**SPECIAL PROJECT REPORT** **FY09-MEFO-8-EC**
**Maine Field Office – Ecological Services** **November 2011**

# Environmental Contaminants in Fillets of Sea-run Atlantic Salmon (*Salmo salar*) from the Gulf of Maine Distinct Population Segment

**Fish and Wildlife Service**

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

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# Environmental Contaminants in Fillets of Sea-Run Atlantic Salmon (*Salmo salar*) from the Gulf of Maine Distinct Population Segment

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## Executive Summary

Between 2008 and 2010, skin-on fillets from seven dead adult sea-run Atlantic salmon from the Gulf of Maine Distinct Population Segment (GOM DPS) were analyzed for organochlorine compounds, PBDE, and trace metals. Five fish were collected from the Penobscot River and single fish were recovered from the Narraguagus and Dennys rivers. Analytical results were:

- Dioxin toxic equivalents (TCDD-TEQ) concentrations in GOM DPS salmon fillets were low, with a mean of 0.21 parts per trillion (pptr) wet weight and a range of 0.04 to 0.62 pptr. Seventeen dioxin and furan congeners were below detection limits in all fish, while several *non-ortho* and *mono-ortho* dioxin-like PCB congeners were frequently detected. The dominant PCB congener contributor to the TCDD-TEQ value varied among fish.

- Polychlorinated biphenyl (PCB) was detected in all samples with a mean concentration of 56.8 parts per billion (ppb) and a range of 41.5 to 77.5 ppb. PCB in GOM DPS salmon fillets seemed elevated compared to reported concentrations in farmed salmon or other wild salmon species.

- The average concentration of the flame retardant, polybrominated diphenyl ether (PBDE), in GOM DPS Atlantic salmon was 1.7 ppb; a low concentration and well below suggested consumption trigger levels (e.g., 500 ppb). BDE#47 was the dominant PBDE congener in all samples.

- Mercury concentrations in GOM DPS salmon fillets were low (0.07 parts per million) compared to other salmon studies and to levels reported in freshwater fish from regional and national bio-monitoring programs.

Too few fish were examined to assess potential harm from contaminants to individual fish. Residue burden analyses of any recovered sea run Atlantic salmon should continue and the analytical suite be expanded to include ovary histology, exposure biomarkers (i.e., cytochrome P4501A), and estrogenic biomarkers. Based on the limited data collected to date, if the Atlantic salmon were removed from the endangered species list and a recreational fishery existed, contaminant concentrations in returning sea-run salmon would trigger state and federal fish consumption advisories for several organochlorine compounds and trace metals.

**Keywords**: Atlantic salmon, *Salmo salar*, Maine, contaminants, fillets

## PREFACE

This report provides documentation of environmental contaminants in skin-on fillets from adult sea-run Atlantic salmon (*Salmo salar*) recovered from the Dennys River, Narraguagus River, and Penobscot River in Maine. Analytical work was completed under the following U.S. Fish and Wildlife Service (USFWS) Analytical Control Facility Catalogs:

5100033 (Purchase Order Numbers 94420-08-Y904 and 94420-08-Y903)
5100040 (Purchase Order Numbers 94420-09-Y999 and 94420-09-Y001)
5100045 (Purchase Order Numbers F11PX01297 and F11PX01762)

Questions, comments, and suggestions related to this report are encouraged. Written inquiries should refer to Report Number FY09-MEFO-8-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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**Acronyms and Abbreviations**

| | |
|---|---|
| BHC | benzene hexachloride (also known as hexachlorocyclohexanes, HCH) |
| BSRFH | Bureau of Sea Run Fisheries and Habitat (MEDMR) |
| EC | environmental contaminants |
| DDD | dichloro-diphenyl-dichloro-ethane |
| DDE | dichloro-diphenyl-dichloro-ethylene |
| DDT | dichloro-diphenyl-trichloro-ethane |
| DENN | Dennys River sample abbreviation |
| HCB | hexachlorobenzene |
| km | kilometer |
| $km^2$ | square kilometers |
| MEBOH | Maine Bureau of Health |
| MEDMR | Maine Department of Marine Resources |
| MEFO | Maine Field Office (USFWS) |
| MeHg | methylmercury |
| µg/g | micrograms per gram (parts-per-million) |
| mi | mile |
| $mi^2$ | square miles |
| NARR | Narraguagus River sample abbreviation |
| ng/g | nanograms per gram (parts-per-billion) |
| pg/g | pictogram per gram (parts-per-trillion) |
| PBDE | polybrominated diphenyl ether |
| PCB | polychlorinated biphenyl |
| PCDD | polychlorinated dibenzo-*p*-dioxins |
| PCDF | polychlorinated dibenzofurans |
| PENO | Penobscot River sample abbreviation |
| ppb | parts-per-billion |
| ppm | parts-per-million |
| pptr | parts-per-trillion |
| QA/QC | quality assurance/quality control |
| RA | risk assessment |
| SW | sea winter |
| TCDD | 2,3,7,8-tetrachlorodibenzo-*p*-dioxin |
| TCDF | 2,3,7,8-tetrachlorodibenzofuran |
| TCDD-TEQ | dioxin toxic equivalents |
| TEFs | toxic equivalency factors |
| USFWS | U.S. Fish and Wildlife Service |
| USGS | U.S. Geological Survey |
| ww | wet weight |

## 1. Background

North Atlantic diadromous fishes have experienced dramatic declines over the past decades (Limburg and Waldman 2009). Among these diadromous species, the Gulf of Maine Distinct Population Segment (GOM DPS) of Atlantic salmon is listed under the U.S. Endangered Species Act and the population is currently at critically low levels. There is a strong public desire and legal mandate to recover the species (Framework 2011).

Wild adult spawners are central to the Atlantic salmon recovery goal. Returning adult sea-run fish will ultimately comprise the self-sustaining portion of the population (Recovery Plan 2011). Marine survival (post-smolt, open-ocean) of Atlantic salmon, however, has declined over the last 25 years. Return rates of wild fish have generally been less than 1.5 percent (Recovery Plan 2011). Low marine survival has been a significant contributing factor, if not the most important factor, in the observed declines in abundance of GOM DPS Atlantic salmon since the early 1990s (Recovery Plan 2011).

The condition of adult sea-run Atlantic salmon returning to Maine rivers has not been well studied. Little is known about contaminant burdens in returning fish and whether these burdens pose a potential risk to individual fish and their reproductive abilities. Due to their critically low population level, opportunities for measuring contaminant burdens in returning sea-run Atlantic salmon are extremely limited.

Between 2008 and 2010, seven sea-run Atlantic salmon were recovered by the MEDMR/BSRFH from three rivers in the GOM DPS. The dead fish were provided to the USFWS so tissue could be extracted for contaminant residue analyses.

## 2. Study Objective

Determine contaminant burdens in sea-run Atlantic salmon returning to Maine rivers.

## 3. Study Areas

Single fish were recovered from the Dennys River and Narraguagus River and five fish from the Penobscot River (Figure 1). Brief notes on each river and 2011 salmon returns (current as of September 19, 2011; MEDMR 2011) are listed below.

3.1 Dennys River. The 32 kilometer (20 mi) Dennys River is located in Washington County and drains an area of 342 $km^2$ (132 $mi^2$) (Beland *et al*. 1982). In 2011, nine returning salmon were recorded at the weir in Dennysville.

3.2 Narraguagus River. The 69 km (43 mi) Narraguagus River is located in Hancock and Washington Counties and drains an area of 601 $km^2$ (232 $mi^2$) (Baum and Jordan 1982). In 2011, 185 returning salmon were recorded at the trap in Cherryfield.

3.3 Penobscot River. From the town of Medway, where the East and West Branchs of the Penobscot River meet, the Penobscot River flows south for approximately 180 km (112 mi) to the Gulf of Maine where it discharges into the Atlantic Ocean. The Penobscot River drains about one-quarter of the State of Maine and has a drainage area of 22,244 $km^2$ (8,588 $mi^2$) (Dudley and Giffen 2001). In 2011, 3090 returning salmon were recorded at the fishway in Veazie.

**4. Methods**

4.1 Endangered Species Act. Activities associated with this investigation are covered under USFWS Threatened and Endangered Species Permit Number TE697823-4.

4.2 Fish Collections. Circumstances relating to each fish recovery are described below:

- NARR-01F: On July 8, 2008 an adult female Atlantic salmon was found in the Stillwater Dam fishway trap on the Narraguagus River in Cherryfield, Maine. The fish's age was 2SW (wild origin, two sea-winter fish). Underwater video footage of the fishway showed the fish thrashing in the trap. The water temperature reached $25^o$ C by 11:30 AM and stayed above this temperature for 13 hours with a temperature spike of $27.8^o$ C around 6:00 PM. The likely cause of death was prolonged exposure to elevated water temperatures.

- DENN-01F: On July 26, 2008 a dead 2SW adult male salmon was recovered from a fish weir on the Dennys River. This salmon had slightly eroded fins.

- PENO-01F: On August 7, 2009, an adult male Atlantic salmon was recovered from the Veazie fish trap on the Penobscot River. The animal was inadvertently left in a barge tank overnight.

- PENO-0901F: This 2SW male fish was captured on May 27, 2009 at the Veazie trap on the Penobscot River, transported to the Craig Brook National Fish Hatchery, and held for spawning. After being held at the hatchery for approximately seven months and used for spawning, the fish was released back into the Penobscot River at the Brewer boat ramp on December 1, 2009. The fish appeared in poor condition prior to release, a normal circumstance after spawning, and was recovered dead later the same day.

- PENO-1001F: On July 14, 2010, a grilse or 1SW male salmon was recovered from the trash rack at the Veazie dam. This fish was originally captured on July 1, 2010 at the Veazie fish trap and released upstream to the Veazie head pond.

- PENO-1002F: On July 14, 2010, a 2SW female Atlantic salmon was recovered from the trash rack at the Veazie dam. This fish was originally captured on May 31, 2010 at the Veazie fish trap and released upstream to the Veazie head pond.

- PENO-1003F: On August 27, 2010, a grilse or 1SW male salmon was recaptured at the Veazie fish trap. The fish was unable to swim, floating on its side, but still alive. MEDMR biologists tried to revive the fish in their transport tank, but the fish died after six hours. This fish was originally captured on July 28, 2010 at the Veazie fish trap and released upstream to the Veazie head pond.

4.3 Fish Processing. Carcasses were frozen the day of collection and stored at MEDMR/BSRFH offices. Fish were transferred under chain-of-custody to the USFWS Maine Field Office for processing.

Carcasses were partially thawed prior to processing. Fish were processed on stainless steel trays decontaminated by a wash of biodegradable soap and tap water followed by a tap water rinse, and a de-ionized water rinse. A similarly decontaminated fillet knife was used to excise a skin-on, boneless fillets from the left side of each fish; both fillets were removed from one fish. Passive integrated transponder (PIT) tags were located with a PIT tag reader and removed. Fillets were wrapped in aluminum foil (dull side towards sample), placed in labeled zip-loc bags, and frozen. Collection date, collection coordinates, total length, total weight, fillet weight, age, sex, and sample lipid content for each fish are listed in Table 1.

4.4 Contaminant Analyses. Fillets were analyzed for polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), polychlorinated biphenyl (PCB) congeners including the *non*-ortho and *mono*-ortho dioxin-like congeners, polybrominated diphenyl ethers (PBDEs), other organochlorine compounds, and lipid content by the Geochemical and Environmental Research Group (GERG) in College Station, Texas. Trace metal determinations were made by the Laboratory and Environmental Testing Inc. (LET), Columbia, Missouri. Analytical work was completed under USFWS Analytical Control Facility Catalog 5100033 (Purchase Order Numbers 94420-08-Y904 and 94420-08-Y903), Catalog 5100040 (Purchase Order Numbers 94420-09-Y999 and 94420-09-Y001), and Catalog 5100045 (Purchase Order Numbers F11PX01297 and F11PX01762).

4.5 Quality Assurance/Quality Control (QA/QC). QA/QC procedures GERG and LET included procedural blanks, duplicates, spike recoveries, and certified reference material. The USFWS Analytical Control Facility reviewed QA/QC results and accepted all data packages.

**Figure 1.** Locations of Collections

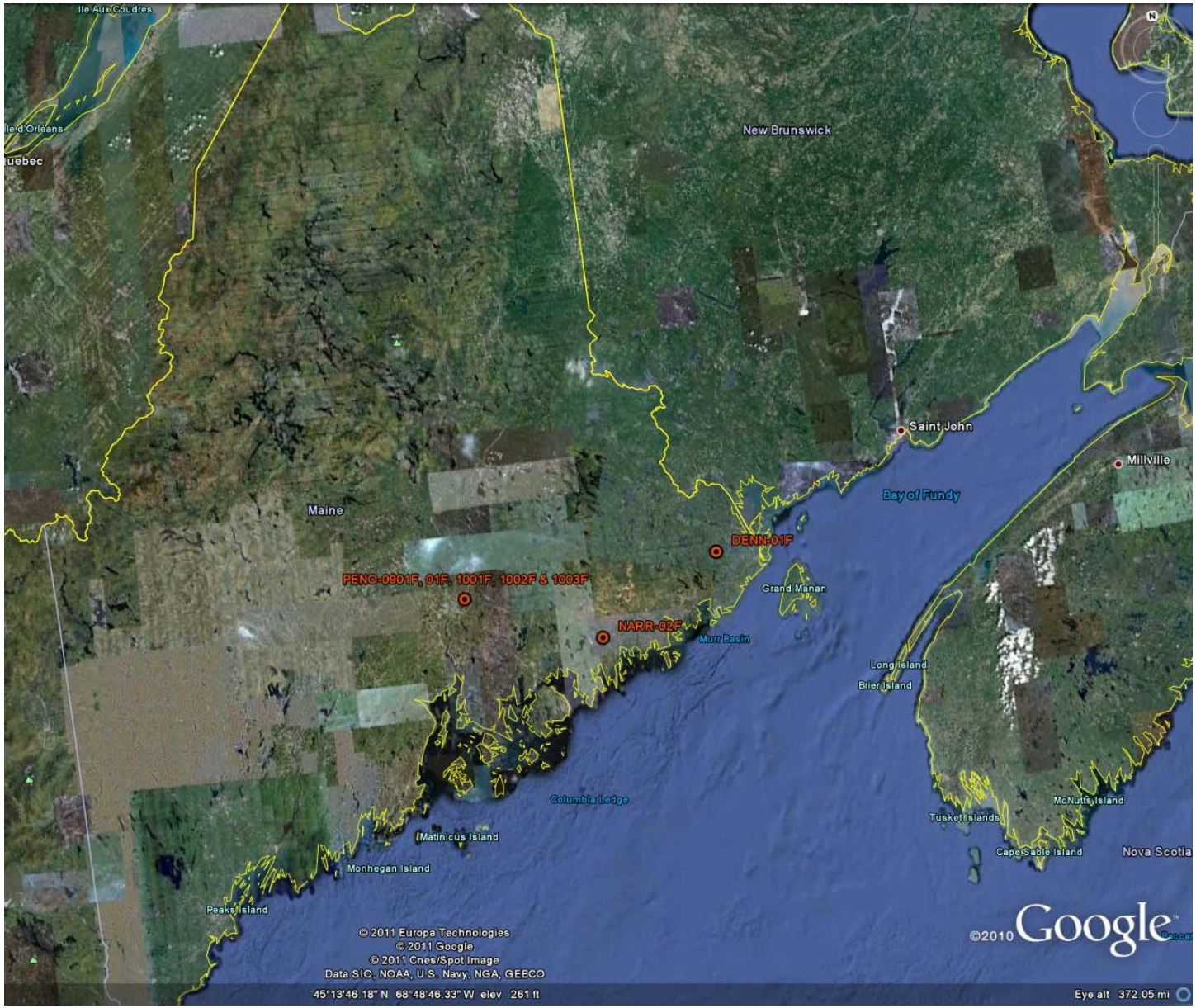


**Table 1.** Atlantic salmon sample designations and metrics

| USFWS Sample No. | Maine DMR - Join ID Number (PIT Tag No.)<br>Coordinates, Map Datum WGS 84 | Date | Sex | Age | Total Length (mm) | Total Weight (g) | Fillet Weight (g) | Lipid Content (%) |
|---|---|---|---|---|---|---|---|---|
| DENN-01F | DE-7Mainst1.48-WT-20080726001<br>N 44° 53' 45" / W -067° 13' 35" | 7/26/2008 | M | 2SW | 790 | 3950 | 521 | 4.68 |
| NARR-02F | NG-3Mainst1.85-FT-20080708002<br>N 44° 36' 29" / W -067° 56' 17" | 7/8/2008 | F | 2SW | 793 | 5100 | 664 | 7.44 |
| PENO-01F | PN-1MAINST47.50-FT-ADL-20090806-0008<br>N 44° 49' 56" / W -068° 42' 05" | 8/7/2009 | M | 2SW | 751 | 3638 | 698 | 4.87 |
| PENO-0901F[a] | PN-1Mainst44.17 (47093D6563)<br>N 44° 49' 27" / W -068° 41' 40" | 12/1/2009 | M | 2SW | 809 | 3662 | 663 | 1.84 |
| PENO-1001F | PN-1Mainst47.50 (3D9.1C2D66C711)<br>N 44° 49' 57" / W -068° 42' 02" | 7/14/2010 | M | 1SW | 591 | 1648 | 399 | 2.63 |
| PENO-1002F | PN-1Mainst47.50 (3D9.1C2D6755D7)<br>N 44° 49' 57" / W -068° 42' 02" | 7/14/2010 | F | 2SW | 713 | 3448 | 590 | 4.17 |
| PENO-1003F | PN-1Mainst47.50 (3D9.1C2D66D267)<br>N 44° 49' 57" / W -068° 42' 02" | 8/27/2010 | M | 1SW | 560 | 1138 | 409[b] | 1.80 |

[a] Post-spawn mortality. Fish was captured in the Penobscot River on May 27, 2009. Held in Craig Brook NFH for spawning purposes until December 1, 2009, and died shortly after release back into the Penobscot.

[b] Two fillets

## 5. Analytical Results

Analytical results are presented in Table 2 (TCDD, TCDF, TCDD-TEQ, PCB, PBDE, and DDT), Table 3 (other organochlorine compounds), and Table 4 (trace metals). Concentrations are presented in pg/g (parts-per-trillion) for TCDD, TCDF, and TCDD-TEQs, in ng/g (parts-per-billion) for ΣPCB, ΣPBDE and other organochlorine compounds, and in µg/g (parts-per-million) for trace metals. All results are presented on a fresh wet weight basis. Contaminant concentrations are typically summarized by the arithmetic mean ± standard deviation and range.

The dioxin toxic equivalent (TCDD-TEQ) value is the sum of TEF-adjusted concentrations of PCDD, PCDF, and dioxin-like PCB congeners. Congeners that were below detection limits were assigned a zero value in the TCDD-TEQ computation. PCDD, PCDF and dioxin-like PCB congener concentrations were adjusted using toxic equivalency factors suggested in Van den Berg *et al*. (1998; human risk assessment and fish) and Van den Berg *et al*. (2006; human risk assessment). Both sets of TEFs (1998 and 2006) were used in data summaries to facilitate comparisons with older and newer studies in the scientific literature.

ΣPBDE is reported as the sum of the following congeners: 1, 2, 3, 7, 8/11 (co-elute), 10, 12, 13, 15, 17, 25, 28, 30, 32, 33, 35, 37, 47, 49, 66, 71, 75, 85, 99, 100, 116, 118, 119, 126, 138, 153, 154, 155, 166, 181, 183, 190, and 209. BDE#209 was not analyzed in DENN-01F and NARR-02F.

For consistency and ease of comparison with published endpoints and action levels (EPA 2000, MEBOH 2001), all concentrations in the appendix tables (Tables A-1 thru A12, Tables B1 thru B4) are presented in µg/g (parts-per-million) on a wet weight basis.

**Table 2.** TCDD, TCDF, TCDD-TEQ, PCB, PBDE, and DDT in salmon fillets

| FWS Sample No.<br>Collection Date | Units | DENN-01F<br>7/26/2008 | NARR-02F<br>7/8/2008 | PENO-01F<br>8/7/2009 | PENO-0901F<br>12/1/2009 | PENO-1001F<br>7/14/2010 | PENO-1002F<br>7/14/2010 | PENO-1003F<br>8/27/2010 | Mean | Standard Deviation |
|---|---|---|---|---|---|---|---|---|---|---|
| **Dioxin, Furan, and Dioxin-like PCBs** | | | | | | | | | | |
| 2,3,7,8-TCDD | pg/g | < 1.81 | < 1.42 | < 0.960 | < 0.940 | < 0.950 | < 0.990 | < 0.990 | BDL | |
| 2,3,7,8-TCDF | pg/g | < 1.81 | < 1.42 | < 0.960 | < 0.940 | < 0.950 | < 0.990 | < 0.990 | BDL | |
| TCDD-TEQ (2005 TEFs human RA) [1] | pg/g | 0.04 | 0.04 | 0.40 | 0.07 | 0.62 | 0.25 | 0.03 | 0.21 | 0.23 |
| TCDD-TEQ (1998 TEFs human RA) [2] | pg/g | 0.24 | 0.28 | 0.55 | 0.27 | 0.72 | 0.35 | 0.13 | 0.36 | 0.20 |
| TCDD-TEQ (1998 TEFs fish) [3] | pg/g | 0.01 | 0.01 | 0.03 | 0.01 | 0.04 | 0.02 | 0.01 | 0.02 | 0.01 |
| **Polychlorinated Biphenyl** | | | | | | | | | | |
| PCB-TOTAL | ng/g | 66.2 | 56.4 | 42.7 | 77.5 | 63.7 | 49.6 | 41.5 | 56.8 | 13.2 |
| **Polybrominated diphenyl ether** | | | | | | | | | | |
| PBDE-TOTAL | ng/g | 1.0 | 0.7 | 1.2 | 1.7 | 0.4 | 2.1 | 4.7 | 1.7 | 1.4 |
| **DDT Metabolites** | | | | | | | | | | |
| o,p'-DDD | ng/g | 0.1 | 0.1 | 0.7 | < 0.0488 | 0.7 | < 0.0489 | 0.8 | | |
| o,p'-DDE | ng/g | 0.4 | 0.3 | 0.3 | 1.3 | 1.4 | 1.1 | 0.7 | | |
| o,p'-DDT | ng/g | 1.0 | < 0.0973 | 0.9 | 1.5 | 1.4 | 1.0 | 1.1 | | |
| p,p'-DDD | ng/g | 0.8 | 1.6 | 2.1 | 3.1 | 2.9 | 1.6 | 2.2 | | |
| p,p'-DDE | ng/g | 5.0 | 3.2 | 4.3 | 10.9 | 7.7 | 5.5 | 7.4 | 6.3 | 2.6 |
| p,p'-DDT | ng/g | 2.4 | 8.1 | 1.1 | 0.9 | 1.4 | 0.9 | 1.2 | | |
| Total DDT | | 9.7 | 13.2 | 9.3 | 17.7 | 15.5 | 10.1 | 13.5 | 12.7 | 3.2 |

pg/g = parts-per-trillion, ng/g = parts-per-billion, all concentrations expressed on a wet weight basis
Values in **red** preceded by the < symbol indicate non-detects and detection limits.
[1] Adjusted with 2005 toxic equivalency factors from Van den Berg *et al* . 2006 for human risk assessments. See Appendix Table C-1.
[2] Adjusted with 1998 toxic equivalency factors from Van den Berg *et al* . 1998 for human risk assessments. See Appendix Table C-2.
[3] Adjusted with 1998 toxic equivalency factors from Van den Berg *et al* . 1998 for fish. See Appendix Table C-3.
PENO-0901F was a post-spawn mortality that died shortly after release. The fish resided in the Craig Brook NFH from May 27 until December 1, 2009.

**Table 3.** Other organochlorine compounds in salmon fillets, ng/g wet weight

| FWS Sample No.<br>Collection Date | DENN-01F<br>7/26/2008 | NARR-02F<br>7/8/2008 | PENO-01F<br>8/7/2009 | PENO-0901F<br>12/1/2009 | PENO-1001F<br>7/14/2010 | PENO-1002F<br>7/14/2010 | PENO-1003F<br>8/27/2010 | Mean | Standard Deviation |
|---|---|---|---|---|---|---|---|---|---|
| **Benzene Hexachloride** | | | | | | | | | |
| alpha BHC | 0.94 | 0.88 | < 0.0497 | < 0.0488 | < 0.0475 | 0.20 | < 0.0493 | | |
| beta BHC | 0.10 | < 0.0973 | 0.05 | < 0.0488 | < 0.0475 | < 0.0489 | < 0.0493 | | |
| gamma BHC | 0.11 | 0.29 | < 0.0497 | < 0.0488 | < 0.0475 | < 0.0489 | < 0.0493 | | |
| delta BHC | 0.31 | < 0.0973 | < 0.0497 | < 0.0488 | < 0.0475 | < 0.0489 | < 0.0493 | | |
| ΣBHC | 1.47 | 1.17 | 0.05 | BDL | BDL | 0.20 | BDL | | |
| **Chlordane Compounds** | | | | | | | | | |
| alpha chlordane | < 0.0975 | < 0.0973 | 1.45 | 2.08 | 1.52 | 0.29 | 1.28 | | |
| gamma chlordane | < 0.0975 | < 0.0973 | 0.63 | 0.68 | 0.67 | 0.35 | 0.51 | | |
| cis-nonachlor | 0.53 | 1.07 | 0.87 | 1.86 | 1.52 | 1.66 | 0.66 | | |
| trans-nonachlor | 2.80 | 0.22 | 2.12 | 4.22 | 2.12 | 1.95 | 4.61 | | |
| oxychlordane | 0.24 | 0.10 | 0.34 | 1.42 | 0.99 | 0.41 | 0.42 | | |
| ΣChlordane | 3.57 | 1.39 | 5.41 | 10.26 | 6.82 | 4.65 | 7.48 | 5.65 | 2.87 |
| heptachlor | 1.53 | 0.96 | 0.10 | < 0.0488 | < 0.0475 | < 0.0489 | 0.29 | | |
| heptachlor epoxide | 0.18 | 0.51 | 0.36 | < 0.0488 | 0.49 | 0.28 | 0.27 | | |
| aldrin | 0.37 | 0.11 | < 0.0497 | < 0.0488 | < 0.0475 | < 0.0489 | < 0.0493 | | |
| endrin | 4.65 | 0.85 | 1.56 | < 0.0488 | < 0.0475 | 0.39 | 0.61 | | |
| dieldrin | 1.07 | 1.80 | 1.67 | 3.05 | 1.98 | 1.30 | 1.44 | 1.76 | 0.65 |
| endosulfan II | 0.26 | < 0.0973 | < 0.0497 | < 0.0488 | 4.02 | < 0.0489 | < 0.0493 | | |
| HCB | 1.12 | 1.57 | 1.92 | 2.78 | 1.93 | 0.32 | 1.25 | 1.56 | 0.77 |
| mirex | 2.72 | 18.20 | < 0.0497 | < 0.0488 | < 0.0475 | < 0.0489 | < 0.0493 | | |
| pentachloro-anisole | 0.56 | 2.63 | 2.13 | 1.14 | 2.11 | 1.38 | 5.07 | 2.15 | 1.47 |
| toxaphene | < 1.95 | < 1.95 | < 0.994 | < 0.976 | < 0.950 | < 0.978 | < 0.986 | BDL | |

Skin-on, boneless fillets
Values in red preceded by < symbol indicate non-detects and detection limits.
BDL = below detection limits
PENO-0901F was a post-spawn mortality that died shortly after release. The fish resided in the Craig Brook NFH from May 27 until December 1, 2009.

**Table 4.** Trace metals in salmon fillets, µg/g wet weight

| FWS Sample No.<br>Collection Date | DENN-01F<br>7/26/2008 | NARR-02F<br>7/8/2008 | PENO-01F<br>8/7/2009 | PENO-0901F<br>12/1/2009 | PENO-1001F<br>7/14/2010 | PENO-1002F<br>7/14/2010 | PENO-1003F<br>8/27/2010 | Mean | Standard Deviation |
|---|---|---|---|---|---|---|---|---|---|
| Aluminum | < 0.600 | < 0.700 | 1.00 | 1.50 | 1.00 | 1.00 | 1.00 | NC | |
| Arsenic | 0.39 | 0.62 | 0.44 | 0.46 | 0.37 | 0.26 | 0.45 | 0.43 | 0.11 |
| Boron | < 0.600 | < 0.700 | < 0.600 | < 0.400 | < 0.500 | < 0.500 | < 0.500 | BDL | |
| Barium | < 0.0600 | < 0.0700 | < 0.0600 | < 0.0400 | < 0.0500 | < 0.0500 | < 0.0500 | BDL | |
| Beryllium | < 0.0300 | < 0.0300 | < 0.0300 | < 0.0200 | < 0.0300 | < 0.0300 | < 0.0200 | BDL | |
| Cadmium | < 0.0300 | < 0.0300 | < 0.0300 | < 0.0200 | < 0.0300 | < 0.0300 | < 0.0200 | BDL | |
| Chromium | < 0.200 | < 0.200 | < 0.200 | < 0.100 | < 0.100 | < 0.100 | < 0.100 | BDL | |
| Copper | 0.38 | 0.40 | 0.20 | 0.44 | 0.35 | 0.31 | 0.29 | 0.34 | 0.08 |
| Iron | 4.0 | 4.3 | 9.5 | 9.2 | 8.9 | 4.3 | 6.7 | 6.70 | 2.51 |
| Mercury | 0.040 | **0.015** | 0.140 | 0.062 | 0.090 | 0.070 | 0.085 | 0.072 | 0.040 |
| Magnesium | 314 | 296 | 286 | 207 | 268 | 256 | 289 | 274 | 35 |
| Manganese | < 0.200 | < 0.200 | < 0.200 | 0.30 | 0.78 | < 0.100 | 0.10 | NC | |
| Molybdenum | < 0.600 | < 0.700 | < 0.600 | < 0.400 | < 0.500 | < 0.500 | < 0.500 | BDL | |
| Nickel | < 0.200 | < 0.200 | < 0.200 | < 0.100 | < 0.100 | < 0.100 | < 0.100 | BDL | |
| Lead | < 0.0600 | < 0.0700 | < 0.0600 | < 0.0400 | 0.08 | < 0.0500 | < 0.0500 | NC | |
| Selenium | 0.28 | 0.28 | 0.33 | 0.26 | 0.38 | 0.33 | 0.40 | 0.32 | 0.05 |
| Strontium | 1.30 | 1.50 | 1.30 | 0.97 | 2.10 | 1.70 | 2.10 | 1.57 | 0.43 |
| Vanadium | < 0.200 | < 0.200 | < 0.200 | < 0.100 | < 0.100 | < 0.100 | < 0.100 | BDL | |
| Zinc | 5.0 | 5.5 | 4.6 | 7.5 | 6.1 | 5.4 | 6.3 | 5.8 | 1.0 |

Skin-on, boneless fillets
Values in red preceded by the < symbol indicate non-detects and detection limits.
NC = not calculated, BDL = below detection limits
Shaded cell is a non-detect and listed value is one-half the sample detection limit.
PENO-0901F was a post-spawn mortality that died shortly after release. The fish resided in the Craig Brook NFH from May 27 until December 1, 2009.

## 6. Discussion

Levels of environmental contaminants have been measured in farmed and wild Atlantic salmon and other salmon species by several researchers (Hites *et al*. 2004a, Hites *et al*. 2004b, Foran *et al*. 2004, Millard *et al*. 2004, Debruyn *et al*. 2004, Foran *et al*. 2005, Shaw *et al*. 2006, Kelly *et al*. 2008). In these investigations, higher levels of organic contaminants were found in farmed salmon than in wild salmon (Hites *et al*. 2004a, Hites *et al*. 2004b), but a similar pattern was not found with metals (Foran *et al*. 2004).

In the present investigation, skin-on fillets of seven adult sea-run Atlantic salmon in Maine were analyzed for organic and trace metal contaminants to compare concentrations with levels reported in the studies mentioned above, other fish tissue residue investigations (Hinck *et al*. 2009, Stahl *et al*. 2009), and to EPA risk-based consumption limits (EPA 2000) and Maine Bureau of Health fish tissue action levels (MEBOH 2001). Recreational fishing for Atlantic salmon in the GOM DPS is currently prohibited due its protected status under the ESA.

### 6.1 Organics.

6.1.1 Dioxin toxic equivalents (TCDD-TEQ). TCDD-TEQ concentrations in GOM DPS Atlantic salmon fillets ranged from 0.04 pg/g to 0.62 pg/g (mean 0.21 ± 0.23 pg/g; Table 2 and Table C-1 based on 2005 toxic equivalency factors for human risk assessments, Van den Berg *et al*. 2006). Seventeen dioxin and furan congeners were below detection limits in all fish. Several *non-ortho* and *mono-ortho* dioxin-like PCB congeners were frequently detected in all samples, but the dominant PCB congener contributor to the TCDD-TEQ value varied among fish (Figure 2). The pattern of dominant PCB congeners in the TCDD-TEQ was similar in the Dennys River and Narraguagus River fish, but different in Penobscot salmon (Figure 2).

GOM DPS salmon fillets did not have elevated TCDD-TEQ compared to studies using farmed salmon or other wild salmon species. Millard *et al*. (2004) reported a geometric mean TCDD-TEQ of 0.53 pg/g in hatchery-reared Atlantic salmon, and a concentration of 1.41 pg/g in a sample of sea-run Atlantic salmon from the Merrimack River, NH. Shaw *et al*. (2006) reported a mean TCDD-TEQ value in farmed Atlantic salmon from Maine of 0.57 pg/g. Sockeye salmon muscle from the Pacific Northwest contained 0.13 pg/g (Debruyn *et al*. 2004). Mean TCDD-TEQ in fillets of GOM DPS salmon was not elevated compared to levels in a freshwater fish based on the national tissue bio-monitoring program (1.5 pg/g which includes multiple species analyzed whole-body and TCDD-TEQ determined with the H4IIE bioassay, Hinck *et al*. 2009).

TCDD-TEQ concentrations in GOM DPS salmon would trigger more restrictive federal and state consumption limits (Table A-1).

6.1.2 Polychlorinated biphenyl (PCB). Mean ΣPCB in GOM DPS salmon fillets was 56.8 ± 13.2 ng/g with a range of 41.5 to 77.5 ng/g (Table 2).

ΣPCB in GOM DPS salmon fillets was elevated compared to studies using farmed salmon or other wild salmon species. In 2000, two adult Atlantic salmon from the Penobscot River were killed during sampling for a statewide contaminant monitoring program. ΣPCB in the two skin-off fillets from the fish was 15.0 ng/g and 22.7 ng/g (MEDEP 2002). Millard *et al*. (2004) reported a geometric mean PCB of 33.5 ng/g in hatchery-reared Atlantic salmon, and a maximum concentration of 89.6 ng/g in a 4-year sea-run Atlantic salmon from the Merrimack River, NH. Shaw *et al*. (2006) reported total PCB concentrations of 7.2 to 29.5 ng/g in farmed Atlantic salmon and 3.9 to 8.1 ng/g in wild Alaskan Chinook salmon. Stahl *et al*. (2009) examined ΣPCB in fillets of predator fish species from 500 lakes in the lower 48 U.S. states and found a median concentration of 2.16 ng/g. Mean ΣPCB in GOM DPS salmon fillets was not elevated compared to multiple freshwater species analyzed whole-body in the national Biomonitoring of Environmental Status and Trends Project (84 ng/g, Hinck *et al*. 2009).

ΣPCB concentrations in GOM DPS salmon would trigger more restrictive federal and state consumption limits (Table A-2).

6.1.3 Polybrominated diphenyl ether (PBDE). ΣPBDE in GOM DPS salmon fillets ranged from 0.4 to 4.7 ng/g (mean 1.7 ± 1.4 ng/g, Table 2). Hites *et al*. (2004b) reported an average ΣPBDE concentration of 2.3 ± 0.6 ng/g (max. 4.1 ng/g) in nine wild Chinook salmon fillets and found that Chinook salmon had significantly elevated PBDE levels relative to other wild species.

BDE#47 was the dominant PBDE congener in all GOM DPS Atlantic salmon samples. In a survey of farmed, supermarket, and wild salmon, Hites *et al*. (2004b) also found BDE#47 as the dominant PBDE congener.

Risk-based thresholds for PBDE have yet to be developed (Hites *et al*. 2004b). Virginia has developed a trigger level of 500 ng PBDE/g for issuance of a fish-eating advisory (Flammia 2010). Fish with average PBDE concentrations ranging from 500 ng/g to 1,000 ng/g would trigger a consumption advisory of 2 fish meals/month. Virginia would recommend no consumption of fish with average PBDE concentrations exceeding 1,000 ng/g (Flammia 2010). Average PBDE concentration in GOM DPS Atlantic salmon is 1.7 ng/g; well below the VA suggested consumption trigger levels.

6.1.4 *p*,*p*'- DDE and ΣDDT. Mean *p*,*p*'-DDE in GOM DPS salmon fillets was 6.3 ± 2.6 ng/g with a range of 3.2 to 10.9 ng/g and mean ΣDDT was 12.7 ± 3.2 ng/g with a range of 9.3 to 17.7 ng/g (Table 2).

DDE and DDT in GOM DPS salmon fillets were well below threshold concentrations in whole-body fish (400 - 600 ng/g, Beckvar and Lotufo 2011) and within ranges reported in other salmon investigations. Mean *p*,*p*'-DDE and ΣDDT in hatchery-reared and sea-run Atlantic salmon at USFWS Region 5 hatcheries was 4.5 ng/g (range: 1.2 – 14.3 ng/g) and 6.6 ng/g (range: 1.6 – 14.8 ng/g), respectively (USFWS unpublished data). Mean DDT in salmon fillets from two eastern

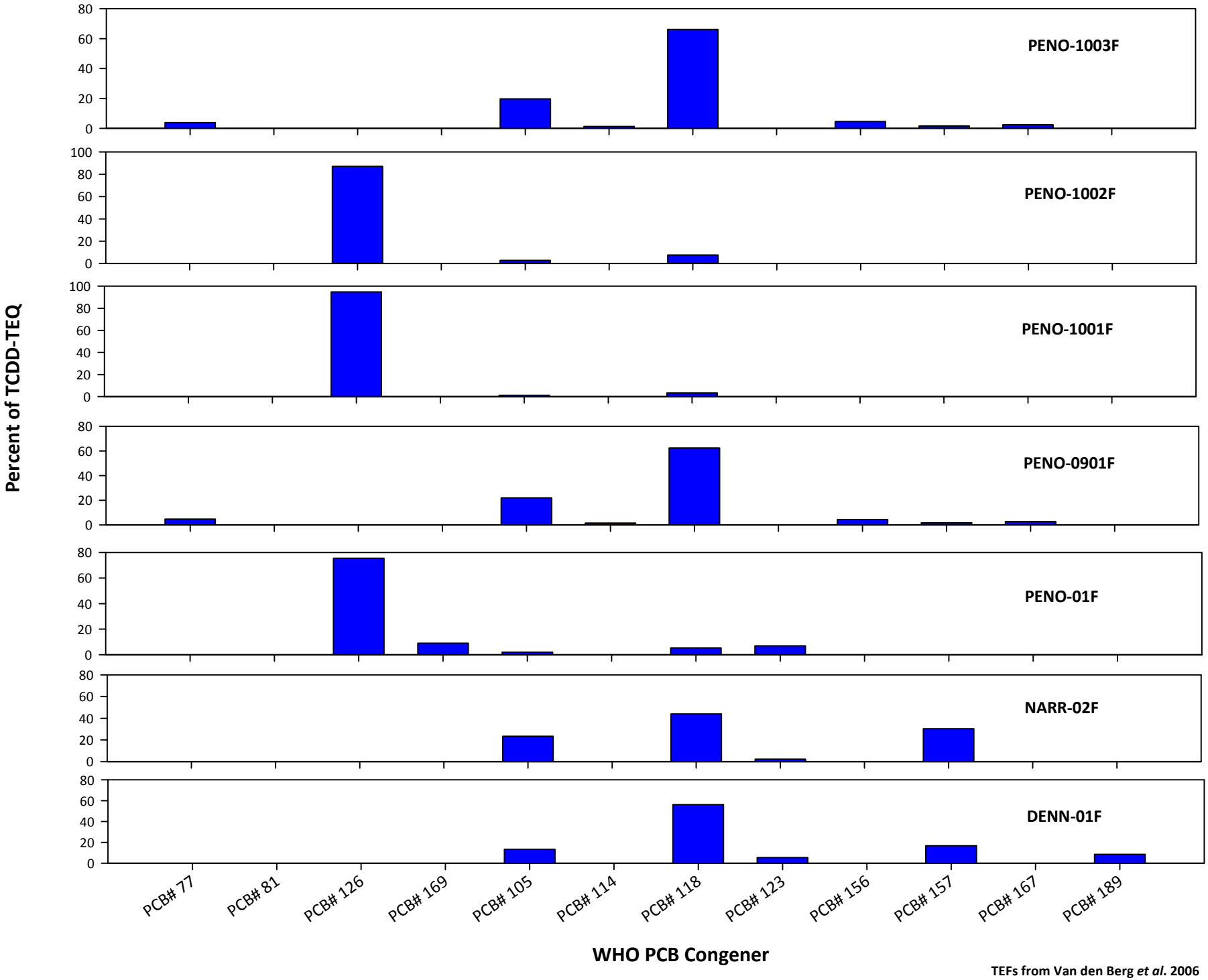
Maine farms was approximately 32.5 ng/g and 27.5 ng/g (Shaw *et al*. 2006). Stahl *et al*. (2009) examined ΣDDT in fillets of predator fish species from 500 lakes in the lower 48 U.S. states and found a median concentration of 1.47 ng/g. Mean *p*,*p*'-DDE and ΣDDT in GOM DPS salmon fillets was not elevated 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 ΣDDT, Hinck *et al*. 2009).

ΣDDT concentrations in GOM DPS salmon would trigger more restrictive federal and state consumption limits (Table A-3).

6.1.5 Other organochlorine compounds. Concentrations of lindane (gamma BHC, Table A-4), chlordane (Table A-5), heptachlor epoxide (Table A-6), heptachlor (Table A-7) aldrin (Table A-8), endrin (Table A-9), hexachlorobenzene (HCB, Table A-11), and mirex (Table A-12) in GOM DPS salmon fillets would not trigger more restrictive federal and state consumption limits.

Four of the salmon fillets contained sufficient levels of dieldrin (Table A-10) to trigger more restrictive federal and state consumption limits.

**Figure 2.** Dominant WHO PCB congeners in the TCDD-TEQ for GOM DPS Atlantic salmon fillets




TEFs from Van den Berg *et al*. 2006

## 6.2 Inorganics.

6.2.1 Arsenic (As). Total arsenic in GOM DPS salmon fillets averaged 0.43 µg/g (range: 0.26 – 0.62 µg/g, Table 4). Compared to other studies, arsenic in GOM DPS salmon fillets did not seem high. Mean arsenic in British Columbia salmon (farmed + wild) was 0.67 µg/g with the highest level observed (1.93 µg/g) occurring in a farmed Atlantic salmon (Kelly *et al*. 2008). Similarly, Foran *et al*. (2004) found significantly higher total arsenic concentrations in farmed fish than in wild salmon.

Arsenic concentrations in salmon fillet samples are reported by LET as total arsenic. EPA Health Endpoints and Maine BOH Action levels, however, are for inorganic arsenic. In Table B-1, the reported salmon fillet arsenic concentrations were multiplied by 0.1 under the assumption that 10% of the total arsenic in fish is inorganic arsenic (FDA 1993, Maine BOH 2009). Non-cancer endpoints would not be exceeded by arsenic levels in GOM DPS salmon fillets, but Maine and EPA endpoints would and result in consumption limits.

6.2.2 Mercury (Hg). Mercury concentrations in GOM DPS salmon fillets ranged from non-detect (< 0.03 µg/g) to 0.14 µg/g with a mean of 0.07 ± 0.04 µg/g (Table 4). The LET analyses for the DPS salmon fillets were for total mercury. It is safe to assume that nearly all the mercury in salmon fillets would be methylmercury (MeHg). Kelly *et al*. (2008) found 97.1% of the total mercury in salmon flesh was in the organometallic (i.e., MeHg) form; a finding consistent with Westoo (1973, average 93% range: 82 – 102%).

Mercury levels in GOM DPS salmon fillets were low. Millard *et al*. (2004) reported a geometric mean Hg concentration of 0.03 µg/g (range: 0.02 – 0.07 µg/g) in fillets of hatchery-reared and sea-run Atlantic salmon. Mercury in fillets of GOM DPS Atlantic salmon was not elevated compared to freshwater regional and national fish tissue bio-monitoring programs (0.17 µg/g, Yeardley *et al*. 1998; 0.13 µg/g, Hinck *et al*. 2009; both include multiple species analyzed whole-body). Kamman *et al*. (2005) reported Hg concentrations in fillets of Atlantic salmon and landlocked salmon of 0.324 µg/g and 0.397 µg/g, respectively. Stahl *et al*. (2009) examined mercury in fillets of predator fish species from 500 lakes in the lower 48 U.S. states and found a mean concentration of 0.352 µg/g.

Sub-lethal effects of mercury on freshwater fish, including changes in reproductive health, have been observed in laboratory and field studies of fish with having approximately 0.50 µg Hg/g wet weight or greater in the fillet (Sandheinrich and Wiener 2011). Mercury in GOM DPS salmon fillets were well below this sub-lethal effect threshold.

Mercury levels in GOM DPS salmon fillets would not trigger Maine consumption advisories, but would result in more restricted consumption levels under EPA's mercury endpoints (Table B-2).

6.2.3 Selenium (Se). Selenium was detected in all GOM DPS Atlantic salmon fillet samples (0.32 ± 0.05 µg/g, range: 0.26 – 0.40 µg/g, Table 4). Selenium is typically not a contaminant of concern in the northeastern United States. Levels of selenium in Maine salmon fillets were similar to a range reported in another study. Selenium ranged from 0.05 to 0.71 µg/g in farmed and wild salmon in British Columbia (Kelly *et al*. 2008). Consumption of salmon fillets from the GOM DPS would be unrestricted for selenium (Table B-3).

6.2.4 Zinc (Zn). Mean zinc concentration in salmon fillets was 5.8 ± 1.0 µg/g with a range of 4.6 to 7.5 µg/g (Table 4). In British Columbia, Kelly *et al*. (2008) found zinc ranging from 1.6 to 16.0 µg/g in farmed and wild salmon. Zinc levels in GOM DPS salmon fillets fell within the range reported by Kelly *et al*. (2008). Consumption of salmon fillets from the GOM DPS would be unrestricted for zinc (Table B-4).

6.2.5 Other inorganics. Boron, barium, beryllium, cadmium, chromium, molybdenum, nickel, and vanadium were below detection limits in all fillet samples (Table 4). Lead was detected in only one Penobscot sample (PENO-1001F) at 0.08 µg/g, which was slightly above the average detection limit (< 0.06 µg/g). Manganese was detected in three samples, all from the Penobscot. Two samples contained manganese near the detection limit (~ 0.20 µg/g), and one had a concentration of 0.78 µg/g. Aluminum was detected in all five Penobscot samples (mean 1.10 µg/g) and was below detection in the Dennys or Narraguagus fillets (< 0.70 µg/g). All fillet samples were wrapped in aluminum foil, so the reported aluminum concentrations have little value. Iron (6.7 ± 2.5 µg/g, range: 4.0 – 9.2 µg/g) and magnesium (274 ± 35 µg/g, range: 207 – 314 µg/g) were detected in all samples. These elements are essential nutrients in fish. Strontium was detected in all samples (1.57 ± 0.43 µg/g, range: 0.97 – 2.10 µg/g). Copper was also detected in all fillet samples (0.34 ± 0.08 µg/g, range: 0.20 – 0.44 µg/g).

## 7. Summary and Management Recommendation

Between 2008 and 2010, skin-on fillets from seven dead adult sea-run Atlantic salmon from the Gulf of Maine Distinct Population Segment (GOM DPS) were analyzed for organochlorine compounds and trace metals. Five fish were collected from the Penobscot River and single fish were recovered from the Narraguagus and Dennys rivers. Analytical results were:

- TCDD-TEQ concentrations in GOM DPS salmon fillets were low with a mean of 0.21 pg/g wet weight and a range of 0.04 to 0.62 pg/g (Table 2). Seventeen dioxin and furan congeners were below detection limits in all fish, while several *non-ortho* and *mono-ortho* dioxin-like PCB congeners were frequently detected. The dominant PCB congener contributor to the TCDD-TEQ value varied among fish (Figure 2).

- ΣPCB was detected in all samples with a mean concentration of 56.8 ng/g and a range of 41.5 to 77.5 ng/g (Table 2). PCB in GOM DPS salmon fillets were elevated compared to studies using farmed salmon or other wild salmon species.

- ΣPBDE in GOM DPS Atlantic salmon was 1.7 ng/g (Table 2); a low concentration and well below suggested consumption trigger levels (e.g., 500 ng/g). BDE#47 was the dominant PBDE congener in all samples.

- Mercury concentrations in GOM DPS salmon fillets were low (0.07 µg/g, Table 4) compared to other salmon studies and to levels reported in freshwater regional and national bio-monitoring programs.

Too few fish were examined to assess potential harm from contaminants to individual fish. Residue burden analyses of any recovered sea run Atlantic salmon should continue and the analytical suite expanded to include morphometrics, ovary histology, exposure biomarkers (i.e., cytochrome P4501A), and estrogenic biomarkers.

Based on the limited data collected to date, if the Atlantic salmon were removed from the endangered species list and a recreational fishery existed, contaminant concentrations in returning sea-run salmon would trigger state and federal fish consumption advisories for several organochlorine compounds (Tables A-1 thru A-12) and trace metals (Table B-1 thru B-4).

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## Appendix Tables

Comparisons to EPA Fish Consumption Limits and Maine Bureau of Health Action Levels
Organics: Tables A-1 thru A-12
Inorganics: Table B-1 thru B-4

TCDD-TEQ Calculations for Individual Fish

**Table A-1**. Dioxin Toxic Equivalents (TCDD-TEQ)

| FWS Sample Number | TCDD-TEQ pg/g ww | EPA Cancer Health Endpoint pg/g ww | EPA Risk-Based Consumption Limit Fish Meals / Month |
|---|---|---|---|
| DENN-01F | 0.04 | > 0.038 – 0.05 | 12 meals / month |
| NARR-02F | 0.04 | > 0.038 – 0.05 | 12 meals / month |
| PENO-01F | 0.40 | > 0.3 – 0.6 | 1 meal / month |
| PENO-0901F | 0.07 | > 0.05 – 0.075 | 8 meals / month |
| PENO-1001F | 0.62 | >0.6 – 1.2 | 0.5 meals / month |
| PENO-1002F | 0.25 | > 0.2 – 0.3 | 2 meals / month |
| PENO-1003F | 0.03 | > 0.038 – 0.05 | 12 meals / month |
| **FWS Sample Number** | **TCDD-TEQ pg/g ww** | **Maine Cancer Action Level pg/g ww** | **Maine Consumption Advisory Recommendation** |
| DENN-01F | 0.04 | > 1.50 | One fish meal / week will not exceed threshold |
| NARR-02F | 0.04 | > 1.50 | One fish meal / week will not exceed threshold |
| PENO-01F | 0.40 | > 1.50 | One fish meal / week will not exceed threshold |
| PENO-0901F | 0.07 | > 1.50 | One fish meal / week will not exceed threshold |
| PENO-1001F | 0.62 | > 1.50 | One fish meal / week will not exceed threshold |
| PENO-1002F | 0.25 | > 1.50 | One fish meal / week will not exceed threshold |
| PENO-1003F | 0.03 | > 1.50 | One fish meal / week will not exceed threshold |
| **FWS Sample Number** | **TCDD-TEQ pg/g ww** | **Maine Non Cancer Action Level pg/g ww** | **Maine Consumption Advisory Recommendation** |
| DENN-01F | 0.04 | > 0.40 | One fish meal / week will not exceed threshold |
| NARR-02F | 0.04 | > 0.40 | One fish meal / week will not exceed threshold |
| PENO-01F | 0.40 | > 0.40 | One fish meal / week will not exceed threshold |
| PENO-0901F | 0.07 | > 0.40 | One fish meal / week will not exceed threshold |
| PENO-1001F | 0.62 | > 0.40 | Threshold exceeded by one fish meal / week |
| PENO-1002F | 0.25 | > 0.40 | One fish meal / week will not exceed threshold |
| PENO-1003F | 0.03 | > 0.40 | One fish meal / week will not exceed threshold |

Note: In this study, sample detection limits for 2,3,7,8-TCDD and 2,3,7,8-TCDF were 0.9 pg/g. In the MEDEP dioxin monitoring program, the state requires a detection limit of less than 0.1 pg/g for these two compounds. Sample TCDD-TEQs levels listed above reflect the 0.9 pg/g detection limits for TCDD and TCDF and should be taken into account when comparing concentrations to Maine fish tissue action levels.

**Table A-2**. Total Polychlorinated Biphenyls (ΣPCB)

| FWS Sample Number | Total PCB µg/g ww | EPA Cancer Health Endpoint µg/g ww | EPA Risk-Based Consumption Limit Fish Meals / Month |
|---|---|---|---|
| DENN-01F | 0.066 | > 0.047 – 0.094 | 0.5 meals / month |
| NARR-02F | 0.056 | > 0.047 – 0.094 | 0.5 meals/ month |
| PENO-01F | 0.043 | > 0.023 – 0.047 | 1 meal / month |
| PENO-0901F | 0.078 | > 0.047 – 0.094 | 0.5 meals / month |
| PENO-1001F | 0.064 | > 0.047 – 0.094 | 0.5 meals / month |
| PENO-1002F | 0.050 | > 0.047 – 0.094 | 0.5 meals / month |
| PENO-1003F | 0.042 | > 0.023 – 0.047 | 1 meal / month |
| **FWS Sample Number** | **Total PCB µg/g ww** | **EPA Non Cancer Health Endpoint µg/g ww** | **EPA Risk-Based Consumption Limit Fish Meals / Month** |
| DENN-01F | 0.066 | > 0.063 – 0.094 | 2 meals / month |
| NARR-02F | 0.056 | > 0.047 – 0.063 | 3 meals / month |
| PENO-01F | 0.043 | > 0.023 – 0.047 | 4 meals / month |
| PENO-0901F | 0.078 | > 0.063 – 0.094 | 2 meals / month |
| PENO-1001F | 0.064 | > 0.063 – 0.094 | 2 meals / month |
| PENO-1002F | 0.050 | > 0.047 – 0.063 | 3 meals / month |
| PENO-1003F | 0.042 | > 0.023 – 0.047 | 4 meals / month |
| **FWS Sample Number** | **Total PCB µg/g ww** | **Maine Cancer Action Level µg/g ww** | **Maine Consumption Advisory Recommendation** |
| DENN-01F | 0.066 | > 0.011 | Threshold exceeded by one fish meal / week |
| NARR-02F | 0.056 | > 0.011 | Threshold exceeded by one fish meal / week |
| PENO-01F | 0.043 | > 0.011 | Threshold exceeded by one fish meal / week |
| PENO-0901F | 0.078 | > 0.011 | Threshold exceeded by one fish meal / week |
| PENO-1001F | 0.064 | > 0.011 | Threshold exceeded by one fish meal / week |
| PENO-1002F | 0.050 | > 0.011 | Threshold exceeded by one fish meal / week |
| PENO-1003F | 0.042 | > 0.011 | Threshold exceeded by one fish meal / week |
| **FWS Sample Number** | **Total PCB µg/g ww** | **Maine Non Cancer Action Level µg/g ww** | **Maine Consumption Advisory Recommendation** |
| DENN-01F | 0.066 | > 0.043 | Threshold exceeded by one fish meal / week |
| NARR-02F | 0.056 | > 0.043 | Threshold exceeded by one fish meal / week |
| PENO-01F | 0.043 | > 0.043 | Threshold exceeded by one fish meal / week |
| PENO-0901F | 0.078 | > 0.043 | Threshold exceeded by one fish meal / week |
| PENO-1001F | 0.064 | > 0.043 | Threshold exceeded by one fish meal / week |
| PENO-1002F | 0.050 | > 0.043 | Threshold exceeded by one fish meal / week |
| PENO-1003F | 0.042 | > 0.043 | One fish meal / week will not exceed threshold |

**Table A-3**. Total DDT (ΣDDT; 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 µg/g ww | EPA Cancer Health Endpoint µg/g ww | EPA Risk-Based Consumption Limit Fish Meals / Month |
|---|---|---|---|
| DENN-01F | 0.0097 | > 0.0086 – 0.017 | 16 meals / month |
| NARR-02F | 0.0133 | > 0.0086 – 0.017 | 16 meals / month |
| PENO-01F | 0.0094 | > 0.0086 – 0.017 | 16 meals / month |
| PENO-0901F | 0.0177 | > 0.017 – 0.023 | 12 meals / month |
| PENO-1001F | 0.0155 | > 0.0086 – 0.017 | 16 meals / month |
| PENO-1002F | 0.0101 | > 0.0086 – 0.017 | 16 meals / month |
| PENO-1003F | 0.0135 | > 0.0086 – 0.017 | 16 meals / month |
| **FWS Sample Number** | **Total DDT µg/g ww** | **EPA Non Cancer Health Endpoint µg/g ww** | **EPA Risk-Based Consumption Limit Fish Meals / Month** |
| DENN-01F | 0.0097 | 0 – 0.015 | Unrestricted (> 16) |
| NARR-02F | 0.0133 | 0 – 0.015 | Unrestricted (> 16) |
| PENO-01F | 0.0094 | 0 – 0.015 | Unrestricted (> 16) |
| PENO-0901F | 0.0177 | > 0.015 – 0.029 | 16 meals / month |
| PENO-1001F | 0.0155 | > 0.015 – 0.029 | 16 meals / month |
| PENO-1002F | 0.0101 | 0 – 0.015 | Unrestricted (> 16) |
| PENO-1003F | 0.0135 | 0 – 0.015 | Unrestricted (> 16) |
| **FWS Sample Number** | **Total DDT µg/g ww** | **Maine Cancer Action Level µg/g ww** | **Maine Consumption Advisory Recommendation** |
| DENN-01F | 0.0097 | > 0.0014 | Threshold exceeded by one fish meal / week |
| NARR-02F | 0.0133 | > 0.0014 | Threshold exceeded by one fish meal / week |
| PENO-01F | 0.0094 | > 0.0014 | Threshold exceeded by one fish meal / week |
| PENO-0901F | 0.0177 | > 0.0014 | Threshold exceeded by one fish meal / week |
| PENO-1001F | 0.0155 | > 0.0014 | Threshold exceeded by one fish meal / week |
| PENO-1002F | 0.0101 | > 0.0014 | Threshold exceeded by one fish meal / week |
| PENO-1003F | 0.0135 | > 0.0014 | Threshold exceeded by one fish meal / week |
| **FWS Sample Number** | **Total DDT µg/g ww** | **Maine Non Cancer Action Level µg/g ww** | **Maine Consumption Advisory Recommendation** |
| DENN-01F | 0.0097 | > 0.108 | One fish meal / week will not exceed threshold |
| NARR-02F | 0.0133 | > 0.108 | One fish meal / week will not exceed threshold |
| PENO-01F | 0.0094 | > 0.108 | One fish meal / week will not exceed threshold |
| PENO-0901F | 0.0177 | > 0.108 | One fish meal / week will not exceed threshold |
| PENO-1001F | 0.0155 | > 0.108 | One fish meal / week will not exceed threshold |
| PENO-1002F | 0.0101 | > 0.108 | One fish meal / week will not exceed threshold |
| PENO-1003F | 0.0135 | > 0.108 | One fish meal / week will not exceed threshold |

**Table A-4**. Lindane (or *gamma* BHC)

| FWS Sample Number | Lindane µg/g ww | EPA Cancer Health Endpoint µg/g ww | EPA Risk-Based Consumption Limit Fish Meals / Month |
|---|---|---|---|
| DENN-01F | 0.00011 | > 0 – 0.0023 | Unrestricted (>16) |
| NARR-02F | 0.00029 | > 0 – 0.0023 | Unrestricted (>16) |
| PENO-01F | < 0.0000497 | > 0 – 0.0023 | Unrestricted (>16) |
| PENO-0901F | < 0.0000488 | > 0 – 0.0023 | Unrestricted (>16) |
| PENO-1001F | < 0.0000475 | > 0 – 0.0023 | Unrestricted (>16) |
| PENO-1002F | < 0.0000489 | > 0 – 0.0023 | Unrestricted (>16) |
| PENO-1003F | < 0.0000493 | > 0 – 0.0023 | Unrestricted (>16) |
| **FWS Sample Number** | **Lindane µg/g ww** | **EPA Non Cancer Health Endpoint µg/g ww** | **EPA Risk-Based Consumption Limit Fish Meals / Month** |
| DENN-01F | 0.00011 | 0 – 0.088 | Unrestricted (> 16) |
| NARR-02F | 0.00029 | 0 – 0.088 | Unrestricted (> 16) |
| PENO-01F | < 0.0000497 | 0 – 0.088 | Unrestricted (> 16) |
| PENO-0901F | < 0.0000488 | 0 – 0.088 | Unrestricted (> 16) |
| PENO-1001F | < 0.0000475 | 0 – 0.088 | Unrestricted (> 16) |
| PENO-1002F | < 0.0000489 | 0 – 0.088 | Unrestricted (> 16) |
| PENO-1003F | < 0.0000493 | 0 – 0.088 | Unrestricted (> 16) |
| **FWS Sample Number** | **Lindane µg/g ww** | **Maine Cancer Action Level µg/g ww** | **Maine Consumption Advisory Recommendation** |
| DENN-01F | 0.00011 | > 0.017 | One fish meal / week will not exceed threshold |
| NARR-02F | 0.00029 | > 0.017 | One fish meal / week will not exceed threshold |
| PENO-01F | < 0.0000497 | > 0.017 | One fish meal / week will not exceed threshold |
| PENO-0901F | < 0.0000488 | > 0.017 | One fish meal / week will not exceed threshold |
| PENO-1001F | < 0.0000475 | > 0.017 | One fish meal / week will not exceed threshold |
| PENO-1002F | < 0.0000489 | > 0.017 | One fish meal / week will not exceed threshold |
| PENO-1003F | < 0.0000493 | > 0.017 | One fish meal / week will not exceed threshold |
| **FWS Sample Number** | **Lindane µg/g ww** | **Maine Non Cancer Action Level µg/g ww** | **Maine Consumption Advisory Recommendation** |
| DENN-01F | 0.00011 | > 0.648 | One fish meal / week will not exceed threshold |
| NARR-02F | 0.00029 | > 0.648 | One fish meal / week will not exceed threshold |
| PENO-01F | < 0.0000497 | > 0.648 | One fish meal / week will not exceed threshold |
| PENO-0901F | < 0.0000488 | > 0.648 | One fish meal / week will not exceed threshold |
| PENO-1001F | < 0.0000475 | > 0.648 | One fish meal / week will not exceed threshold |
| PENO-1002F | < 0.0000489 | > 0.648 | One fish meal / week will not exceed threshold |
| PENO-1003F | < 0.0000493 | > 0.648 | One fish meal / week will not exceed threshold |

Concentrations in green preceded by the less than symbol (<) indicate non-detects and the detection limit

**Table A-5**. Total Chlordane (ΣChlordane; sum of *alpha* chlordane, *gamma* chlordane, *cis*-nonachlor, *trans*-nonachlor and oxychlordane)

| FWS Sample Number | ΣChlordane µg/g ww | EPA Cancer Health Endpoint µg/g ww | EPA Risk-Based Consumption Limit Fish Meals / Month |
|---|---|---|---|
| DENN-01F | 0.0036 | 0 – 0.0084 | Unrestricted (>16) |
| NARR-02F | 0.0014 | 0 – 0.0084 | Unrestricted (>16) |
| PENO-01F | 0.0054 | 0 – 0.0084 | Unrestricted (>16) |
| PENO-0901F | 0.0103 | > 0.0084 – 0.017 | 16 meals / month |
| PENO-1001F | 0.0068 | 0 – 0.0084 | Unrestricted (>16) |
| PENO-1002F | 0.0047 | 0 – 0.0084 | Unrestricted (>16) |
| PENO-1003F | 0.0075 | 0 – 0.0084 | Unrestricted (>16) |
| **FWS Sample Number** | **ΣChlordane µg/g ww** | **EPA Non Cancer Health Endpoint µg/g ww** | **EPA Risk-Based Consumption Limit Fish Meals / Month** |
| DENN-01F | 0.0036 | 0 – 0.15 | Unrestricted (> 16) |
| NARR-02F | 0.0014 | 0 – 0.15 | Unrestricted (> 16) |
| PENO-01F | 0.0054 | 0 – 0.15 | Unrestricted (> 16) |
| PENO-0901F | 0.0103 | 0 – 0.15 | Unrestricted (> 16) |
| PENO-1001F | 0.0068 | 0 – 0.15 | Unrestricted (> 16) |
| PENO-1002F | 0.0047 | 0 – 0.15 | Unrestricted (> 16) |
| PENO-1003F | 0.0075 | 0 – 0.15 | Unrestricted (> 16) |
| **FWS Sample Number** | **ΣChlordane µg/g ww** | **Maine Cancer Action Level µg/g ww** | **Maine Consumption Advisory Recommendation** |
| DENN-01F | 0.0036 | > 0.017 | One fish meal / week will not exceed threshold |
| NARR-02F | 0.0014 | > 0.017 | One fish meal / week will not exceed threshold |
| PENO-01F | 0.0054 | > 0.017 | One fish meal / week will not exceed threshold |
| PENO-0901F | 0.0103 | > 0.017 | One fish meal / week will not exceed threshold |
| PENO-1001F | 0.0068 | > 0.017 | One fish meal / week will not exceed threshold |
| PENO-1002F | 0.0047 | > 0.017 | One fish meal / week will not exceed threshold |
| PENO-1003F | 0.0075 | > 0.017 | One fish meal / week will not exceed threshold |
| **FWS Sample Number** | **ΣChlordane µg/g ww** | **Maine Non Cancer Action Level µg/g ww** | **Maine Consumption Advisory Recommendation** |
| DENN-01F | 0.0036 | > 0.130 | One fish meal / week will not exceed threshold |
| NARR-02F | 0.0014 | > 0.130 | One fish meal / week will not exceed threshold |
| PENO-01F | 0.0054 | > 0.130 | One fish meal / week will not exceed threshold |
| PENO-0901F | 0.0103 | > 0.130 | One fish meal / week will not exceed threshold |
| PENO-1001F | 0.0068 | > 0.130 | One fish meal / week will not exceed threshold |
| PENO-1002F | 0.0047 | > 0.648 | One fish meal / week will not exceed threshold |
| PENO-1003F | 0.0075 | > 0.648 | One fish meal / week will not exceed threshold |

**Table A-6**. 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 |
|---|---|---|---|
| DENN-01F | 0.000181 | > 0 – 0.00032 | Unrestricted (>16) |
| NARR-02F | 0.000513 | > 0.00032 – 0.00064 | 16 meals / month |
| PENO-01F | 0.000359 | > 0.00032 – 0.00064 | 16 meals / month |
| PENO-0901F | < 0.0000488 | > 0 – 0.00032 | Unrestricted (>16) |
| PENO-1001F | 0.000486 | > 0.00032 – 0.00064 | 16 meals / month |
| PENO-1002F | 0.000281 | > 0 – 0.00032 | Unrestricted (>16) |
| PENO-1003F | 0.000274 | > 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** |
| DENN-01F | 0.000181 | 0 – 0.0038 | Unrestricted (> 16) |
| NARR-02F | 0.000513 | 0 – 0.0038 | Unrestricted (> 16) |
| PENO-01F | 0.000359 | 0 – 0.0038 | Unrestricted (> 16) |
| PENO-0901F | < 0.0000488 | 0 – 0.0038 | Unrestricted (> 16) |
| PENO-1001F | 0.000486 | 0 – 0.0038 | Unrestricted (> 16) |
| PENO-1002F | 0.000281 | 0 – 0.0038 | Unrestricted (> 16) |
| PENO-1003F | 0.000274 | 0 – 0.0038 | Unrestricted (> 16) |
| **FWS Sample Number** | **Heptachlor epoxide µg/g ww** | **Maine Cancer Action Level µg/g ww** | **Maine Consumption Advisory Recommendation** |
| DENN-01F | 0.000181 | > 0.0024 | One fish meal / week will not exceed threshold |
| NARR-02F | 0.000513 | > 0.0024 | One fish meal / week will not exceed threshold |
| PENO-01F | 0.000359 | > 0.0024 | One fish meal / week will not exceed threshold |
| PENO-0901F | < 0.0000488 | > 0.0024 | One fish meal / week will not exceed threshold |
| PENO-1001F | 0.000486 | > 0.0024 | One fish meal / week will not exceed threshold |
| PENO-1002F | 0.000281 | > 0.0024 | One fish meal / week will not exceed threshold |
| PENO-1003F | 0.000274 | > 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** |
| DENN-01F | 0.000181 | > 0.028 | One fish meal / week will not exceed threshold |
| NARR-02F | 0.000513 | > 0.028 | One fish meal / week will not exceed threshold |
| PENO-01F | 0.000359 | > 0.028 | One fish meal / week will not exceed threshold |
| PENO-0901F | < 0.0000488 | > 0.028 | One fish meal / week will not exceed threshold |
| PENO-1001F | 0.000486 | > 0.028 | One fish meal / week will not exceed threshold |
| PENO-1002F | 0.000281 | > 0.028 | One fish meal / week will not exceed threshold |
| PENO-1003F | 0.000274 | > 0.028 | One fish meal / week will not exceed threshold |

Concentrations in green preceded by the less than symbol (<) indicate non-detects and the detection limit

**Table A-7**. Heptachlor

| FWS Sample Number | Heptachlor µg/g ww | Maine Cancer Action Level µg/g ww | Maine Consumption Advisory Recommendation |
|---|---|---|---|
| DENN-01F | 0.0015 | > 0.005 | One fish meal / week will not exceed threshold |
| NARR-02F | 0.0010 | > 0.005 | One fish meal / week will not exceed threshold |
| PENO-01F | 0.0001 | > 0.005 | One fish meal / week will not exceed threshold |
| PENO-0901F | < 0.0000488 | > 0.005 | One fish meal / week will not exceed threshold |
| PENO-1001F | < 0.0000475 | > 0.005 | One fish meal / week will not exceed threshold |
| PENO-1002F | < 0.0000489 | > 0.005 | One fish meal / week will not exceed threshold |
| PENO-1003F | 0.0003 | > 0.005 | One fish meal / week will not exceed threshold |
| **FWS Sample Number** | **Heptachlor µg/g ww** | **Maine Non Cancer Action Level µg/g ww** | **Maine Consumption Advisory Recommendation** |
| DENN-01F | 0.0015 | > 1.08 | One fish meal / week will not exceed threshold |
| NARR-02F | 0.0010 | > 1.08 | One fish meal / week will not exceed threshold |
| PENO-01F | 0.0001 | > 1.08 | One fish meal / week will not exceed threshold |
| PENO-0901F | < 0.0000488 | > 1.08 | One fish meal / week will not exceed threshold |
| PENO-1001F | < 0.0000475 | > 1.08 | One fish meal / week will not exceed threshold |
| PENO-1002F | < 0.0000489 | > 1.08 | One fish meal / week will not exceed threshold |
| PENO-1003F | 0.0003 | > 1.08 | One fish meal / week will not exceed threshold |

Concentrations in green preceded by the less than symbol (<) indicate non-detects and the detection limit

**Table A-8**. Aldrin

| FWS Sample Number | Aldrin µg/g ww | Maine Cancer Action Level µg/g ww | Maine Consumption Advisory Recommendation |
|---|---|---|---|
| DENN-01F | 0.0004 | > 0.0013 | One fish meal / week will not exceed threshold |
| NARR-02F | 0.0001 | > 0.0013 | One fish meal / week will not exceed threshold |
| PENO-01F | < 0.0000497 | > 0.0013 | One fish meal / week will not exceed threshold |
| PENO-0901F | < 0.0000488 | > 0.0013 | One fish meal / week will not exceed threshold |
| PENO-1001F | < 0.0000475 | > 0.0013 | One fish meal / week will not exceed threshold |
| PENO-1002F | < 0.0000489 | > 0.0013 | One fish meal / week will not exceed threshold |
| PENO-1003F | < 0.0000493 | > 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** |
| DENN-01F | 0.0004 | > 0.065 | One fish meal / week will not exceed threshold |
| NARR-02F | 0.0001 | > 0.065 | One fish meal / week will not exceed threshold |
| PENO-01F | < 0.0000497 | > 0.065 | One fish meal / week will not exceed threshold |
| PENO-0901F | < 0.0000488 | > 0.065 | One fish meal / week will not exceed threshold |
| PENO-1001F | < 0.0000475 | > 0.065 | One fish meal / week will not exceed threshold |
| PENO-1002F | < 0.0000489 | > 0.065 | One fish meal / week will not exceed threshold |
| PENO-1003F | < 0.0000493 | > 0.065 | One fish meal / week will not exceed threshold |

**Table A-9**. Endrin

| FWS Sample Number | Endrin µg/g ww | EPA Non Cancer Health Endpoint µg/g ww | EPA Risk-Based Consumption Limit Fish Meals / Month |
|---|---|---|---|
| DENN-01F | 0.0047 | 0 – 0.088 | Unrestricted (> 16) |
| NARR-02F | 0.0008 | 0 – 0.088 | Unrestricted (> 16) |
| PENO-01F | 0.0016 | 0 – 0.088 | Unrestricted (> 16) |
| PENO-0901F | < 0.0000488 | 0 – 0.088 | Unrestricted (> 16) |
| PENO-1001F | < 0.0000475 | 0 – 0.088 | Unrestricted (> 16) |
| PENO-1002F | 0.0004 | 0 – 0.088 | Unrestricted (> 16) |
| PENO-1003F | 0.0006 | 0 – 0.088 | Unrestricted (> 16) |

Concentrations in green preceded by the less than symbol (<) indicate non-detects and the detection limit

**Table A-10**. Dieldrin

| FWS Sample Number | Dieldrin µg/g ww | EPA Cancer Health Endpoint µg/g ww | EPA Risk-Based Consumption Limit Fish Meals / Month |
|---|---|---|---|
| DENN-01F | 0.0011 | > 0.00073 – 0.0015 | 4 meals / month |
| NARR-02F | 0.0018 | > 0.0015 – 0.002 | 3 meals / month |
| PENO-01F | 0.0017 | > 0.0015 – 0.002 | 3 meals / month |
| PENO-0901F | 0.0031 | > 0.0029 – 0.0059 | 1 meal / month |
| PENO-1001F | 0.0020 | > 0.0015 – 0.002 | 3 meals / month |
| PENO-1002F | 0.0013 | > 0.00073 – 0.0015 | 4 meals / month |
| PENO-1003F | 0.0014 | > 0.00073 – 0.0015 | 4 meals / month |
| **FWS Sample Number** | **Dieldrin µg/g ww** | **EPA Non Cancer Health Endpoint µg/g ww** | **EPA Risk-Based Consumption Limit Fish Meals / Month** |
| DENN-01F | 0.0011 | 0 – 0.015 | Unrestricted (> 16) |
| NARR-02F | 0.0018 | 0 – 0.015 | Unrestricted (> 16) |
| PENO-01F | 0.0017 | 0 – 0.015 | Unrestricted (> 16) |
| PENO-0901F | 0.0031 | 0 – 0.015 | Unrestricted (> 16) |
| PENO-1001F | 0.0020 | 0 – 0.015 | Unrestricted (> 16) |
| PENO-1002F | 0.0013 | 0 – 0.015 | Unrestricted (> 16) |
| PENO-1003F | 0.0014 | 0 – 0.015 | Unrestricted (> 16) |
| **FWS Sample Number** | **Dieldrin µg/g ww** | **Maine Cancer Action Level µg/g ww** | **Maine Consumption Advisory Recommendation** |
| DENN-01F | 0.0011 | > 0.0014 | One fish meal / week will not exceed threshold |
| NARR-02F | 0.0018 | > 0.0014 | Threshold exceeded by one fish meal / week |
| PENO-01F | 0.0017 | > 0.0014 | Threshold exceeded by one fish meal / week |
| PENO-0901F | 0.0031 | > 0.0014 | Threshold exceeded by one fish meal / week |
| PENO-1001F | 0.0020 | > 0.0014 | Threshold exceeded by one fish meal / week |
| PENO-1002F | 0.0013 | > 0.0014 | One fish meal / week will not exceed threshold |
| PENO-1003F | 0.0014 | > 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** |
| DENN-01F | 0.0011 | > 0.108 | One fish meal / week will not exceed threshold |
| NARR-02F | 0.0018 | > 0.108 | One fish meal / week will not exceed threshold |
| PENO-01F | 0.0017 | > 0.108 | One fish meal / week will not exceed threshold |
| PENO-0901F | 0.0031 | > 0.108 | One fish meal / week will not exceed threshold |
| PENO-1001F | 0.0020 | > 0.108 | One fish meal / week will not exceed threshold |
| PENO-1002F | 0.0013 | > 0.108 | One fish meal / week will not exceed threshold |
| PENO-1003F | 0.0014 | > 0.108 | One fish meal / week will not exceed threshold |

**Table A-11**. Hexachlorobenzene (HCB)

| FWS Sample Number | HCB µg/g ww | EPA Cancer Health Endpoint µg/g ww | EPA Risk-Based Consumption Limit Fish Meals / Month |
|---|---|---|---|
| DENN-01F | 0.0011 | 0 – 0.0018 | Unrestricted (>16) |
| NARR-02F | 0.0016 | 0 – 0.0018 | Unrestricted (>16) |
| PENO-01F | 0.0019 | > 0.0018 – 0.0037 | 16 meals / month |
| PENO-0901F | 0.0028 | > 0.0018 – 0.0037 | 16 meals /month |
| PENO-1001F | 0.0019 | > 0.0018 – 0.0037 | 16 meals / month |
| PENO-1002F | 0.0003 | 0 – 0.0018 | Unrestricted (>16) |
| PENO-1003F | 0.0013 | 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** |
| DENN-01F | 0.0011 | 0 – 0.23 | Unrestricted (> 16) |
| NARR-02F | 0.0016 | 0 – 0.23 | Unrestricted (> 16) |
| PENO-01F | 0.0019 | 0 – 0.23 | Unrestricted (> 16) |
| PENO-0901F | 0.0028 | 0 – 0.23 | Unrestricted (> 16) |
| PENO-1001F | 0.0019 | 0 – 0.23 | Unrestricted (> 16) |
| PENO-1002F | 0.0003 | 0 – 0.23 | Unrestricted (> 16) |
| PENO-1003F | 0.0013 | 0 – 0.23 | Unrestricted (> 16) |
| **FWS Sample Number** | **HCB µg/g ww** | **Maine Cancer Action Level µg/g ww** | **Maine Consumption Advisory Recommendation** |
| DENN-01F | 0.0011 | > 0.014 | One fish meal / week will not exceed threshold |
| NARR-02F | 0.0016 | > 0.014 | One fish meal / week will not exceed threshold |
| PENO-01F | 0.0019 | > 0.014 | One fish meal / week will not exceed threshold |
| PENO-0901F | 0.0028 | > 0.014 | One fish meal / week will not exceed threshold |
| PENO-1001F | 0.0019 | > 0.014 | One fish meal / week will not exceed threshold |
| PENO-1002F | 0.0003 | > 0.014 | One fish meal / week will not exceed threshold |
| PENO-1003F | 0.0013 | > 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** |
| DENN-01F | 0.0011 | > 1.728 | One fish meal / week will not exceed threshold |
| NARR-02F | 0.0016 | > 1.728 | One fish meal / week will not exceed threshold |
| PENO-01F | 0.0019 | > 1.728 | One fish meal / week will not exceed threshold |
| PENO-0901F | 0.0028 | > 1.728 | One fish meal / week will not exceed threshold |
| PENO-1001F | 0.0019 | > 1.728 | One fish meal / week will not exceed threshold |
| PENO-1002F | 0.0003 | > 1.728 | One fish meal / week will not exceed threshold |
| PENO-1003F | 0.0013 | > 1.728 | One fish meal / week will not exceed threshold |

**Table A-12**. Mirex

| FWS Sample Number | Mirex µg/g ww | EPA Non Cancer Health Endpoint µg/g ww | EPA Risk-Based Consumption Limit Fish Meals / Month |
|---|---|---|---|
| DENN-01F | 0.003 | 0 – 0.059 | Unrestricted (> 16) |
| NARR-02F | 0.018 | 0 – 0.059 | Unrestricted (> 16) |
| PENO-01F | < 0.0000497 | 0 – 0.059 | Unrestricted (> 16) |
| PENO-0901F | < 0.0000488 | 0 – 0.059 | Unrestricted (> 16) |
| PENO-1001F | < 0.0000475 | 0 – 0.059 | Unrestricted (> 16) |
| PENO-1002F | < 0.0000489 | 0 – 0.059 | Unrestricted (> 16) |
| PENO-1003F | < 0.0000493 | 0 – 0.059 | Unrestricted (> 16) |
| **FWS Sample Number** | **Mirex µg/g ww** | **Maine Non Cancer Action Level µg/g ww** | **Maine Consumption Advisory Recommendation** |
| DENN-01F | 0.003 | > 0.432 | One fish meal / week will not exceed threshold |
| NARR-02F | 0.018 | > 0.432 | One fish meal / week will not exceed threshold |
| PENO-01F | < 0.0000497 | > 0.432 | One fish meal / week will not exceed threshold |
| PENO-0901F | < 0.0000488 | > 0.432 | One fish meal / week will not exceed threshold |
| PENO-1001F | < 0.0000475 | > 0.432 | One fish meal / week will not exceed threshold |
| PENO-1002F | < 0.0000489 | > 0.432 | One fish meal / week will not exceed threshold |
| PENO-1003F | < 0.0000493 | > 0.432 | One fish meal / week will not exceed threshold |

Concentrations in green preceded by the less than symbol (<) indicate non-detects and the 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 |
|---|---|---|---|
| DENN-01F | 0.039 | > 0.031 – 0.063 | 1 |
| NARR-02F | 0.062 | > 0.031 – 0.063 | 1 |
| PENO-01F | 0.044 | > 0.031 – 0.063 | 1 |
| PENO-0901F | 0.046 | > 0.031 – 0.063 | 1 |
| PENO-1001F | 0.037 | > 0.031 – 0.063 | 1 |
| PENO-1002F | 0.026 | > 0.021 – 0.031 | 2 |
| PENO-1003F | 0.045 | > 0.031 – 0.063 | 1 |
| **FWS Sample Number** | **As µg/g ww** | **EPA Non Cancer Health Endpoint µg/g ww** | **EPA Risk-Based Consumption Limit Fish Meals / Month** |
| DENN-01F | 0.039 | 0 – 0.088 | Unrestricted (> 16) |
| NARR-02F | 0.062 | 0 – 0.088 | Unrestricted (> 16) |
| PENO-01F | 0.044 | 0 – 0.088 | Unrestricted (> 16) |
| PENO-0901F | 0.046 | 0 – 0.088 | Unrestricted (> 16) |
| PENO-1001F | 0.037 | 0 – 0.088 | Unrestricted (> 16) |
| PENO-1002F | 0.026 | 0 – 0.088 | Unrestricted (> 16) |
| PENO-1003F | 0.045 | 0 – 0.088 | Unrestricted (> 16) |
| **FWS Sample Number** | **As µg/g ww** | **Maine Cancer Action Level µg/g ww** | **Maine Consumption Advisory Recommendation** |
| DENN-01F | 0.039 | 0.014 | Threshold exceeded by one fish meal / week |
| NARR-02F | 0.062 | 0.014 | Threshold exceeded by one fish meal / week |
| PENO-01F | 0.044 | 0.014 | Threshold exceeded by one fish meal / week |
| PENO-0901F | 0.046 | 0.014 | Threshold exceeded by one fish meal / week |
| PENO-1001F | 0.037 | 0.014 | Threshold exceeded by one fish meal / week |
| PENO-1002F | 0.026 | 0.014 | Threshold exceeded by one fish meal / week |
| PENO-1003F | 0.045 | 0.014 | Threshold exceeded by one fish meal / week |
| **FWS Sample Number** | **As µg/g ww** | **Maine Non Cancer Action Level µg/g ww** | **Maine Consumption Advisory Recommendation** |
| DENN-01F | 0.039 | 0.6 | One fish meal / week will not exceed threshold |
| NARR-02F | 0.062 | 0.6 | One fish meal / week will not exceed threshold |
| PENO-01F | 0.044 | 0.6 | One fish meal / week will not exceed threshold |
| PENO-0901F | 0.046 | 0.6 | One fish meal / week will not exceed threshold |
| PENO-1001F | 0.037 | 0.6 | One fish meal / week will not exceed threshold |
| PENO-1002F | 0.026 | 0.6 | One fish meal / week will not exceed threshold |
| PENO-1003F | 0.045 | 0.6 | One fish meal / week will not exceed threshold |

Original salmon fillet sample concentrations reported as total arsenic. EPA Health Endpoints and Maine BOH Action levels are for inorganic arsenic. Reported salmon 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).

**Table B-2**. 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 |
|---|---|---|---|
| DENN-01F | 0.040 | > 0.029 – 0.059 | 16 |
| NARR-02F | < 0.030 | > 0.029 – 0.059 | 16 |
| PENO-01F | 0.140 | > 0.12 – 0.23 | 4 |
| PENO-0901F | 0.062 | > 0.059 – 0.078 | 12 |
| PENO-1001F | 0.090 | > 0.078 – 0.12 | 8 |
| PENO-1002F | 0.070 | > 0.059 – 0.078 | 12 |
| PENO-1003F | 0.085 | > 0.078 – 0.12 | 8 |
| **FWS Sample Number** | **Hg µg/g ww** | **Maine Non Cancer Action Level µg/g ww** | **Maine Consumption Advisory Recommendation** |
| DENN-01F | 0.040 | > 0.20 | One fish meal / week will not exceed threshold |
| NARR-02F | < 0.030 | > 0.20 | One fish meal / week will not exceed threshold |
| PENO-01F | 0.140 | > 0.20 | One fish meal / week will not exceed threshold |
| PENO-0901F | 0.062 | > 0.20 | One fish meal / week will not exceed threshold |
| PENO-1001F | 0.090 | > 0.20 | One fish meal / week will not exceed threshold |
| PENO-1002F | 0.070 | > 0.20 | One fish meal / week will not exceed threshold |
| PENO-1003F | 0.085 | > 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.

Concentrations in green preceded by the less than symbol (<) indicate non-detects and the detection limit

**Table B-3**. Selenium (Se)

| FWS Sample Number | Se µg/g ww | EPA Non Cancer Health Endpoint µg/g ww | EPA Risk-Based Consumption Limit Fish Meals / Month |
|---|---|---|---|
| DENN-01F | 0.28 | 0 – 1.5 | Unrestricted (> 16) |
| NARR-02F | 0.28 | 0 – 1.5 | Unrestricted (> 16) |
| PENO-01F | 0.33 | 0 – 1.5 | Unrestricted (> 16) |
| PENO-0901F | 0.26 | 0 – 1.5 | Unrestricted (> 16) |
| PENO-1001F | 0.38 | 0 – 1.5 | Unrestricted (> 16) |
| PENO-1002F | 0.33 | 0 – 1.5 | Unrestricted (> 16) |
| PENO-1003F | 0.40 | 0 – 1.5 | Unrestricted (> 16) |
| **FWS Sample Number** | **Se µg/g ww** | **Maine Non Cancer Action Level µg/g ww** | **Maine Consumption Advisory Recommendation** |
| DENN-01F | 0.28 | 11 | One fish meal / week will not exceed threshold |
| NARR-02F | 0.28 | 11 | One fish meal / week will not exceed threshold |
| PENO-01F | 0.33 | 11 | One fish meal / week will not exceed threshold |
| PENO-0901F | 0.26 | 11 | One fish meal / week will not exceed threshold |
| PENO-1001F | 0.38 | 11 | One fish meal / week will not exceed threshold |
| PENO-1002F | 0.33 | 11 | One fish meal / week will not exceed threshold |
| PENO-1003F | 0.40 | 11 | One fish meal / week will not exceed threshold |

**Table B-4**. Zinc (Zn)

| FWS Sample Number | Zn µg/g ww | Maine Non Cancer Action Level µg/g ww | Maine Consumption Advisory Recommendation |
|---|---|---|---|
| DENN-01F | 5.0 | 648 | One fish meal / week will not exceed threshold |
| NARR-02F | 5.5 | 648 | One fish meal / week will not exceed threshold |
| PENO-01F | 4.6 | 648 | One fish meal / week will not exceed threshold |
| PENO-0901F | 7.5 | 648 | One fish meal / week will not exceed threshold |
| PENO-1001F | 6.1 | 648 | One fish meal / week will not exceed threshold |
| PENO-1002F | 5.4 | 648 | One fish meal / week will not exceed threshold |
| PENO-1003F | 6.3 | 648 | One fish meal / week will not exceed threshold |

**Table C-1.** TCDD-TEQ calculations in salmon fillets using 2005 TEFs for human risk assessments, pg/g wet weight

| | TEF [a] | Dennys River DENN-01F pg/g ww | TEF Adjusted pg/g ww | Narraguagus River NARR-02F pg/g ww | TEF Adjusted pg/g ww | Penobscot River PENO-01F pg/g ww | TEF Adjusted pg/g ww |
|---|---|---|---|---|---|---|---|
| **Dioxins** | | | | | | | |
| 2,3,7,8-TCDD | 1 | < 1.81 | BDL | < 1.42 | BDL | < 0.960 | BDL |
| 1,2,3,7,8-PeCDD | 1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,4,7,8-HxCDD | 0.1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,6,7,8-HxCDD | 0.1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,7,8,9-HxCDD | 0.1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,4,6,7,8-HpCDD | 0.01 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| OCDD | 0.0003 | < 18.1 | BDL | < 14.2 | BDL | < 9.58 | BDL |
| **Furans** | | | | | | | |
| 2,3,7,8-TCDF | 0.1 | < 1.81 | BDL | < 1.42 | BDL | < 0.960 | BDL |
| 1,2,3,7,8-PeCDF | 0.03 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 2,3,4,7,8-PeCDF | 0.3 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,4,7,8-HxCDF | 0.1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,6,7,8-HxCDF | 0.1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,7,8,9-HxCDF | 0.1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 2,3,4,6,7,8-HxCDF | 0.1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| OCDF | 0.0003 | < 18.1 | BDL | < 14.2 | BDL | < 9.58 | BDL |
| **Non-ortho PCBs** | | | | | | | |
| PCB# 77 | 0.0001 | < 19.5 | BDL | < 19.5 | BDL | 8.8 | 0.00088 |
| PCB# 81 | 0.0003 | < 19.5 | BDL | < 19.5 | BDL | < 0.190 | BDL |
| PCB# 126 | 0.1 | < 19.5 | BDL | < 19.5 | BDL | 3 | 0.3 |
| PCB# 169 | 0.03 | < 19.5 | BDL | < 19.5 | BDL | 1.2 | 0.036 |
| **Mono-ortho PCBs** | | | | | | | |
| PCB# 105 | 0.00003 | 195 | 0.00585 | 301 | 0.00903 | 255 | 0.00765 |
| PCB# 114 | 0.00003 | < 19.5 | BDL | < 19.5 | BDL | 16.6 | 0.000498 |
| PCB# 118 | 0.00003 | 823 | 0.02469 | 566 | 0.01698 | 705 | 0.02115 |
| PCB# 123 | 0.00003 | 78 | 0.00234 | 30 | 0.00090 | 912 | 0.02736 |
| PCB# 156 | 0.00003 | < 19.5 | BDL | < 19.5 | BDL | 58.1 | 0.001743 |
| PCB# 157 | 0.00003 | 245 | 0.00735 | 390 | 0.01170 | 17.6 | 0.000528 |
| PCB# 167 | 0.00003 | < 19.5 | BDL | < 19.5 | BDL | 45.5 | 0.001365 |
| PCB# 189 | 0.00003 | 123 | 0.00369 | < 19.5 | BDL | 9 | 0.00027 |
| **TCDD-TEQ (PCDD/Fs + planar PCBs)** | | | **0.04** | | **0.04** | | **0.40** |

[a] TEFs for human risk assessments from Van den Berg *et al.* (2006). Values in red preceded by < symbol indicate non-detects and detection limits.

**Table C-1 (continued).** TCDD-TEQ calculations in salmon fillets using 2005 TEFs for human risk assessments, pg/g wet weight

| | TEF [a] | Penobscot River PENO-0901F pg/g ww | TEF Adjusted pg/g ww | Penobscot River PENO-1001F pg/g ww | TEF Adjusted pg/g ww | Penobscot River PENO-1002F pg/g ww | TEF Adjusted pg/g ww |
|---|---|---|---|---|---|---|---|
| **Dioxins** | | | | | | | |
| 2,3,7,8-TCDD | 1 | < 0.940 | BDL | < 0.950 | BDL | < 0.990 | BDL |
| 1,2,3,7,8-PeCDD | 1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,4,7,8-HxCDD | 0.1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,6,7,8-HxCDD | 0.1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,7,8,9-HxCDD | 0.1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,4,6,7,8-HpCDD | 0.01 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| OCDD | 0.0003 | < 9.45 | BDL | < 9.49 | BDL | < 9.87 | BDL |
| **Furans** | | | | | | | |
| 2,3,7,8-TCDF | 0.1 | < 0.940 | BDL | < 0.950 | BDL | < 0.990 | BDL |
| 1,2,3,7,8-PeCDF | 0.03 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 2,3,4,7,8-PeCDF | 0.3 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,4,7,8-HxCDF | 0.1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,6,7,8-HxCDF | 0.1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,7,8,9-HxCDF | 0.1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 2,3,4,6,7,8-HxCDF | 0.1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| OCDF | 0.0003 | < 9.45 | BDL | < 9.49 | BDL | < 9.87 | BDL |
| **Non-ortho PCBs** | | | | | | | |
| PCB# 77 | 0.0001 | 31.20 | 0.00312 | 11.10 | 0.00111 | 11.70 | 0.00117 |
| PCB# 81 | 0.0003 | < 0.190 | BDL | < 0.190 | BDL | 4.50 | 0.00135 |
| PCB# 126 | 0.1 | < 0.190 | BDL | 5.90 | 0.59 | 2.20 | 0.22 |
| PCB# 169 | 0.03 | < 0.190 | BDL | < 0.190 | BDL | < 0.200 | BDL |
| **Mono-ortho PCBs** | | | | | | | |
| PCB# 105 | 0.00003 | 478.00 | 0.01434 | 244.00 | 0.00732 | 234.00 | 0.00702 |
| PCB# 114 | 0.00003 | 33.70 | 0.001011 | 15.70 | 0.000471 | 15.80 | 0.000474 |
| PCB# 118 | 0.00003 | 1370.00 | 0.0411 | 686.00 | 0.02058 | 647.00 | 0.01941 |
| PCB# 123 | 0.00003 | < 0.190 | BDL | < 0.190 | BDL | < 0.200 | BDL |
| PCB# 156 | 0.00003 | 97.90 | 0.002937 | 49.70 | 0.001491 | 50.40 | 0.001512 |
| PCB# 157 | 0.00003 | 36.70 | 0.001101 | 13.10 | 0.000393 | 19.30 | 0.000579 |
| PCB# 167 | 0.00003 | 60.80 | 0.001824 | 34.10 | 0.001023 | 30.40 | 0.000912 |
| PCB# 189 | 0.00003 | 9.20 | 0.000276 | 6.50 | 0.000195 | 5.90 | 0.000177 |
| **TCDD-TEQ (PCDD/Fs + planar PCBs)** | | | **0.07** | | **0.62** | | **0.25** |

[a] TEFs for human risk assessments from Van den Berg *et al.* (2006). Values in red preceded by < symbol indicate non-detects and detection limits.

**Table C-1 (continued).** TCDD-TEQ calculations in salmon fillets using 2005 TEFs for human risk assessments, pg/g wet weight

| | TEF [a] | Penobscot River PENO-1003F pg/g ww | TEF Adjusted pg/g ww |
|---|---|---|---|
| **Dioxins** | | | |
| 2,3,7,8-TCDD | 1 | < 0.990 | BDL |
| 1,2,3,7,8-PeCDD | 1 | < 4.97 | BDL |
| 1,2,3,4,7,8-HxCDD | 0.1 | < 4.97 | BDL |
| 1,2,3,6,7,8-HxCDD | 0.1 | < 4.97 | BDL |
| 1,2,3,7,8,9-HxCDD | 0.1 | < 4.97 | BDL |
| 1,2,3,4,6,7,8-HpCDD | 0.01 | < 4.97 | BDL |
| OCDD | 0.0003 | < 9.93 | BDL |
| **Furans** | | | |
| 2,3,7,8-TCDF | 0.1 | < 0.990 | BDL |
| 1,2,3,7,8-PeCDF | 0.03 | < 4.97 | BDL |
| 2,3,4,7,8-PeCDF | 0.3 | < 4.97 | BDL |
| 1,2,3,4,7,8-HxCDF | 0.1 | < 4.97 | BDL |
| 1,2,3,6,7,8-HxCDF | 0.1 | < 4.97 | BDL |
| 1,2,3,7,8,9-HxCDF | 0.1 | < 4.97 | BDL |
| 2,3,4,6,7,8-HxCDF | 0.1 | < 4.97 | BDL |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | < 4.97 | BDL |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | < 4.97 | BDL |
| OCDF | 0.0003 | < 9.93 | BDL |
| **Non-ortho PCBs** | | | |
| PCB# 77 | 0.0001 | 12.10 | 0.00121 |
| PCB# 81 | 0.0003 | < 0.200 | BDL |
| PCB# 126 | 0.1 | < 0.200 | BDL |
| PCB# 169 | 0.03 | < 0.200 | BDL |
| **Mono-ortho PCBs** | | | |
| PCB# 105 | 0.00003 | 203.00 | 0.00609 |
| PCB# 114 | 0.00003 | 13.40 | 0.000402 |
| PCB# 118 | 0.00003 | 680.00 | 0.0204 |
| PCB# 123 | 0.00003 | < 0.200 | BDL |
| PCB# 156 | 0.00003 | 47.50 | 0.001425 |
| PCB# 157 | 0.00003 | 16.50 | 0.000495 |
| PCB# 167 | 0.00003 | 25.20 | 0.000756 |
| PCB# 189 | 0.00003 | < 0.200 | BDL |
| **TCDD-TEQ (PCDD/Fs + planar PCBs)** | | | **0.03** |

[a] TEFs for human risk assessments from Van den Berg *et al.* (2006). Values in red preceded by < symbol indicate non-detects and detection limits.

**Table C-2.** TCDD-TEQ calculations in salmon fillets using 1998 TEFs for human risk assessments, pg/g wet weight

| | TEF [a] | Dennys River DENN-01F pg/g ww | TEF Adjusted pg/g ww | Narraguagus River NARR-02F pg/g ww | TEF Adjusted pg/g ww | Penobscot River PENO-01F pg/g ww | TEF Adjusted pg/g ww |
|---|---|---|---|---|---|---|---|
| **Dioxins** | | | | | | | |
| 2,3,7,8-TCDD | 1 | < 1.81 | BDL | < 1.42 | BDL | < 0.960 | BDL |
| 1,2,3,7,8-PeCDD | 1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,4,7,8-HxCDD | 0.1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,6,7,8-HxCDD | 0.1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,7,8,9-HxCDD | 0.1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,4,6,7,8-HpCDD | 0.01 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| OCDD | 0.0001 | < 18.1 | BDL | < 14.2 | BDL | < 9.58 | BDL |
| **Furans** | | | | | | | |
| 2,3,7,8-TCDF | 0.1 | < 1.81 | BDL | < 1.42 | BDL | < 0.960 | BDL |
| 1,2,3,7,8-PeCDF | 0.05 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 2,3,4,7,8-PeCDF | 0.5 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,4,7,8-HxCDF | 0.1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,6,7,8-HxCDF | 0.1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,7,8,9-HxCDF | 0.1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 2,3,4,6,7,8-HxCDF | 0.1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| OCDF | 0.0001 | < 18.1 | BDL | < 14.2 | BDL | < 9.58 | BDL |
| **Non-ortho PCBs** | | | | | | | |
| PCB# 77 | 0.0001 | < 19.5 | BDL | < 19.5 | BDL | 8.8 | 0.00088 |
| PCB# 81 | 0.0001 | < 19.5 | BDL | < 19.5 | BDL | < 0.190 | BDL |
| PCB# 126 | 0.1 | < 19.5 | BDL | < 19.5 | BDL | 3 | 0.3 |
| PCB# 169 | 0.01 | < 19.5 | BDL | < 19.5 | BDL | 1.2 | 0.012 |
| **Mono-ortho PCBs** | | | | | | | |
| PCB# 105 | 0.0001 | 195 | 0.0195 | 301 | 0.03010 | 255 | 0.0255 |
| PCB# 114 | 0.0005 | < 19.5 | BDL | < 19.5 | BDL | 16.6 | 0.0083 |
| PCB# 118 | 0.0001 | 823 | 0.0823 | 566 | 0.05660 | 705 | 0.0705 |
| PCB# 123 | 0.0001 | 78 | 0.0078 | 30 | 0.00300 | 912 | 0.0912 |
| PCB# 156 | 0.0005 | < 19.5 | BDL | < 19.5 | BDL | 58.1 | 0.02905 |
| PCB# 157 | 0.0005 | 245 | 0.1225 | 390 | 0.19500 | 17.6 | 0.0088 |
| PCB# 167 | 0.00001 | < 19.5 | BDL | < 19.5 | BDL | 45.5 | 0.000455 |
| PCB# 189 | 0.0001 | 123 | 0.0123 | < 19.5 | BDL | 9 | 0.0009 |
| **TCDD-TEQ (PCDD/Fs + planar PCBs)** | | | **0.24** | | **0.28** | | **0.55** |

[a] TEFs for human risk assessments from Van den Berg *et al.* (1998). Values in red preceded by < symbol indicate non-detects and detection limits.

**Table C-2 (continued).** TCDD-TEQ calculations in salmon fillets using 1998 TEFs for human risk assessments, pg/g wet weight

| | TEF [a] | Penobscot River PENO-0901F pg/g ww | TEF Adjusted pg/g ww | Penobscot River PENO-1001F pg/g ww | TEF Adjusted pg/g ww | Penobscot River PENO-1002F pg/g ww | TEF Adjusted pg/g ww |
|---|---|---|---|---|---|---|---|
| **Dioxins** | | | | | | | |
| 2,3,7,8-TCDD | 1 | < 0.940 | BDL | < 0.950 | BDL | < 0.990 | BDL |
| 1,2,3,7,8-PeCDD | 1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,4,7,8-HxCDD | 0.1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,6,7,8-HxCDD | 0.1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,7,8,9-HxCDD | 0.1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,4,6,7,8-HpCDD | 0.01 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| OCDD | 0.0001 | < 9.45 | BDL | < 9.49 | BDL | < 9.87 | BDL |
| **Furans** | | | | | | | |
| 2,3,7,8-TCDF | 0.1 | < 0.940 | BDL | < 0.950 | BDL | < 0.990 | BDL |
| 1,2,3,7,8-PeCDF | 0.05 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 2,3,4,7,8-PeCDF | 0.5 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,4,7,8-HxCDF | 0.1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,6,7,8-HxCDF | 0.1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,7,8,9-HxCDF | 0.1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 2,3,4,6,7,8-HxCDF | 0.1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| OCDF | 0.0001 | < 9.45 | BDL | < 9.49 | BDL | < 9.87 | BDL |
| **Non-ortho PCBs** | | | | | | | |
| PCB# 77 | 0.0001 | 31.20 | 0.00312 | 11.10 | 0.00111 | 11.70 | 0.00117 |
| PCB# 81 | 0.0001 | < 0.190 | BDL | < 0.190 | BDL | 4.50 | 0.00045 |
| PCB# 126 | 0.1 | < 0.190 | BDL | 5.90 | 0.59 | 2.20 | 0.22 |
| PCB# 169 | 0.01 | < 0.190 | BDL | < 0.190 | BDL | < 0.200 | BDL |
| **Mono-ortho PCBs** | | | | | | | |
| PCB# 105 | 0.0001 | 478.00 | 0.0478 | 244.00 | 0.0244 | 234.00 | 0.0234 |
| PCB# 114 | 0.0005 | 33.70 | 0.01685 | 15.70 | 0.00785 | 15.80 | 0.0079 |
| PCB# 118 | 0.0001 | 1370.00 | 0.137 | 686.00 | 0.0686 | 647.00 | 0.0647 |
| PCB# 123 | 0.0001 | < 0.190 | BDL | < 0.190 | BDL | < 0.200 | BDL |
| PCB# 156 | 0.0005 | 97.90 | 0.04895 | 49.70 | 0.02485 | 50.40 | 0.0252 |
| PCB# 157 | 0.0005 | 36.70 | 0.01835 | 13.10 | 0.00655 | 19.30 | 0.00965 |
| PCB# 167 | 0.00001 | 60.80 | 0.000608 | 34.10 | 0.000341 | 30.40 | 0.000304 |
| PCB# 189 | 0.0001 | 9.20 | 0.00092 | 6.50 | 0.00065 | 5.90 | 0.00059 |
| **TCDD-TEQ (PCDD/Fs + planar PCBs)** | | | **0.27** | | **0.72** | | **0.35** |

[a] TEFs for human risk assessments from Van den Berg *et al.* (1998). Values in red preceded by < symbol indicate non-detects and detection limits.

**Table C-2 (continued).** TCDD-TEQ calculations in salmon fillets using 1998 TEFs for human risk assessments, pg/g wet weight

| | TEF [a] | Penobscot River PENO-1003F pg/g ww | TEF Adjusted pg/g ww |
|---|---|---|---|
| **Dioxins** | | | |
| 2,3,7,8-TCDD | 1 | < 0.990 | BDL |
| 1,2,3,7,8-PeCDD | 1 | < 4.97 | BDL |
| 1,2,3,4,7,8-HxCDD | 0.1 | < 4.97 | BDL |
| 1,2,3,6,7,8-HxCDD | 0.1 | < 4.97 | BDL |
| 1,2,3,7,8,9-HxCDD | 0.1 | < 4.97 | BDL |
| 1,2,3,4,6,7,8-HpCDD | 0.01 | < 4.97 | BDL |
| OCDD | 0.0001 | < 9.93 | BDL |
| **Furans** | | | |
| 2,3,7,8-TCDF | 0.1 | < 0.990 | BDL |
| 1,2,3,7,8-PeCDF | 0.05 | < 4.97 | BDL |
| 2,3,4,7,8-PeCDF | 0.5 | < 4.97 | BDL |
| 1,2,3,4,7,8-HxCDF | 0.1 | < 4.97 | BDL |
| 1,2,3,6,7,8-HxCDF | 0.1 | < 4.97 | BDL |
| 1,2,3,7,8,9-HxCDF | 0.1 | < 4.97 | BDL |
| 2,3,4,6,7,8-HxCDF | 0.1 | < 4.97 | BDL |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | < 4.97 | BDL |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | < 4.97 | BDL |
| OCDF | 0.0001 | < 9.93 | BDL |
| **Non-ortho PCBs** | | | |
| PCB# 77 | 0.0001 | 12.10 | 0.00121 |
| PCB# 81 | 0.0001 | < 0.200 | BDL |
| PCB# 126 | 0.1 | < 0.200 | BDL |
| PCB# 169 | 0.01 | < 0.200 | BDL |
| **Mono-ortho PCBs** | | | |
| PCB# 105 | 0.0001 | 203.00 | 0.0203 |
| PCB# 114 | 0.0005 | 13.40 | 0.0067 |
| PCB# 118 | 0.0001 | 680.00 | 0.068 |
| PCB# 123 | 0.0001 | < 0.200 | BDL |
| PCB# 156 | 0.0005 | 47.50 | 0.02375 |
| PCB# 157 | 0.0005 | 16.50 | 0.00825 |
| PCB# 167 | 0.00001 | 25.20 | 0.000252 |
| PCB# 189 | 0.0001 | < 0.200 | BDL |
| **TCDD-TEQ (PCDD/Fs + planar PCBs)** | | | **0.13** |

[a] TEFs for human risk assessments from Van den Berg *et al.* (1998). Values in red preceded by < symbol indicate non-detects and detection limits.

**Table C-3.** TCDD-TEQ calculations in salmon fillets using 1998 TEFs for fish, pg/g wet weight

| | TEF [a] | Dennys River DENN-01F pg/g ww | TEF Adjusted pg/g ww | Narraguagus River NARR-02F pg/g ww | TEF Adjusted pg/g ww | Penobscot River PENO-01F pg/g ww | TEF Adjusted pg/g ww |
|---|---|---|---|---|---|---|---|
| **Dioxins** | | | | | | | |
| 2,3,7,8-TCDD | 1 | < 1.81 | BDL | < 1.42 | BDL | < 0.960 | BDL |
| 1,2,3,7,8-PeCDD | 1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,4,7,8-HxCDD | 0.5 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,6,7,8-HxCDD | 0.01 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,7,8,9-HxCDD | 0.01 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,4,6,7,8-HpCDD | 0.001 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| OCDD | 0.0001 | < 18.1 | BDL | < 14.2 | BDL | < 9.58 | BDL |
| **Furans** | | | | | | | |
| 2,3,7,8-TCDF | 0.05 | < 1.81 | BDL | < 1.42 | BDL | < 0.960 | BDL |
| 1,2,3,7,8-PeCDF | 0.05 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 2,3,4,7,8-PeCDF | 0.5 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,4,7,8-HxCDF | 0.1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,6,7,8-HxCDF | 0.1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,7,8,9-HxCDF | 0.1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 2,3,4,6,7,8-HxCDF | 0.1 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | < 9.04 | BDL | < 7.11 | BDL | < 4.79 | BDL |
| OCDF | 0.0001 | < 18.1 | BDL | < 14.2 | BDL | < 9.58 | BDL |
| **Non-ortho PCBs** | | | | | | | |
| PCB# 77 | 0.0001 | < 19.5 | BDL | < 19.5 | BDL | 8.8 | 0.00088 |
| PCB# 81 | 0.0005 | < 19.5 | BDL | < 19.5 | BDL | < 0.190 | BDL |
| PCB# 126 | 0.005 | < 19.5 | BDL | < 19.5 | BDL | 3 | 0.015 |
| PCB# 169 | 0.00005 | < 19.5 | BDL | < 19.5 | BDL | 1.2 | 0.00006 |
| **Mono-ortho PCBs** | | | | | | | |
| PCB# 105 | 0.000005 | 195 | 0.000975 | 301 | 0.00151 | 255 | 0.001275 |
| PCB# 114 | 0.000005 | < 19.5 | BDL | < 19.5 | BDL | 16.6 | 0.000083 |
| PCB# 118 | 0.000005 | 823 | 0.004115 | 566 | 0.00283 | 705 | 0.003525 |
| PCB# 123 | 0.000005 | 78 | 0.00039 | 30 | 0.00015 | 912 | 0.00456 |
| PCB# 156 | 0.000005 | < 19.5 | BDL | < 19.5 | BDL | 58.1 | 0.0002905 |
| PCB# 157 | 0.000005 | 245 | 0.001225 | 390 | 0.00195 | 17.6 | 0.000088 |
| PCB# 167 | 0.000005 | < 19.5 | BDL | < 19.5 | BDL | 45.5 | 0.0002275 |
| PCB# 189 | 0.000005 | 123 | 0.000615 | < 19.5 | BDL | 9 | 0.000045 |
| **TCDD-TEQ (PCDD/Fs + planar PCBs)** | | | **0.01** | | **0.01** | | **0.03** |

[a] TEFs for fish from Van den Berg *et al.* (1998). Values in red preceded by < symbol indicate non-detects and detection limits.

**Table C-3 (continued).** TCDD-TEQ calculations in salmon fillets using 1998 TEFs for fish, pg/g wet weight

| | TEF [a] | Penobscot River PENO-0901F pg/g ww | TEF Adjusted pg/g ww | Penobscot River PENO-1001F pg/g ww | TEF Adjusted pg/g ww | Penobscot River PENO-1002F pg/g ww | TEF Adjusted pg/g ww |
|---|---|---|---|---|---|---|---|
| **Dioxins** | | | | | | | |
| 2,3,7,8-TCDD | 1 | < 0.940 | BDL | < 0.950 | BDL | < 0.990 | BDL |
| 1,2,3,7,8-PeCDD | 1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,4,7,8-HxCDD | 0.5 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,6,7,8-HxCDD | 0.01 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,7,8,9-HxCDD | 0.01 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,4,6,7,8-HpCDD | 0.001 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| OCDD | 0.0001 | < 9.45 | BDL | < 9.49 | BDL | < 9.87 | BDL |
| **Furans** | | | | | | | |
| 2,3,7,8-TCDF | 0.05 | < 0.940 | BDL | < 0.950 | BDL | < 0.990 | BDL |
| 1,2,3,7,8-PeCDF | 0.05 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 2,3,4,7,8-PeCDF | 0.5 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,4,7,8-HxCDF | 0.1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,6,7,8-HxCDF | 0.1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,7,8,9-HxCDF | 0.1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 2,3,4,6,7,8-HxCDF | 0.1 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | < 4.72 | BDL | < 4.74 | BDL | < 4.94 | BDL |
| OCDF | 0.0001 | < 9.45 | BDL | < 9.49 | BDL | < 9.87 | BDL |
| **Non-ortho PCBs** | | | | | | | |
| PCB# 77 | 0.0001 | 31.20 | 0.00312 | 11.10 | 0.00111 | 11.70 | 0.00117 |
| PCB# 81 | 0.0005 | < 0.190 | BDL | < 0.190 | BDL | 4.50 | 0.00225 |
| PCB# 126 | 0.005 | < 0.190 | BDL | 5.90 | 0.0295 | 2.20 | 0.011 |
| PCB# 169 | 0.00005 | < 0.190 | BDL | < 0.190 | BDL | < 0.200 | BDL |
| **Mono-ortho PCBs** | | | | | | | |
| PCB# 105 | 0.000005 | 478.00 | 0.00239 | 244.00 | 0.00122 | 234.00 | 0.00117 |
| PCB# 114 | 0.000005 | 33.70 | 0.0001685 | 15.70 | 0.0000785 | 15.80 | 0.000079 |
| PCB# 118 | 0.000005 | 1370.00 | 0.00685 | 686.00 | 0.00343 | 647.00 | 0.003235 |
| PCB# 123 | 0.000005 | < 0.190 | BDL | < 0.190 | BDL | < 0.200 | BDL |
| PCB# 156 | 0.000005 | 97.90 | 0.0004895 | 49.70 | 0.0002485 | 50.40 | 0.000252 |
| PCB# 157 | 0.000005 | 36.70 | 0.0001835 | 13.10 | 0.0000655 | 19.30 | 0.0000965 |
| PCB# 167 | 0.000005 | 60.80 | 0.000304 | 34.10 | 0.0001705 | 30.40 | 0.000152 |
| PCB# 189 | 0.000005 | 9.20 | 0.000046 | 6.50 | 0.0000325 | 5.90 | 0.0000295 |
| **TCDD-TEQ (PCDD/Fs + planar PCBs)** | | | **0.01** | | **0.04** | | **0.02** |

[a] TEFs for fish from Van den Berg *et al.* (1998). Values in red preceded by < symbol indicate non-detects and detection limits.

**Table C-3 (continued).** TCDD-TEQ calculations in salmon fillets using 1998 TEFs for fish, pg/g wet weight

| | TEF [a] | Penobscot River PENO-1003F pg/g ww | TEF Adjusted pg/g ww |
|---|---|---|---|
| **Dioxins** | | | |
| 2,3,7,8-TCDD | 1 | < 0.990 | BDL |
| 1,2,3,7,8-PeCDD | 1 | < 4.97 | BDL |
| 1,2,3,4,7,8-HxCDD | 0.5 | < 4.97 | BDL |
| 1,2,3,6,7,8-HxCDD | 0.01 | < 4.97 | BDL |
| 1,2,3,7,8,9-HxCDD | 0.01 | < 4.97 | BDL |
| 1,2,3,4,6,7,8-HpCDD | 0.001 | < 4.97 | BDL |
| OCDD | 0.0001 | < 9.93 | BDL |
| **Furans** | | | |
| 2,3,7,8-TCDF | 0.05 | < 0.990 | BDL |
| 1,2,3,7,8-PeCDF | 0.05 | < 4.97 | BDL |
| 2,3,4,7,8-PeCDF | 0.5 | < 4.97 | BDL |
| 1,2,3,4,7,8-HxCDF | 0.1 | < 4.97 | BDL |
| 1,2,3,6,7,8-HxCDF | 0.1 | < 4.97 | BDL |
| 1,2,3,7,8,9-HxCDF | 0.1 | < 4.97 | BDL |
| 2,3,4,6,7,8-HxCDF | 0.1 | < 4.97 | BDL |
| 1,2,3,4,6,7,8-HpCDF | 0.01 | < 4.97 | BDL |
| 1,2,3,4,7,8,9-HpCDF | 0.01 | < 4.97 | BDL |
| OCDF | 0.0001 | < 9.93 | BDL |
| **Non-ortho PCBs** | | | |
| PCB# 77 | 0.0001 | 12.10 | 0.00121 |
| PCB# 81 | 0.0005 | < 0.200 | BDL |
| PCB# 126 | 0.005 | < 0.200 | BDL |
| PCB# 169 | 0.00005 | < 0.200 | BDL |
| **Mono-ortho PCBs** | | | |
| PCB# 105 | 0.000005 | 203.00 | 0.001015 |
| PCB# 114 | 0.000005 | 13.40 | 0.000067 |
| PCB# 118 | 0.000005 | 680.00 | 0.0034 |
| PCB# 123 | 0.000005 | < 0.200 | BDL |
| PCB# 156 | 0.000005 | 47.50 | 0.0002375 |
| PCB# 157 | 0.000005 | 16.50 | 0.0000825 |
| PCB# 167 | 0.000005 | 25.20 | 0.000126 |
| PCB# 189 | 0.000005 | < 0.200 | BDL |
| **TCDD-TEQ (PCDD/Fs + planar PCBs)** | | | **0.01** |

[a] TEFs for fish from Van den Berg *et al.* (1998). Values in red preceded by < symbol indicate non-detects and detection limits.