Temporal and spatial trends of polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans in digestive glands of American lobster (*Homarus americanus*) from the Miramichi estuary (New Brunswick, Canada)

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TEMPORAL AND SPATIAL TRENDS OF POLYCHLORINATED DIBENZO-*p*-DIOXINS AND POLYCHLORINATED DIBENZOFURANS IN DIGESTIVE GLANDS OF AMERICAN LOBSTER (*Homarus americanus*) FROM THE MIRAMICHI ESTUARY (NEW BRUNSWICK, CANADA)

by

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ABSTRACT

The Miramichi estuary located in the southwestern Gulf of St. Lawrence, Canada, supports valuable commercial and recreational fisheries, including the American lobster (*Homarus americanus*) fishery. Past industrial activity including pulp and paper mills and wood preservation operations were sources of polychlorinated dibenzo-*p*-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) in the Miramichi estuary. This report presents results from four studies carried out in the past thirty years (1983, 1989-90, 1993-95 and 2011). Data from the first two studies have been published and those of the latter two are presented here for the first time. Concentrations of PCDD and PCDF congeners in digestive gland of lobsters from the Miramichi have declined approximately five fold between 1983 and 2011, as have the related Toxic Equivalents (TEQs). Similar declines over time in PCDD and PCDF concentrations in crabs have been observed on Canada's west coast.

RESUME

L'estuaire de la Miramichi est situé dans le sud-ouest du golfe du Saint-Laurent, Canada, et soutient les pêches commerciales et récréatives, y compris celle du homard (*Homarus americanus*). Les activités industrielles du passé, y compris les usines de pâtes et papiers et les opérations de préservation du bois étaient sources de polychlorodibenzo-*p*-dioxines (PCDD) et de polychlorodibenzo-furanes (PCDF) dans l'estuaire de la Miramichi. Ce rapport présente les résultats de quatre études au cours des trente dernières années (1983, 1989-90, 1993-95 et 2011). Les données des deux premières études ont été publiées dans des rapports et celles des deux dernières études sont présentées ici pour la première fois. Les concentrations des congénères PCDD et PCDF dans les glandes digestives de homards récoltés dans la Miramichi ont diminués d'un facteur d'environ cinq entre 1983 et 2011, tout comme les Facteur d'équivalence toxique (FETs) connexes. Des baisses similaires au fil du temps dans les concentrations des PCDD et PCDF dans les crabes ont été observées sur la côte ouest du Canada.

PREFACE

This data report has been prepared to compile, compare and make available in one source in a concise and non-exhaustive fashion the results from four studies in the past thirty years (1983, 1989-90, 1993-95 & 2011) which focused on determining the concentrations of polychlorinated dibenzo-*p*-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) in digestive glands (i.e. hepatopancreas) of American lobsters (*Homarus americanus*) collected from sites within the Miramichi estuary.

The lead participants of these studies were the Miramichi River Environmental Assessment Committee (MREAC), Environment Canada (EC) and Fisheries and Oceans Canada (DFO).

No further interpretation or publication of these results is planned and so they are available for use in other more integrative ecological or toxicological studies.

INTRODUCTION

The Miramichi estuary located in the southwestern Gulf of St. Lawrence, Canada, supports valuable commercial and recreational fisheries. The commercial fishery of the American lobster (*Homarus americanus*) in Miramichi estuary is an important contributor to the economic activity in that area (Chiasson 1995).

Past industrial activity in the Miramichi (i.e. pulp and paper mills and wood preservation operations) were prevalent sources of polychlorinated dibenzo-*p*-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) (MREAC 1992, 2007). PCDDs and PCDFs are highly toxic, hydrophobic, and persistent compounds with a strong affinity for organic particles (i.e. as in some aquatic sediment) and a high potential for accumulating in biological tissues and magnifying up food chains (Duncan 1998; Van den Berg *et al*. 2006).

In 1983 a study was conducted to assess the PCDD and PCDF concentrations in the digestive gland tissue (i.e. hepatopancreas) of lobsters collected from the Miramichi estuary (Clement *et al*. 1987). That was followed by a study conducted by the Miramichi River Environmental Assessment Committee (MREAC) in 1989 and 1990 (MREAC 1992). A third and more extensive study was conducted between 1993 and 1995 by Fisheries and Oceans Canada (DFO) under the Green Plan Toxic Chemicals Program (J.T.M. Arsenault, pers. comm.). The forth and most recent study was conducted in 2011. This latter study was a joint study between DFO, MREAC and Environment Canada (EC) as a follow-up of previous studies.

Results from the four studies carried out between 1983 and 2011 are presented here and provide a temporal trend of the overall concentration of PCDDs and PCDFs in the digestive gland of lobsters from the Miramichi estuary across a time span of almost 3 decades.

MATERIALS AND METHODS

SAMPLE COLLECTION, PREPARATION AND STORAGE

In all studies, commercial size adult lobsters were collected with lobster traps and stored in coolers at the sampling sites. They were brought to the laboratory alive, where they were measured (carapace length in mm) and the molt stage and sex were determined. Commercial size lobster have a carapace length (CL) equal or above the minimal legal size that increased from 63.5 mm to 71.0 mm between 1983 and 2011 and can be legally retained and sold for human consumption. Digestive glands were then removed and placed in glass jars and stored at -20°C until analysis. In general, each sample comprised of a pool of digestive glands from 10 males per site. Glassware, storage material and dissecting tools used in the handling of lobster digestive glands were pre-washed with pesticide grade organic solvents.

SAMPLING DESIGN

1983 study (Clement et al. 1987)

Results were reported for one inner-estuary site, located in an area suspected of pentachlorophenol contamination. Within the Miramichi estuary, samples were

comprised of 2 replicates, each composed of digestive glands from two lobsters from four locations (total of 8 per replicate).

1989-90 MREAC study

Lobster samples were collected from 2 sites located in the inner estuary (Fig. 1).

1993-95 DFO study

Lobster samples were collected from 5 sites distributed along a transect extending from the middle of the inner estuary to the entrance of the barrier islands and from one site outside the barrier islands (Fig. 1). A total of 10 commercial size male lobsters (>66.6 mm CL) were collected per site. Digestive gland tissue was removed from each of the 10 lobsters per site and pooled together for analyses, for a total of 6 pools of 10 digestive glands each.

2011 MREAC-DFO-EC study

Lobster samples were collected from 5 sites distributed along a transect extending from east of Sheldrake Island to the entrance of the barrier islands and from one site located outside the barrier islands offshore of Neguac Beach (Fig. 2). A total of 10 commercial size male lobsters (>70.9 mm CL) were collected per site. Digestive gland tissue was removed from each of the 10 lobsters per site and pooled together for analyses, for a total of 6 pools of 10 digestive glands each.

LABORATORY ANALYSES

The analytical protocols were not the same in all studies. Detection levels were not as low and many congeners were not able to be quantified with accuracy. AXYS Analytical Services Ltd., Sidney, BC, Canada conducted the analyses for all the studies in this report except for the Clement *et al*. 1987 study.

1983 study (Clement et al. 1987)

The samples were analyzed by gas chromatography-mass spectrometry (GC-MS) operated in the selected ion monitoring (SIM) mode. Quantification was by comparison of area of response of sample peaks with external standards representative of each congener group and concentrations were expressed in picograms per gram (ppt, parts per trillion) wet weight (Clement *et al*. 1987).

1989-90 MREAC and 1993-95 DFO studies

The analytical method used was the AXYS METHOD #: DX-T-03/Ver.1. High resolution analyses of PCDD and PCDF were carried out on a VG 70SE mass spectrometer equipped with a Hewlett Packard 5890 GC, a 60 m DB-5 chromatography column (0.25 mm i.d. x 0.1 J.UIl film thickness) and a CTC auto sampler. Data were acquired in the Multiple Ion Detection (MID) mode to enhance sensitivity. Two ions were monitored for each group of isomers. Two ions were used to monitor each of the ^{13}C labelled surrogate standards, and five additional ions were monitored to check for

interference from chlorinated diphenyl ethers. Congener concentrations were expressed in picograms per gram (ppt) wet weight.

2011 MREAC-EC-DFO study

The analytical method used was the USEPA 1613B method for Chlorinated Dioxins and Furans (AXYS Method = MLA-017), (Instrument Type = High Resolution GC/MS). Congener concentrations were expressed in picograms per gram (ppt) wet weight.

CALCULATION OF TOXIC EQUIVALENTS (TEQs)

Calculation of Toxic Equivalents (TEQs) and Toxic Equivalency Factors (TEFs) for dioxins and dioxin-like compounds was based on Van den Berg *et al*. (2006).

RESULTS

Direct cross comparison of the results obtained for each study was somewhat difficult due to the differences in their sampling designs (i.e. site locations, number of samples collected per site, male or female lobsters and molt stage, number of digestive glands per pool, differing percent lipid, etc.). Results from the two most recent studies (i.e. 1993-95 and 2011) could easily be compared because of the many similarities with their sampling design and analytical methods. Notwithstanding the many difference between the studies, it is clear that the general trend of PCDD and PCDF congener wet weight concentrations in the digestive gland samples of lobster collected from the Miramichi estuary has, in general, declined approximately five fold between 1983 and 2011 (Fig 3). The calculated TEQs for Dioxins and Dioxin-Like Compounds generally followed the ranking of the TCDD concentrations and had declined approximately eight fold in the past twenty years (Fig. 4).

1989-90 MREAC study

Results of this study provided an indication of the distribution of PCDDs and PCDFs in lobsters from the Miramichi estuary. It was found that there were measurable concentrations of PCDDs and PCDFs within the digestive gland tissue of the lobster, but Health and Welfare Canada determined that it was not to a high enough level to require a health advisory warning.

1993-95 DFO study

The five highest concentrations measured (5.8-12 pg/g wet-weight) were all from samples within the barrier islands of the estuary (i.e. Portage Island and Fox Island). Four samples from 1995 show a clear spatial gradient, with TCDD concentration declining out into the estuary (Fig. 5). For all sites the calculated TEQ generally followed the ranking of the TCDD concentrations (J.T.M. Arsenault, pers. comm.).

The profiles of 2,3,7,8 substituted PCDDs and PCDFs of the inner Miramichi estuary are characterized by prominent 2,3,7,8 -tetra congener signals relative to other congeners. The full spectrums of 2,3,7,8 substituted congeners are generally present in the inner estuary.

2011 MREAC-EC-DFO study

In general, the PCDD and PCDF congener concentrations determined for the 2011 study were approximately 2-4 fold lower than those measured in the DFO 1993-95 study (Fig. 5). The 2011 results also showed a progressive gradient decline of the congener concentrations out into the estuary (Fig. 5 and 6).

DISCUSSION

These studies show that concentrations of individual PCDDs and PCDFs in digestive gland of lobsters from the Miramichi have progressively declined over time, as have the related TEQ values. This follows the improvements in industrial processes over the years and the gradual closures in the mid-1990's and onward of the primary industrial sources of PCDD and PCDF discharge in the estuary (MREAC/ACAP 2007). Decline in TEQs may be slightly more than indicated from earlier literature due to the change in calculation method for TEQs accepted in 2005 by the World Health Organization (Van den berg *et al*. 2006). Regardless of any calculation change, there is still a major decline in TEQ indicated by these results, which is in keeping with findings in the DFO summary report "Clear Progress" (Duncan 1998), on the National Dioxin Sampling Program 1989-1994. Similar declines in PCDD and PCDF concentrations in crabs have been observed on Canada's west coast (BC MOE 2007).

ACKNOWLEDGMENTS

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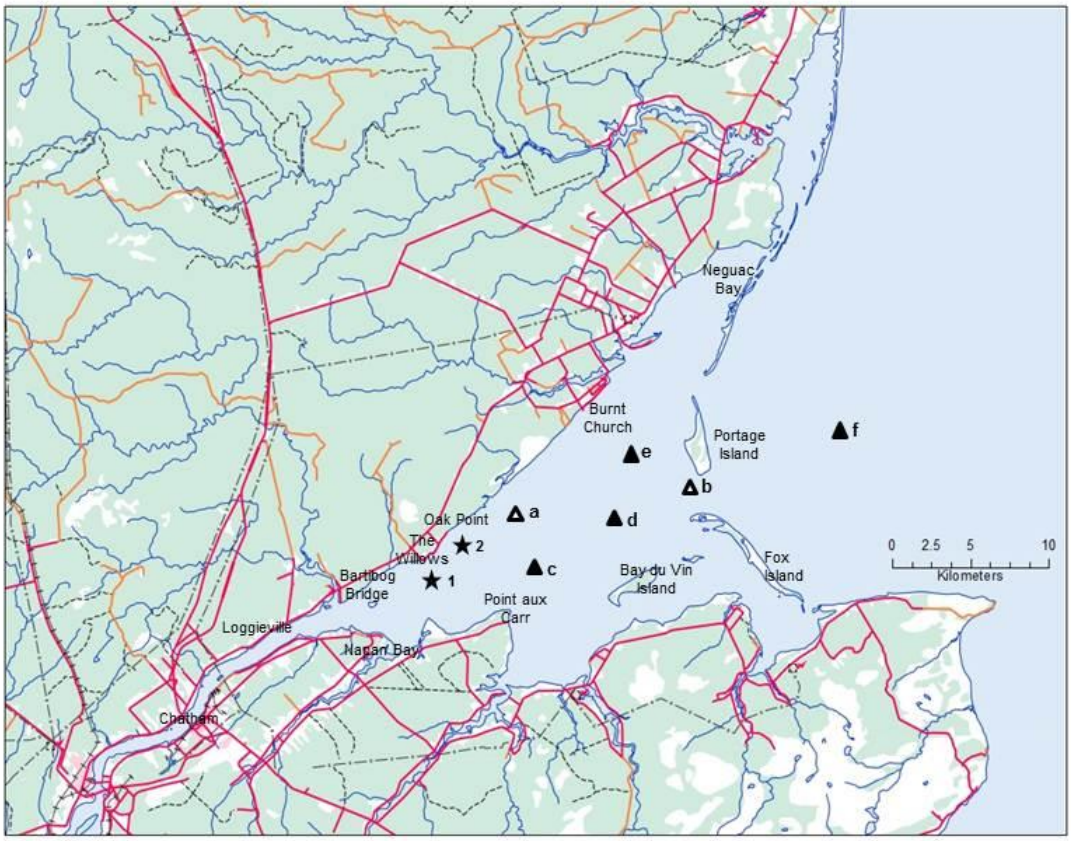

Figure 1: Approximate locations of the lobster sampling sites within the Miramichi estuary for the Miramichi River Environmental Assessment Committee 1989-90 study (★1-2) and for the Fisheries and Oceans Canada 1993 (△ a-b) and 1995 (▲c-f) study. The symbols (★1) and (▲c) represent the inner-most sampling site in the estuary for both studies.

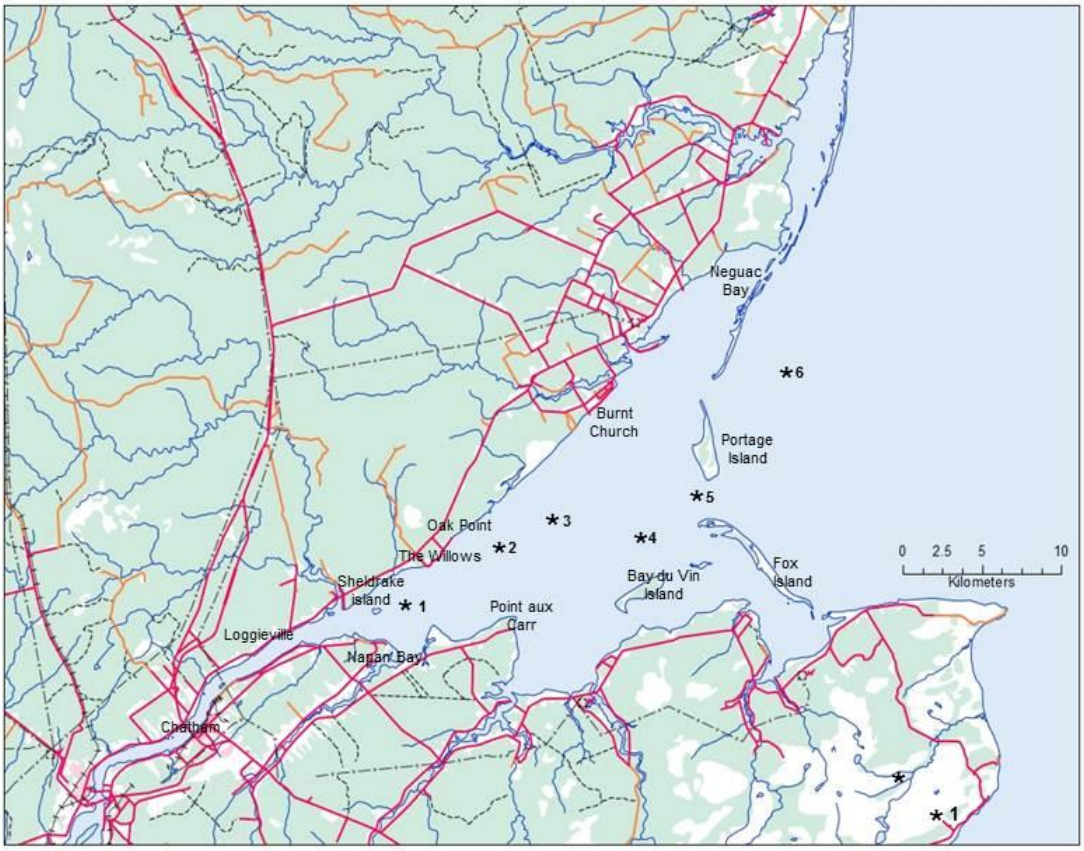

Figure 2: Approximate locations of the lobster sampling sites (*) within the Miramichi estuary for the 2011 Miramichi River Environmental Assessment Committee - Environment Canada - Fisheries and Oceans study. The symbol *1 represents the inner-most sampling site in the estuary for this study.

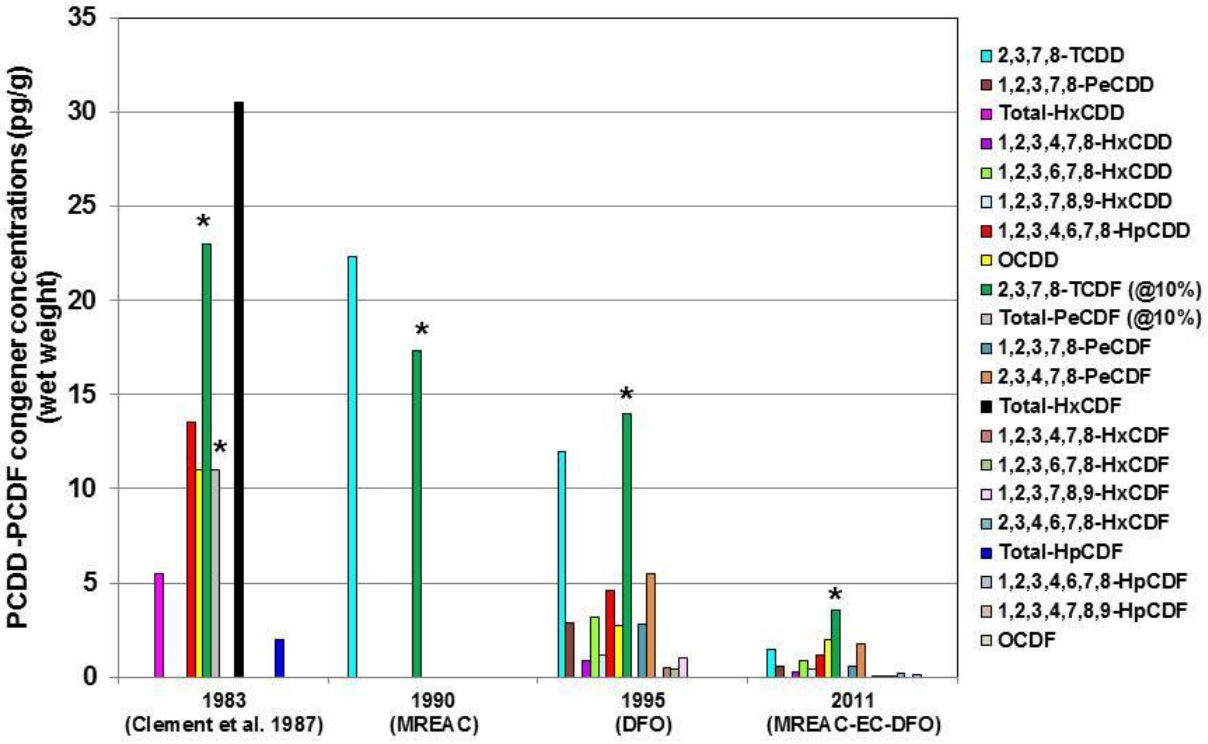

Figure 3: Polychlorinated dibenzo-p-dioxins (PCDD) – polychlorinated-dibenzo furans (PCDF) congener concentration profiles from the digestive gland samples of lobsters collected from the inner-most site in the estuary of each study between 1983-2011. Note 1: Concentration values expressed at 10% of their actual value are demarked by the symbol (*). Note 2: The 1983 congener concentration profile depicts the profile of the mean replicate values for that study.

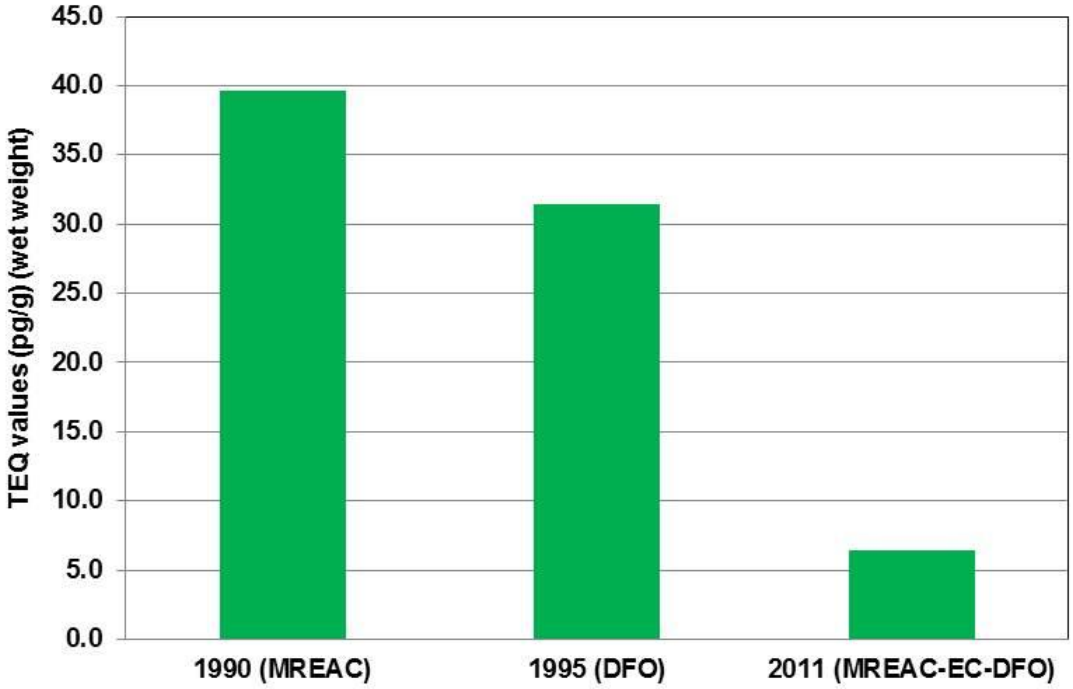

Figure 4. Toxic Equivalent (TEQ) values for the digestive gland samples of lobsters collected from the inner-most site in the estuary of each study between 1983-2011.

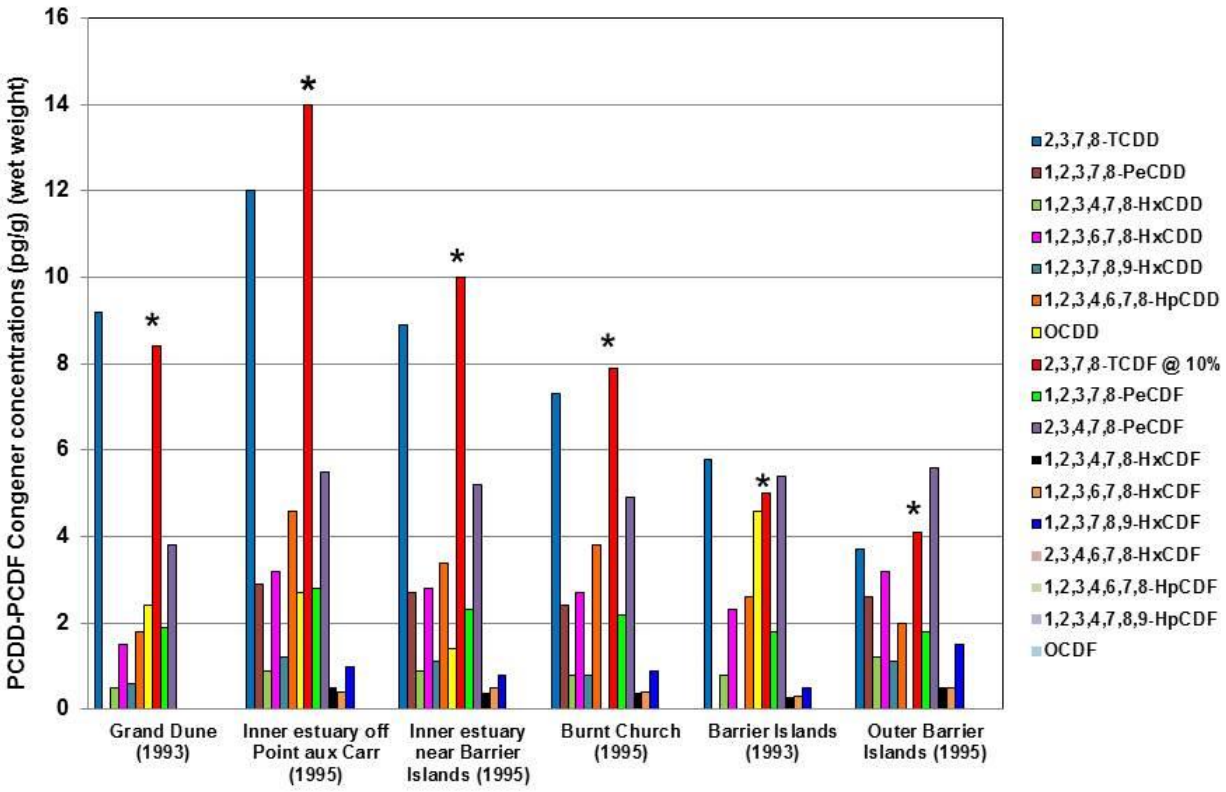

Figure 5: Polychlorinated dibenzo-*p*-dioxins (PCDD) – polychlorinated-dibenzo furans (PCDF) congener concentration profiles from the digestive gland samples of lobsters collected from five inner-Miramichi estuary sites and from one site located outside the barrier islands for the 1993-95 Fisheries and Oceans Canada study. The symbol (*) represents concentration values expressed at 10% of their actual value.

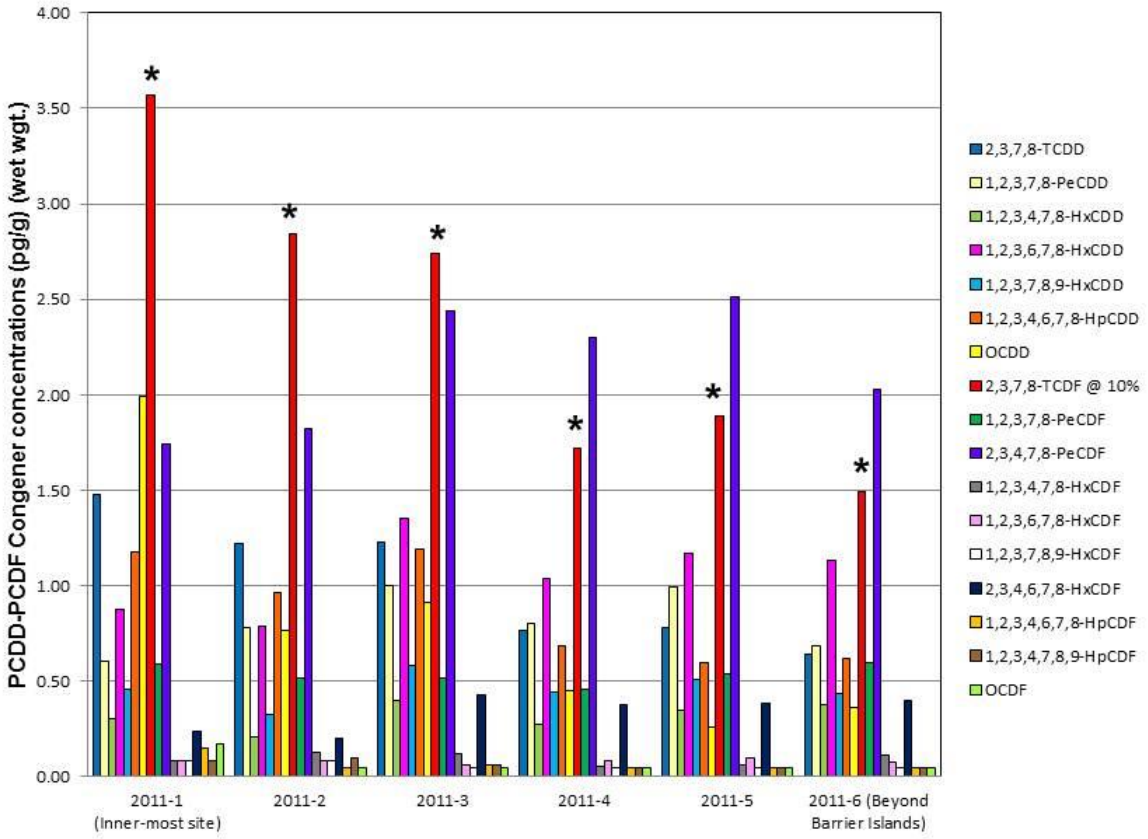

Figure 6: Polychlorinated dibenzo-*p*-dioxins (PCDD) – polychlorinated-dibenzo furans (PCDF) congener concentration profiles from the digestive gland samples of lobsters collected from five inner-Miramichi estuary sites and from one site located outside the barrier islands for the 2011 Miramichi River Environmental Assessment Committee - Environment Canada - Fisheries and Oceans study. The symbol (*) represents concentration values expressed at 10% of their actual value.

Appendix 1: Polychlorinated dibenzo-*p*-dioxins (PCDD) – polychlorinated dibenzofurans (PCDF) congener concentrations (pg/g) (wet weight) for inner-most site of each study between 1983-2011.

PCDD-PCDF Congeners	**1983** (replicate values)	**1990 MREAC**	**1995 DFO**	**2011 MREAC-DFO-EC**
2,3,7,8-TCDD	ND, ND	22.3	12	1.48
1,2,3,7,8-PeCDD	ND, ND	ND	2.9	0.61
Total-HxCDD	7, 4			
1,2,3,4,7,8-HxCDD		ND	0.9	0.30
1,2,3,6,7,8-HxCDD		ND	3.2	0.88
1,2,3,7,8,9-HxCDD		ND	1.2	0.46
1,2,3,4,6,7,8-HpCDD	26, 1	ND	4.6	1.18
OCDD	11, 1	ND	2.7	1.99
2,3,7,8-TCDF	190, 270	173.5	140	35.70
Total- PeCDF	81, 140			
1,2,3,7,8-PeCDF		ND	2.8	0.59
2,3,4,7,8-PeCDF		ND	5.5	1.74
Total- HxCDF	21, 40			
1,2,3,4,7,8-HxCDF		ND	0.5	0.08
1,2,3,6,7,8-HxCDF		ND	0.4	0.08
1,2,3,7,8,9-HxCDF		ND	1	0.08
2,3,4,6,7,8-HxCDF		ND	ND	0.24
Total-HpCDF	2, 2			
1,2,3,4,6,7,8-HpCDF		ND	ND	0.15
1,2,3,4,7,8,9-HpCDF		ND	ND	ND
OCDF	ND, ND	ND	ND	ND

*ND: Not detected

Appendix 2: Polychlorinated dibenzo-*p*-dioxins (PCDD) – polychlorinated dibenzofurans (PCDF) congener concentrations (pg/g) (wet weight) for the Miramichi River Environmental Assessment Committee 1989-90 study.

PCDD-PCDF Congeners	**MREAC 1989 site concentrations**	**MREAC 1990 site concentrations**
2,3,7,8-TCDD	16.0	22.3
1,2,3,7,8-PeCDD	ND	ND
1,2,3,4,7,8-HxCDD	ND	ND
1,2,3,6,7,8-HxCDD	ND	ND
1,2,3,7,8,9-HxCDD	ND	ND
1,2,3,4,6,7,8-HpCDD	ND	ND
OCDD	ND	ND
2,3,7,8-TCDF	174.0	173.5
1,2,3,7,8-PeCDF	ND	ND
2,3,4,7,8-PeCDF	ND	ND
1,2,3,4,7,8-HxCDF	ND	ND
1,2,3,6,7,8-HxCDF	ND	ND
1,2,3,7,8,9-HxCDF	ND	ND
2,3,4,6,7,8-HxCDF	ND	ND
1,2,3,4,6,7,8-HpCDF	ND	ND
1,2,3,4,7,8,9-HpCDF	ND	ND
OCDF	ND	ND

*ND: Not detected

Appendix 3: Polychlorinated dibenzo-*p*-dioxins (PCDD) – polychlorinated dibenzofurans (PCDF) congener site concentrations (pg/g) (wet weight) for the Fisheries and Oceans Canada 1993-95 study.

PCDD-PCDF Congeners	**1993 Grand Dune**	**1995 Inner estuary (off Point aux Carr)**	**1995 Inner estuary (near Barrier Islands)**	**1995 Burnt Church**	**1993 Barrier Islands**	**1995 Outer Barrier Islands**
2,3,7,8-TCDD	9.2	12	8.9	7.3	5.8	3.7
1,2,3,7,8-PeCDD	ND	2.9	2.7	2.4	ND	2.6
1,2,3,4,7,8-HxCDD	0.5	0.9	0.9	0.8	0.8	1.2
1,2,3,6,7,8-HxCDD	1.5	3.2	2.8	2.7	2.3	3.2
1,2,3,7,8,9-HxCDD	0.6	1.2	1.1	0.8	ND	1.1
1,2,3,4,6,7,8-HpCDD	1.8	4.6	3.4	3.8	2.6	2
OCDD	2.4	2.7	1.4	ND	4.6	ND
2,3,7,8-TCDF	84	140	100	79	50	41
1,2,3,7,8-PeCDF	1.9	2.8	2.3	2.2	1.8	1.8
2,3,4,7,8-PeCDF	3.8	5.5	5.2	4.9	5.4	5.6
1,2,3,4,7,8-HxCDF	ND	0.5	0.4	0.4	0.3	0.5
1,2,3,6,7,8-HxCDF	ND	0.4	0.5	0.4	0.3	0.5
1,2,3,7,8,9-HxCDF	ND	1	0.8	0.9	0.5	1.5
2,3,4,6,7,8-HxCDF	ND	ND	ND	ND	ND	ND
1,2,3,4,6,7,8-HpCDF	ND	ND	ND	ND	ND	ND
1,2,3,4,7,8,9-HpCDF	ND	ND	ND	ND	ND	ND
OCDF	ND	ND	ND	ND	ND	ND

*ND: Not detected

Appendix 4: Polychlorinated dibenzo-*p*-dioxins (PCDD) – polychlorinated dibenzofurans (PCDF) congener site concentrations (pg/g) (wet weight) for the 2011 study.

PCDD-PCDF Congeners	**2011-1**	**2011-2**	**2011-3**	**2011-4**	**2011-5**	**2011-6**
2,3,7,8-TCDD	1.48	1.22	1.23	0.76	0.78	0.64
1,2,3,7,8-PeCDD	0.61	0.78	1.00	0.80	0.99	0.68
1,2,3,4,7,8-HxCDD	0.30	0.21	0.40	0.28	0.35	0.38
1,2,3,6,7,8-HxCDD	0.88	0.79	1.35	1.04	1.17	1.13
1,2,3,7,8,9-HxCDD	0.46	0.32	0.58	0.44	0.51	0.44
1,2,3,4,6,7,8-HpCDD	1.18	0.97	1.19	0.69	0.60	0.62
OCDD	1.99	0.77	0.91	0.45	0.26	0.36
2,3,7,8-TCDF	35.7	28.4	27.4	17.2	18.9	14.9
1,2,3,7,8-PeCDF	0.59	0.52	0.52	0.46	0.54	0.60
2,3,4,7,8-PeCDF	1.74	1.82	2.44	2.30	2.51	2.03
1,2,3,4,7,8-HxCDF	0.08	0.13	0.12	0.05	0.06	0.11
1,2,3,6,7,8-HxCDF	0.08	0.08	0.06	0.08	0.10	0.08
1,2,3,7,8,9-HxCDF	0.08	0.08	0.05	0.05	0.05	0.05
2,3,4,6,7,8-HxCDF	0.24	0.20	0.43	0.38	0.38	0.40
1,2,3,4,6,7,8-HpCDF	0.15	0.05	0.06	0.05	0.05	0.05
1,2,3,4,7,8,9-HpCDF	0.08	0.10	0.06	0.05	0.05	0.05
OCDF	0.17	0.05	0.05	0.05	0.05	0.05
Total Tetra-Dioxins	2.57	3.25	6.27	5.75	7.00	6.01
Total Penta-Dioxins	0.45	1.06	4.20	3.78	1.89	2.43
Total Hexa-Dioxins	1.45	2.80	7.63	3.59	6.31	4.36
Total Hepta-Dioxins	1.18	0.05	1.19	1.44	1.49	1.51

Total Tetra-Furans	52.90	51.10	67.80	41.30	46.20	41.00
Total Penta-Furans	1.96	7.37	12.50	10.90	12.70	9.97
Total Hexa-Furans	0.87	0.08	1.88	1.87	2.19	1.31
Total Hepta-Furans	0.15	0.05	0.06	0.05	0.05	0.05
2,3,7,8-TCDF (C)	34.30	30.10	26.00	15.50	16.80	12.50
TEQ (WHO 2005) ND=0	3.51	5.63	4.81	3.88	4.44	2.57
TEQ (WHO 2005) ND=1/2DL	3.64	5.66	4.86	3.90	4.44	2.61

Appendix 5: Additional descriptive information for the Miramichi estuary sampling sites and pooled lobster digestive gland samples between 1983-2011.

Studies across time	**Approximate geographic location of each sampling site across time**	**Sampling date**	**Number of individuals per sample pool**	**Sex**	**Molt stage**	**% Lipid**
Clement *et al.* 1987.	• **Within the estuary** • Latitude: N/A* • Longitude: N/A	08 May 1983	8	N/A	N/A	N/A
MREAC (1989-90) **Site 1** (Fig.1)	• **Midway between White's Brook and Dredged Channel** • Latitude: N/A • Longitude: N/A	1989	N/A	N/A	N/A	N/A
MREAC (1989-90) **Site 2** (Fig.1)	• **Midway between White's Brook and Cheval Point** • Latitude: N/A • Longitude: N/A	1990	N/A	N/A	N/A	18.2
DFO (1993 & 1995) **Site a** (Fig.1)	• **Grand Dune** • Latitude: 47.14 • Longitude: -65.21	01 June 1993	6	F	C2	30.1
DFO (1993 & 1995) **Site b** (Fig.1)	• **Barrier Islands** • Latitude: 47.15 • Longitude: -65.04	15 July 1993	5	F	C2	35.3

DFO (1993 & 1995) **Site c** (Fig.1)	• **Robichaud Buoy** • Latitude: 47.11 • Longitude: -65.18	23 MAY 1995	10	M	C4	N/A
DFO (1993 & 1995) **Site d** (Fig.1)	• **Inner Bay towards Barrier Islands** • Latitude: 47.13 • Longitude: -65.09	23 MAY 1995	10	M	C4	N/A
DFO (1993 & 1995) **Site e** (Fig.1)	• **Burnt Church** • Latitude: 47.17 • Longitude: -65.08	25 MAY 1995	10	M	C4	N/A
DFO (1993 & 1995) **Site f** (Fig.1)	• **Outer Barrier Islands** • Latitude: 47.16 • Longitude: -64.93	25 MAY 1995	10	M	C4	N/A
MREAC-EC-DFO (2011) **Site 1** (Fig.2)	• **East of Sheldrake Island** • Latitude: 47.09 • Longitude: -65.29	20 SEP 2011	1	M	N/A	6.16
MREAC-EC DFO (2011) **Site 2** (Fig.2)	• **South of Grand Dune Inlet** • Latitude: 47.12 • Longitude: -65.23	20 SEP 2011	10	M	N/A	10.3
MREAC-EC-DFO (2011) **Site 3** (Fig.2)	• **South of Peat Harvesting Operation** • Latitude: 47.13 • Longitude: -65.18	20 SEP 2011	10	M	N/A	12.8

MREAC-EC-DFO (2011) **Site 4** (Fig.2)	• **North of Bay du Vin Island** • Latitude: 47.12 • Longitude: -65.09	20 SEP 2011	10	M	N/A	16.4
MREAC-EC-DFO (2011) **Site 5** (Fig.2)	• **Near Ship Channel** • Latitude: 47.14 • Longitude: -65.05	20 SEP 2011	10	M	N/A	17.9
MREAC-EC-DFO (2011) **Site 6** (Fig.2)	• **Offshore of Neguac Beach** • Latitude: 47.21 • Longitude: -64.98	20 SEP 2011	10	M	N/A	13.5

*N/A: Not available