold