Final Report: BUI Delisting Studies in the Niagara River AOC, 2014-2015

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Executive Summary

1. From 8 December 2013 to 6 April 2015, 24 mink were caught in the Niagara River AOC, 12 upriver and 12 downriver from Niagara Falls.
2. Average concentrations of total mercury in mink brain and PAH REP in mink liver were 22 and 201 times lower, respectively, than their LOAELs for deformities or reproductive impairment.
3. The average concentration of total PCB in mink liver was 1.15 times higher than the LOAEL for deformities or reproductive impairment, but two mink (one caught upriver and one downriver from Niagara Falls) had very high concentrations of both total PCB and total TEQ (mostly comprised of PCB TEQ).
4. Average concentrations of PCB TEQ and CDD/CDF TEQ in mink liver were 2.9 times higher and 2.9 times lower, respectively, than their LOAELs for deformities or reproductive impairment.
5. The average concentration of total TEQ (sum of PCB, CDD/CDF and PAH) in mink liver was 3.3 times higher than the LOAEL for deformities or reproductive impairment.
6. Mink are one of the most sensitive mammals to CDD/CDF and co-planar PCB congeners, and 67% of the mink trapped in the NR AOC exceeded one or both of the published LOAELs for deformities or reproductive impairment for total PCB and total TEQ. Yet mink are reasonably abundant in suitable habitats in the AOC; thus they are either reproducing there or migrating in from adjacent areas with lower contaminant exposures.
7. The most sensitive biomarker of mink health after exposure to total PCB or total TEQ is the presence of pre-cancerous tissues associated with the jawbone. Of the nine mink with the highest total PCB or total TEQ concentrations, two (22%) had the mildest form and one (11%) had the most severe form of this condition. All of the affected mink were captured in the lower river below Niagara Falls.
8. For the "*Bird or Animal Deformities or Reproductive Problems*" BUI, in terms of mink health in the NR AOC, it appears that the time for delisting is not yet at hand.

Introduction

The Niagara River Area of Concern (NR AOC) is a bi-national AOC, which the Canadian government manages on its side of the river. This project addressed only the U.S. portion of the AOC, which extends along 37 miles of the Niagara River from the mouth of Smokes Creek on Lake Erie to the mouth of the river at Fort Niagara on Lake Ontario, and also includes a portion of the Buffalo Outer Harbor Area, Grand Island, and the Tonawanda channel (Figure 1). NYS DEC Region 9 recommended that sampling occur only along the U.S. shore of the Niagara River, including in the vicinities of the mouths of Gill Creek, Two Mile Creek, Scajaquada Creek, and the Little Rivers around Tonawanda and Cayuga Islands.

Mink feeding ranges vary according to habitat, prey availability, and population levels (Birks and Linn 1982; Yamaguchi and Macdonald, 2003). For the purposes of this study, an "AOC mink" was defined as any mink collected within 3 miles of the mapped AOC. This replicated the distance used to define "lakeshore mink" in a study of mink exposed to the waters and food webs of Lake St. Clair and Lake Erie (Martin *et al*. 2006).

The contaminants of concern listed for the beneficial use impairment (BUI) "*Bird or Animal Deformities or Reproductive Problems*" for the NR AOC (Table 1) are polychlorinated biphenyls (PCB), dioxin (CDD) and the pesticides benzene hexachloride (BHC/lindane), dieldrin, chlordane, hexachlorobenzene (HCB), dichlorodiphenyltrichloroethane (DDT), and dichlorodiphenyldichloroethylene (DDE) and its metabolites (NYSDEC 1994; Ecology & Environment 2016). To maintain consistency with concurrent studies in the Rochester Embayment of Lake Ontario AOC (RE AOC: Haynes and Wellman 2015) and the Buffalo River AOC (BR AOC: Haynes and Wellman 2016), the project management team from the DEC and SUNY Brockport decided to study PCB, PAH (polycyclic aromatic hydrocarbons), CDD/CDF (chlorinated dibenzo-dioxins and dibenzo-furans) and total mercury (Hg) in the NR AOC. We aligned the three BUI delisting studies because:

1. The mink (*Neovison vison*) is one of the most sensitive mammals to dioxin-like chemicals but organochlorine pesticides have not been considered to be a hazard to Great Lakes mink populations since the 1970s (Giesey *et al*. 1994; Bursian *et al*. 2006a). Accordingly, the pesticides listed in Table 1 are unlikely to cause "*Bird or Animal Deformities or Reproductive Problems*," in mink, while chemicals not listed in Table 1 (e.g., Hg, CDF, PAH) may cause these problems.
2. Haynes *et al*. (2007) reported concentrations of total Hg, total PCB and CDD/CDF congeners for mink in and out of the RE AOC, on the Lake Ontario shore and inland in western New York. Haynes and Wellman (2015, 2016) reported concentrations for the same BUI contaminants, plus PCB and PAH congeners, in mink prey from the RE and BR AOCs. Because these chemicals were likely to be the important hazards with regard to "*Bird or Animal Deformities or Reproductive Problems*" in the NR AOC, focusing on the same chemicals in mink there allowed us to compare results from the NR AOC to mink in the nearby "Western Lake Ontario region."

Research questions

1. Are concentrations of PCB, CDD/CDF, PAH and total mercury measured in the tissue of mink trapped in the NR AOC below those associated with mink deformities or reproductive failure?
2. Is there a significant difference in concentrations of BUI contaminants in liver and brain from NR AOC mink compared to the same tissues from mink collected in the nearby "Western Lake Ontario region" in 2007?

Methods

Capturing and processing mink

Two experienced trappers helped capture mink in the NR AOC. Mr. Stephen Sliwinski did all trapping in the portion of the AOC above Niagara Falls from 8 December 2013 to 6 April 2015, centering his efforts around Two Mile Creek (Figure 2). Mr. Randall Baase identified likely mink habitat along the portion of the NR AOC below Niagara Falls, and showed co-author Marsocci how and in which microhabitats to set traps. Two areas along the lower Niagara River had good mink habitat: Stella Niagara (Figure 3) and Fort Niagara (Figure 4), and trapping occurred at these sites from 6 September to 30 October 2014.

Captured mink were placed on ice in labeled bags in the field. Upon return to the laboratory at the College at Brockport, each mink was processed as follows:

1. Measured (mm) and weighed (g).
2. Examined for external and internal DELTs (deformities, erosions, lesions, tumors), sex and uterine placental scars as indicators of implantation (none could be seen).
3. Excised the liver with hexane-rinsed tools and froze it in a labeled, hexane-rinsed glass jar.
4. Excised 10 g of hind leg muscle with hexane-rinsed tools and froze it in a labeled, hexane-rinsed glass vial.
5. Removed the head with a bone saw.
6. Removed the brain with hexane-rinsed tools and froze it in a labeled, hexane-rinsed glass jar.
7. Put the head in a labeled glass jar with 10% buffered formalin (9:1 liquid: head ratio).
8. Froze the remaining carcass in a labeled zip lock bag.
9. Entered all data with sample code numbers into laboratory spreadsheets as they were determined then saved the data on two data storage devices and in the cloud at the end of each processing session.

After processing, mink tissues were shipped for analysis as follows:

1. Liver and brain were sent with dry ice to ALS Environmental (formerly Columbia Analytical Services) in Kelso, WA for analysis of PCB, PAH and CDD/CDF congeners (liver), and total mercury (brain).

2. Muscle was sent with dry ice to the Cornell Stable Isotope Laboratory in Ithaca, NY for δN (trophic level) analysis.
3. Heads were transferred to Michigan State University in Lansing, MI for extraction of two premolars and jaw lesion analysis (the most sensitive biomarker of effect for PCB and CDD/CDF in mink).
4. Extracted teeth were sent from Michigan State to Matson's Laboratory in Milltown, MT for aging of mink.

Frozen mink tissue samples received by ALS Global Environmental were homogenized and analyzed as follows:

1. Total mercury (brain): USEPA Method 1631app; ALS-Kelso.
2. PAH congeners (liver): USEPA Method 8270D; ALS-Kelso.
3. CDD/CDF congeners (liver): USEPA Method1613B; ALS-Houston, TX.
4. Total PCB and PCB congeners (liver): USEPA Method 1668A; Pace Analytical Services-Minneapolis, MN.

Stable isotope analysis to determine mink prey trophic levels

Stable isotopes of nitrogen are used to evaluate trophic webs of ecosystems to give lifetime, integrated estimates of trophic level for organisms (DeNiro and Epstein 1978; Cabana and Rasmussen 1994). ^{14}N has a stable, heavier isotope (^{15}N) which occurs naturally, and the heavier and lighter isotopes are differentially absorbed and metabolized by organisms (Fry 1991). Usually the lighter isotope is excreted preferentially, leading to a relative enrichment of the heavier isotope in organisms relative to their environment or diet. This enrichment is measurable through mass spectrometry, and is reported in parts per thousand (δ‰) relative to a standard: $\delta X = [(R_{sample} - R_{standard}) / (R_{standard})] \times 10^3$, where X is ^{15}N and R is the corresponding ratio of $^{15}N/^{14}N$. The standard for nitrogen is atmospheric nitrogen (Fry 1991).

Selective excretion of ^{14}N over ^{15}N by animals results in an increase of approximately 3.4‰ in the $\delta^{15}N$ at each trophic level; thus, ^{15}N analysis can determine the average trophic level at which an animal feeds (Peterson and Fry 1987; Cabana and Rasmussen 1994). Frozen samples of muscle tissue from mink limbs (10 g) were analyzed by the Cornell Stable Isotope Laboratory (COIL) in Ithaca, NY for isotopic ratios of $^{15}N/^{14}N$ (δN) to determine the trophic level of individual mink collected in the NR AOC.

Hazards to mink reproduction

The LOAEL for total mercury was derived from Dansereau (1999), who reported concentrations of Hg in diet and liver, but not in brain. We used an average diet-to-brain Hg biomagnification factor of 3.7, derived from three other studies (see Haynes *et al.* 2007 for details), to convert Dansereau's LOAEL of 500 ng/g Hg in diet to 21,600 ng/g Hg in mink brain.

The most sensitive biomarker of effect known in mink is a precancerous squamous cell proliferation in mandibles or maxillae (reviewed in Haynes *et al.* 2009). Because the resulting lesion can lead to tooth loss, and thus impair feeding ability, it is considered not only a deformity but a survival issue (Bursian *et al.* 2006b). In a study of reproductive effects of PCB and CCD/CDF, jaw lesions were reported in 31-week-old mink kits fed as little as 9.2 pg/g TEQ (dietary wet weight) after their mothers were fed the same diet from before breeding through weaning (Bursian *et al.* 2006b). The mean concentrations (LOAELs) of total PCB and total TEQ in the livers of affected kits were 1,698 ng/g and 40.2 pg/g, respectively (Bursian *et al.* 2006b).

Concentrations of total Hg, total PCB and total TEQ (PAH+CDD/CDF+co-planar PCB TEQs) in the livers of mink trapped within 3 miles of the NR AOC were compared with LOAELs to determine whether reproduction of mink in the NR AOC might be impaired. We used World Health Organization (WHO) toxic equivalency factors (TEF) from Van den Berg *et al.* (2006) as multipliers for the concentration of PCB, CDD and CDF congeners to calculate toxic equivalencies (TEQ). In order to calculate PAH TEQ values, we used relative potency factors (RPF) from Villeneuve *et al*. (2002) as multipliers for PAH congener concentrations to calculate relative potencies (REP=TEQ). Congener TEQs were summed to yield PAH TEQ, PCB TEQ and CDD/CDF TEQ, which were then summed to yield total TEQ. In addition, jaw tissue was examined for pre-cancerous lesions in nine of the 24 mink collected in the NR AOC: the four with the highest TEQ upriver and the five with the highest TEQ downriver from Niagara Falls.

Statistical analysis

> Research Question 1: Are concentrations of PCB, CDD/CDF, PAH and total mercury measured in the tissue of mink trapped in the NR AOC below those associated with mink deformities or reproductive failure?

To determine health hazards for mink trapped within 3 miles of the U.S. shore of the NR AOC, concentrations of the BUI contaminants of concern in mink were compared with LOAELs (lowest observed adverse effect levels) reported for:

1. Total mercury (brain): 21,600 ng/g (Haynes *et al.* 2007, derived from Dansereau 1999).
2. Total PCB (liver): 1,698 ng/g (Bursian *et al.* 2006b).
3. PAH REP, PCB TEQ, CDD/CDF TEQ and total TEQ (liver): 40.2 pg/g (Bursian *et al.* 2006b).
4. Precancerous squamous cell proliferation in mink jaws (diet): 9.2 pg/g (reviewed in Haynes *et al.* 2009)

Research Question 2: Is there a significant difference in concentrations of BUI contaminants in liver and brain tissue from NR AOC mink compared to the same tissues from mink collected in the nearby “Western Lake Ontario region” in 2007?

Because BUI contaminant concentration data from NR AOC mink were not normally distributed with equal variance, they were analyzed using non-parametric Wilcoxon Rank-Sum tests to determine whether mink BUI contaminant concentrations differed between the upper and lower portions of the Niagara River. For the same reasons, non-parametric Kruskal-Wallis one-way ANOVA tests were used to determine whether BUI contaminant concentrations (total mercury, total PCB and CDD/CDF TEQ, which were the BUI contaminants analyzed in the western New York region by Haynes *et al*. (2007), differed among the NR AOC, the Lake Ontario shoreline in and out of the Rochester Embayment of Lake Ontario AOC, and at inland sites in and out of the RE AOC. Dunn's All-Pairwise Comparison test was used to distinguish which regional BUI contaminant concentrations were significantly different (Statistix 2013). Length, weight and trophic level data for mink collected in the NR AOC met the assumptions of normality and equality of variance, so two sample T-Tests were used to assess differences between mink captured above and below Niagara Falls (Statistix 2013).

Results

Upper vs. lower portions of the NR AOC

Twelve mink were caught in the portion of the NR AOC upriver from Niagara Falls (Figure 2) during 361 trapping nights (CPUE: 0.033 mink per trap night). Trapping occurred during two periods: 8 December 2013 to 14 March 2014 and 28 October 2014 to 6 April 2015. Twelve mink also were caught downstream from Niagara Falls (Figures 3 and 4) from 6 September to 30 November 2014 (2,890 trap nights; CPUE: 0.004 mink per trap night).

Dates of capture, sex, length (body and body+tail), weight, age and trophic level were determined for each mink (Appendix 1). Body+tail and body lengths were significantly correlated ($r = 0.889$, $P < 0.0001$). By both length measures, mink trapped below Niagara Falls (body: 38.9 $\pm$ 3.5 cm; body+tail: 59.7 $\pm$ 5.2 cm) were significantly longer (body: $P = 0.041$; body+tail: $P = 0.014$) than mink trapped above the Falls (body: 35.4 $\pm$ 4.2 cm; body+tail: 52.1 $\pm$ 7.6 cm). Mink weights were not significantly different ($P = 0.136$) above (783.1 $\pm$ 348.9 g) and below (995.3 $\pm$ 320.5 g) the Falls, nor were ages ($P = 0.112$) above (1.7 $\pm$ 1.0 years) and below (1.0 $\pm$ 0.9 years) the Falls. Mean trophic level ($\delta N \pm SD$) also was not significantly different ($P = 0.328$) among mink trapped above (3.87 $\pm$ 0.80) and below (4.26 $\pm$ 1.09) Niagara Falls (Table 2).

Similarly, there were no significant differences in the concentrations of BUI contaminants of concern in the tissue of mink trapped above and below Niagara Falls (Table 2): total mercury ($P = 0.183$), total PCB ($P = 0.630$), PAH REP ($P = 0.550$), CDD/CDF TEQ ($P = 0.057$; LNR almost > UNR), PCB TEQ ($P = 0.932$) and total TEQ ($P = 0.843$). So, chemical data for mink trapped above and below the Falls (Appendix 2) were combined for comparisons with mink collected inland and near the shore of Lake Ontario in western New York by Haynes *et al*. (2007).

BUI contaminants of concern in NR AOC mink tissue

Total Mercury

Total mercury in 24 NR AOC mink brains (range: 73.7-3,540.0 ng/g) averaged 22.1 times lower (977.4 $\pm$ 909.6 ng/g; Table 3) than the LOAEL for brain (21,600 ng/g; Haynes *et al.*

2007). None of the brains exceeded the LOAEL for total mercury (Appendix 2); the highest concentration of mercury (3,540.0 ng/g) in a mink's brain was 6.1 times lower than the LOAEL.

Total PCB

Total PCB in 24 NR AOC mink livers (range: 54.0-19,300 ng/g) averaged 1.15 times higher (1,958 $\pm$ 4,027 ng/g; Table 3) than the LOAEL in mink liver for reproductive impairment (1,698 ng/g; Bursian *et al.* 2006b). Five (20.8%) of the livers exceeded the total PCB LOAEL for reproductive impairment (range: 1,810.0-19,300.0 ng/g; Appendix 2); the highest concentration of total PCB in a mink's liver (19,300.0 ng/g) was 11.4 times greater than the LOAEL.

PCB TEQ

Data were reported for 11 PCB congeners, with TEFs ranging from 0.00003-0.1 (3,3',4,4',5-Pentachlorobiphenyl, PCB 126; Van den Berg *et al.* 2006). TEQ from PCB in 24 NR AOC mink livers (range: 0.1-904.8 pg/g) averaged 2.9 times higher (117.2 $\pm$ 219.3 pg/g; Table 3) than the LOAEL for reproductive impairment (40.2 pg/g; Bursian *et al.* 2006b). Fourteen (58.3%) of the livers exceeded the PCB TEQ LOAEL for reproductive impairment (range: 49.3-904.8 pg/g; Appendix 2); the highest concentration of PCB TEQ in a mink's liver (904.8 pg/g) was 22.5 times greater than the LOAEL.

CDD/CDF TEQ

Data were reported for 17 CDD/CDF congeners, with TEFs ranging from 0.0003-1.0 (2,3,7,8-Tetrachlorodibenzo-p-dioxin, TCDD; Van den Berg *et al.* 2006). Concentrations of TEQ from CDD/CDF in 24 NR AOC mink livers (range: 2.8-71.3 pg/g) averaged 2.9 times lower (14.0 $\pm$ 14.6 pg/g; Table 3) than the LOAEL for reproductive impairment (40.2 pg/g; Bursian *et al.* 2006b). Only one (4.2%) liver exceeded (71.3 pg/g; Appendix 2) the CDD/CDF LOAEL for reproductive impairment; the concentration of CDD/CDF TEQ in this mink's liver was 1.8 times greater than the LOAEL.

PAH Relative Potencies (REP=TEQ)

Data were reported for 18 PAH congeners, none of which has a relative potency factor >0.00014 (Villeneuve *et al.* 2002). REP from PAH congeners in 24 NR AOC mink livers (range: 0-2.8 pg/g) averaged 201 times lower (0.2 $\pm$ 0.6 pg/g; Table 3) than the LOAEL in liver for reproductive impairment (40.2 pg/g; Bursian *et al.* 2006b). The mink with the highest REP in its liver (2.8 pg/g; Appendix 2) had a concentration 14.3 times lower than the LOAEL.

Total TEQ

Total TEQ (PCB TEQ+CDD/CDF TEQ+PAH REP) in 24 NR AOC mink livers (range: 3.0-976.1 pg/g) averaged 3.3 times higher (131.4 $\pm$ 232.2 pg/g) than the LOAEL for reproductive impairment (40.2 pg/g; Bursian *et al.* 2006b). Sixteen (66.7%) of the 24 mink exceeded the total TEQ LOAEL (range: 43.5-976.1 pg/g; Appendix 2); the highest concentration of total TEQ in a mink's liver (976.1 pg/g) was 24.3 times greater than the LOAEL.

BUI contaminant concentrations in the NR AOC vs. the western New York region

Total mercury in brain and total PCB and CDD/CDF TEQ liver were compared among mink caught in the NR AOC (this study), along the central Lake Ontario shoreline (extending ~20 miles west of the Genesee River) and from nearby inland areas in western New York (Haynes *et al*. 2007). Total mercury was significantly higher ($P < 0.0001$) for NR AOC mink (977.4 $\pm$ 909.6 ng/g) than for central Lake Ontario shoreline (358.9 $\pm$ 328.8 ng/g) and nearby inland (175.1 $\pm$ 146.6 ng/g) mink. Total PCB also was significantly higher ($P < 0.0001$) for NR AOC mink (1,958.0 $\pm$ 4,027.0 ng/g) than for central Lake Ontario shoreline (644.8 $\pm$ 1,418.3 ng/g) and nearby inland (61.1 $\pm$ 131.2 ng/g) mink. CDD/CDF TEQ was significantly higher ($P < 0.0001$) for NR AOC mink (14.0 $\pm$ 14.6 pg/g) than for inland mink in western New York (0.7 $\pm$ 1.4 pg/g). However, there was no significant difference between CDD/CDF TEQ for central Lake Ontario shoreline mink (11.0 $\pm$ 16.8 pg/g) and either of NR AOC and western New York inland mink (Table 3).

Jaw lesion analysis

Among the nine sets of mink jaws analyzed for squamous cell hyperplastic foci, six had no evidence of pre-cancerous lesions. Two mink had the most minor form of the lesion, in spite of having one or both of total PCB and total TEQ well above the LOAELs of 1,698 ng/g and 40.2 pg/g, respectively, and one mink had the most severe form (Table 4). Concentrations of total PCB and total TEQ were significantly correlated ($r = 0.802$; $P = 0.009$), but there was no apparent correlation between concentrations of BUI contaminants and jaw lesions in the nine mink examined. For example, one upper Niagara River mink (2015-UNR-MI-12) had total PCB = 8,160 ng/g, total TEQ = 976 pg/g, and no jaw lesions, while two lower Niagara River mink (2014-LNR-MI-04 and 2014-LNR-MI-08) had total PCB = 1,310 and 1,210 ng/g, total TEQ = 99 and 89 pg/g, and three lesions between them (Table 4). Correlations of mink weight with total PCB ($r = -0.314$, $P = 0.408$) and TEQ ($r = -0.130$, $P = 0.738$) were not significant. Similarly, correlations of mink trophic level with total PCB ($r = 0.311$, $P = 0.415$) and TEQ ($r = 0.214$, $P = 0.580$) were not significant. Finally, there was no significant correlation between mink weight and trophic level ($r = -0.083$, $P = 0.832$

Discussion

BUI contaminants of concern in NR AOC mink tissue

Research Question 1: Are concentrations of PCB, CDD/CDF, PAH and total mercury measured in the tissue of mink trapped in the NR AOC below those associated with mink deformities or reproductive failure? Answer: Not for all BUI contaminants studied.

Concentrations of total mercury in 24 mink brains and PAH REP in 24 mink livers averaged 22 and 201 times lower than, respectively, and none exceeded the LOAELs for total mercury (21,600 ng/g; Haynes *et al.*2007) and PAH REP (40.2 pg/g; Bursian *et al.* 2006b). The average concentration of total PCB in 24 mink livers was 1.15 times higher than the LOAEL for reproductive impairment (1,698 ng/g; Bursian *et al.*2006b), but two mink (Appendix 2) had extraordinarily high concentrations of both total PCB and PCB TEQ (LNR05: 19,300 ng/g TPCB and 715.0 pg/g PCB TEQ; UNR12: 8,160 ng/g TPCB and 904.8 pg/g PCB TEQ). The average concentrations of PCB TEQ and CDD/CDF TEQ in 24 mink livers were 2.9 times higher and 2.9 times lower, respectively, than their LOAELs for reproductive impairment (both 40.2 pg/g; Bursian *et al.*2006b). Finally, the average concentration of total TEQ (PCB TEQ+CDD/CDF TEQ+PAH REP) in 24 mink livers was 3.3 times higher than the LOAEL for reproductive impairment (40.2 pg/g; Bursian *et al.*2006b).

BUI contaminant concentrations in the NR AOC vs. the western New York region

Research Question 2: Is there a significant difference in concentrations of BUI contaminants in liver and brain tissue from NR AOC mink compared to the same tissues from mink collected in the nearby "Western Lake Ontario region" in 2007? Answer: Yes.

Concentrations of three BUI contaminants of concern in mink (total mercury, total PCB, CDD/CDF TEQ) were compared between this study (NR AOC) and a previous study which trapped mink and analyzed BUI contaminants of concern in western New York (Haynes *et al*. 2007). NR AOC mink had significantly higher concentrations of total mercury and total PCB in their brains and livers, respectively, than mink living near the Lake Ontario shore and in nearby inland areas. CDD/CDF TEQ was significantly higher for NR AOC mink than for inland mink in western New York, but there was no significant difference between CDD/CDF TEQ for central Lake Ontario shoreline mink and mink living in the NR AOC and inland in western New York.

BUI contaminant concentrations: NR AOC vs. Lake St. Clair, Lake Erie and western New York

Martin *et al.* (2006) measured BUI contaminant concentrations in livers of Canadian mink collected along Lake St. Clair (including Walpole Island), from three locations along Lake Erie (western basin, near Long Point, eastern basin) and inland near eastern Lake Erie. They reported total PCB, TEQ for five of 11 PCB congeners, seven CCD congeners and ten CDF congeners, and total TEQ (Table 5). They measured other chlorinated hydrocarbons, but not PAHs, and stated that mean concentrations of total PCB had not changed significantly in any of the locations compared to a similar study done in 1979 by the Canadian Wildlife Service. The latter statement suggests that concentrations of BUI contaminants of concern in the NR AOC may not have changed greatly in recent decades.

In calculating TEQ, Martin *et al.* (2006) used WHO 1998 TEFs, whereas we used the WHO 2005 TEFs (Van den Berg *et al.* 2006). In order to compare our NR AOC results with Martin *et al*.'s, we recalculated their PCB and CDD/CDF TEQs by multiplying their reported congener concentrations by 2005 TEFs (Table 5). Because Martin *et al*. (2006) measured only five congeners (37, 77, 126, 169, and 189), we recalculated our PCB TEQs using only those congeners (Table 5) for comparisons with the NR AOC study and studies in western New York (Haynes *et al*. 2007).

Our data combined with that of Martin *et al.* (2006) give an interesting picture of the geographic distribution of BUI contaminant burdens in mink living near waters that pass from

Lake St. Clair through Lake Erie and the Niagara River into Lake Ontario. BUI contaminant concentrations in mink liver appear to be lowest in Lake St. Clair, upstream of Detroit, where total PCB = 80 ng/g and total TEQ = 11.6 pg/g. For partial comparison, Martin *et al.* (2006) also measured total PCB in inland mink north of eastern Lake Erie (84 ng/g). The western basin of Lake Erie was most heavily polluted by all measures: total PCB (1,692 ng/g) approached the LOAEL (1,698 ng/g), while PCB TEQ (72.4 pg/g) and total TEQ (84.6 pg/g) surpassed the LOAEL of 40.2 pg/g (Table 5).

BUI contaminant concentrations in mink liver (total PCB and total TEQ, respectively) reported by Martin *et al*. (2006) decreased eastward across Lake Erie, from 1,692 ng/g and 84.6 pg/g in the western basin to 263.0 ng/g and 20.4 pg/g at Long Point to 221.0 ng/g and 14.6 pg/g in the eastern basin, respectively (Table 5). Concentrations of total PCB and PCB TEQ in the NR AOC, both upstream and downstream of Niagara Falls, were an order of magnitude higher than those reported by Martin *et al*. (2006), while total TEQ and CDD/CDF TEQ were three to five times higher in UNR and LNR, respectively, than in Lake St. Clair and the eastern basin of Lake Erie (Table 5). Finally, BUI contaminant concentrations in mink liver (total PCB and CDD/CDF TEQ, respectively) reported by Haynes *et al*. (2007) were 644.8 ng/g and 22-110 pg/g in mink caught within 3 miles of the Lake Ontario shoreline and 61.1 ng/g and 1.6-6.0 pg/g in mink caught inland in western New York (Table 5). It is clear from these results that the highest levels of BUI contaminants reported from Lake St. Clair to Lake Ontario near Rochester, NY are in close proximity to the cities of Detroit and Buffalo.

It should be noted that PCB 126 contributed at least 96% to each of Martin *et al.*'s (2006) PCB TEQ values, and at least 69% to each total TEQ. Their findings were very similar to our NR AOC results; using the same five PCB congeners reported by Martin *et al*. in calculations for the Niagara River, PCB 126 contributed 97.3% and 94.7% to PCB TEQ for the UNR and LNR, respectively. High proportions of PCB 126 contributions to PCB TEQ in Great Lakes basin mink are supported by Leonards *et al.* (1997) who reported that the diet-to-tissue biomagnification factor for PCB 126 in European otters (*Lutra lutra*) is much higher than for other PCB congeners. PCBs 77 and 81 are apparently metabolized by mustelids (Leonards *et al.* 1997; Rice *et al.* 2003), which may account for their much lower concentrations in mink liver than PCB 126, which is not metabolized.

Hazard analysis for mink reproductive health

Among the 24 mink collected for chemical analysis in the NR AOC, five (21%) exceeded the LOAEL (1,698 ng/g) for total PCB and 16 (67%) exceeded the LOAEL (40.2 pg/g) for total TEQ (87% of TEQ exceedances due to PCB TEQ). No mink exceeded LOAELs for total mercury (21,600 ng/g) and PAH REP (40.2 pg/g). The mildest symptoms (pre-cancerous squamous cell hyperplastic foci) of the jaw lesion deformity were found in two (22%) of the nine mink analyzed, but the mink with the highest total PCB (19,300 ng/g) and second highest total TEQ (747 pg/g) had the most severe form of the jaw lesion. The combined results from mink trapping, chemical analysis for BUI contaminants, and jaw lesion analysis suggest three things:

1. Mink are reasonably abundant in suitable habitats within the NR AOC and may be reproducing there, but they also could be migrating into the AOC from adjacent areas with lower concentrations of BUI contaminants.
2. Jaw lesion frequency (33%, 3/9 mink), the most sensitive bioindicator of mink health effects after exposure to total PCB or total TEQ (Haynes *et al*. 2009), was lower among trapped NR AOC mink than the frequency of exceedances of LOAELs (67%; 16/24 mink) in the same mink (Appendix 2).
3. Published LOAELs for the major BUI contaminants of concern in the NR AOC (total PCB and total TEQ, particularly PCB TEQ) appear to be conservative with regard to protecting the reproductive health of mink.

Recommendation

The "*Bird or Animal Deformities or Reproductive Problems*" BUI delisting criterion relating to mink states that this aspect of the BUI can be considered unimpaired when "Levels of contaminants in mink livers collected within the Niagara River AOC are not significantly higher than in those collected throughout the Western Lake Ontario region."

Although mink are reasonably abundant in suitable habitats and may be reproducing in the NR AOC, 67% of trapped mink exceeded one or both of the published LOAELs for reproductive impairment for total PCB and total TEQ. For the "*Bird or Animal Deformities or Reproductive Problems*" BUI, in terms of mink health in the NR AOC it appears that the time for delisting is not yet at hand.

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Table 1: Niagara River AOC and “Bird or Animal Deformities or Reproductive Problems” BUI information (NYSDEC 1994; Ecology & Environment 2016).

	Niagara River AOC
Contaminants of Concern	PCBs, BHC, dioxin, dieldrin, chlordane, DDT and DDE, hexachlorobenzene
Status of “Bird or Animal Deformities or Reproductive Problems” BUI	Impaired
Delisting Criteria for this BUI	1) Levels of contaminants in Herring Gull and Double-crested Cormorant eggs collected within the Niagara River AOC are not significantly higher than in eggs collected at other locations throughout the Great Lakes basin; AND 2) Levels of contaminants in mink livers collected within the Niagara River AOC are not significantly higher than in those collected throughout the Western Lake Ontario region.

Table 2. Summary results for biological and chemical data of mink trapped in the NR AOC. LOAELs (lowest observed adverse effect levels on mink reproduction) are from Haynes (2007: Hg) and Bursian *et al*. (2006b). P-values in bold type indicate a significant difference between mink trapped in the portions of the Niagara River above and below Niagara Falls, while the italicized P-value suggests significance (0.05 < P < 0.1).

	Tissue LOAEL	**Lower Niagara River (SD)**	**Upper Niagara River (SD)**	**P**
Total Mercury (ng/g)	21,600	1,147.20 (934.87)	807.64 (890.61)	0.183
Total PCB (ng/g)	1,698	2,523.00 (5,329)	1,393.00 (2,193)	0.630
PCB TEQ (pg/g)	41.2	113.04 (196.49)	121.46 (248.81)	0.932
PAH REP (pg/g)	41.2	0.06 (0.12)	0.26 (0.80)	0.550
CCD/CDF TEQ (pg/g)	41.2	15.34 (9.30)	12.57 (18.78))	*0.057*
Total REP/TEQ (pg/g)	41.2	128.45 (202.99)	134.29 (267.41)	0.843
Body Length (mm)	na	38.8 (3.4)	35.4 (4.2)	**0.041**
Body+Tail Length (mm)	na	59.5 (5.0)	52.1 (7.6)	**0.012**
Weight (g)	na	995.3 (320.5)	783.1 (348.9)	0.136
Age (years)	na	1.0 (0.9)	1.7 (1.0)	0.112
Trophic Level (δN)	na	4.26 (1.09)	3.87 (0.80)	0.328

Table 3. BUI contaminants of concern measured in mink tissue from the NR AOC (this study) and in western New York near and west of Rochester (Haynes et al. 2007).

Location	N	Mean	SD	Min	Max	P	Result
Total Mercury: Central Lake Ontario Shoreline (ng/g)	18	358.9	328.8	0.08	1.55		
Total Mercury: Western New York Inland (ng/g)	19	175.1	146.6	0.01	0.46		
Total Mecury: Niagara River AOC (ng/g)	24	977.4	909.6	73.7	3540	<0.0001	NR AOC > LO Shore = WNY Inland
Total PCB: Central Lake Ontario Shoreline (ng/g)	18	644.8	1418.3	13.6	5870.8		
Total PCB: Western New York Inland (ng/g)	19	61.1	131.2	7.0	554.4		
Total PCB: Niagara River AOC (ng/g)	24	1,958.0	4,027.0	54.1	19,300	<0.0001	NR AOC > LO Shore = WNY Inland
CDD/CDF TEQ: Central Lake Ontario Shoreline (pg/g)	10	11.0	16.8	0.2	47.6		
CDD/CDF TEQ: : Western New York Inland (pg/g)	9	0.6	1.3	0	4.16		
CDD/CDF TEQ: Niagara River AOC (pg/g)	24	14.0	14.6	2.8	71.3	<0.0001	NR AOC > WNY Inland; LO Shore = WNY Inland & NR AOC
PCB TEQ: Niagara River AOC (pg/g)	24	117.2	219.3	0.1	904.8		
PAH REP: Niagara River AOC (pg/g)	24	0.2	0.6	0	2.8		
Total TEQ: Niagara River AOC (pg/g)	24	131.4	232.2	3.0	976.1		

Table 4. Histopathology of jaws from mink collected above and below Niagara Falls. LOAELs for total PCB and total TEQ are 1,698 ng/g and 40.2 pg/g, respectively (Bursian *et al.* 2006b).

ID Number	**TPCB (ng/g)**	**TTEQ (pg/g)**	**Maxilla**	**Right Mandible**	**Left Mandible**	**Result**	**Sex**	**Weight (g)**
Upper Niagara								
2014-UNR-MI-05	379	33	None	None	None	Normal	F	341
2014-UNR-MI-07	1150	93.2	None	None	None	Normal	M	823
2014-UNR-MI-09	792	71.6	None	None	None	Normal	F	849
2015-UNR-MI-12	8,160	976.1	None	None	None	Normal	M	985
Lower Niagara								
2014-LNR-MI-03	1,660	207.7	None	None	None	Normal	M	992
2014-LNR-MI-04	1,310	99.1	None	1+scc molar	1+scc molar	1+scc	M	726
2014-LNR-MI-05	19,300	746.7	3+scc incisor, premolar, molars	3+scc premolar, molar	3+scc premolar, molar	3+ scc	F	447
2014-LNR-MI-06	1,810	79.8	None	None	None	Normal	M	1,624
2014-LNR-MI-08	1,210	88.9	1+scc premolar	None	None	1+scc	M	1,003

Key:

scc = squamous cell hyperplastic foci in jaw bones

1+ = mild, single focus; 2+ = multiple foci; 3+ = multiple coalescing foci in multiple areas of the dental arcade

Zones of the dental arcade: molar, premolar and incisor = regions of the jaw bones

Table 5. Great Lakes BUI contaminant concentrations in mink liver collected in the Lake St. Clair, Lake Erie and Lake Ontario regions. All PCB TEQ and total TEQ values are adjusted for the four PCB congeners with TEF (77, 126, 169, 189) reported by Martin *et al*. (2006), who pooled their samples and, therefore, could not compute standard deviations for TEQ values.

Study/Location	**N (TPCB)**	**Total PCB (ng/g)**	**N (TEQ)**	**Total TEQ (pg/g)**	**PCB TEQ (pg/g)**	**CDD/CDF TEQ (pg/g)**
Martin *et al*. (2006)		Mean (SD)		Mean	Mean	Mean
Lake St. Clair/Walpole Is.	14	80.0 (86.0)	5	11.6	8.2	3.4
Lake Erie Western Basin	16	1,692 (2228)	6	84.6	72.4	12.1
Lake Erie Long Point	18	263.0 (479.4)	4	20.4	16.2	4.1
Lake Erie Eastern Basin	12	221.0 (304.8)	4	14.6	11.8	2.8
Lake Erie Eastern Basin Inland	14	84.0 (75.6)		nd	nd	nd
Haynes et al. (2016)						
Upper Niagara River	12	1,393.0 (2193.0)	12	131.2	118.6	12.6
Lower Niagara River	12	2,522.9 (5328.6)	12	124.5	109.1	15.3
Haynes *et al*. (2007)						
Lake Ontario Shoreline	18	644.8 (1418.3)	10	[a]22.0-110.0	nd	11.0
Western New York Inland	19	61.1 (131.2)	9	[a]1.6-6.0	nd	0.6

[a]Extrapolated range based on measured CCD/CDF TEQ and literature-based proportions of PCB TEQ in total TEQ.

Figure 1: Niagara River Area of Concern (https://www.epa.gov/sites/production/files/2015-08/documents/niagara_final_state)

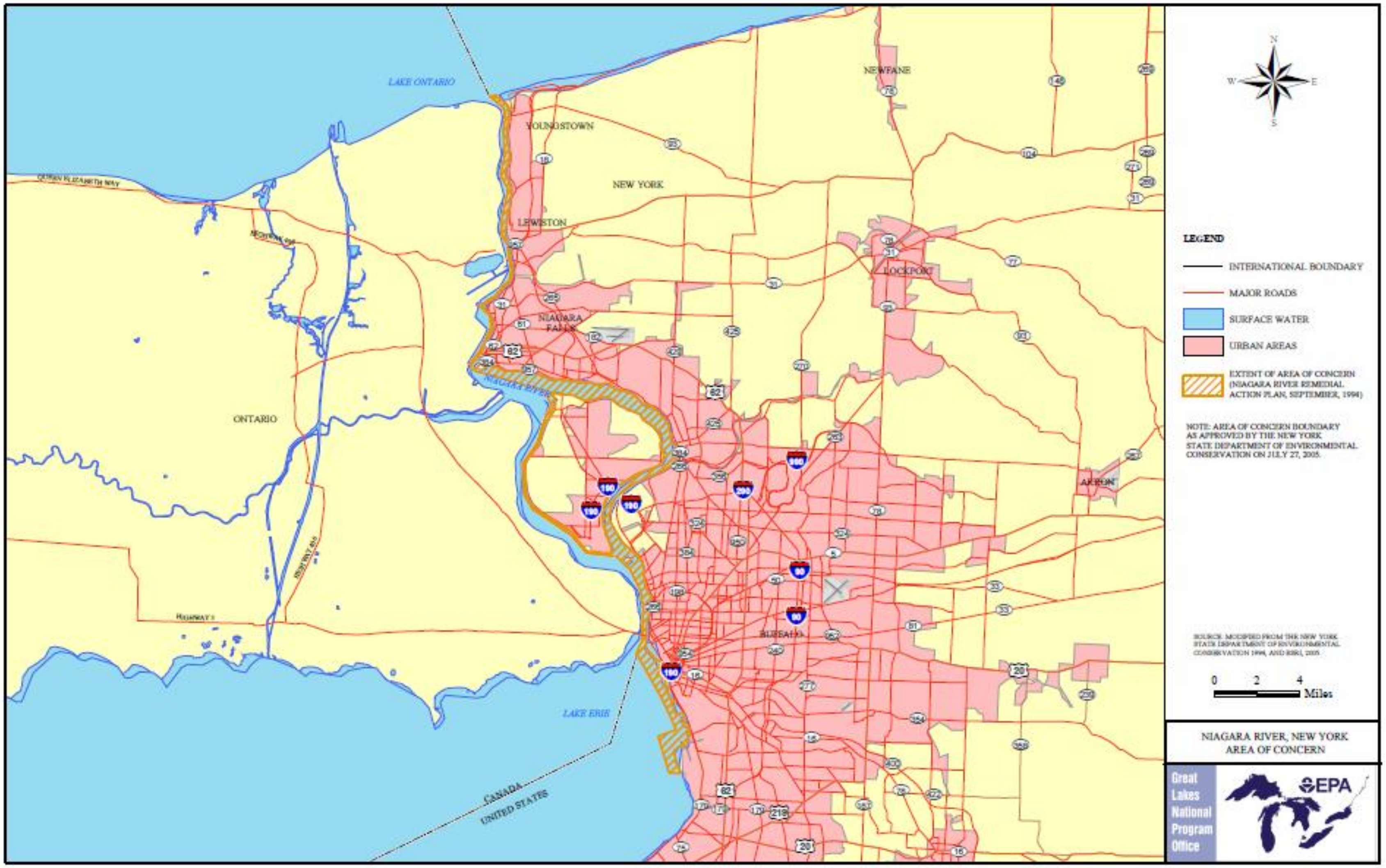


Figure 2: Mink trapping locations in the upper portion of the NR AOC upstream from Niagara Falls (A. Marsocci).

Figure 3: Mink trapping locations near Stella Niagara in the lower portion of the NR AOC downstream from Niagara Falls (A. Marsocci).

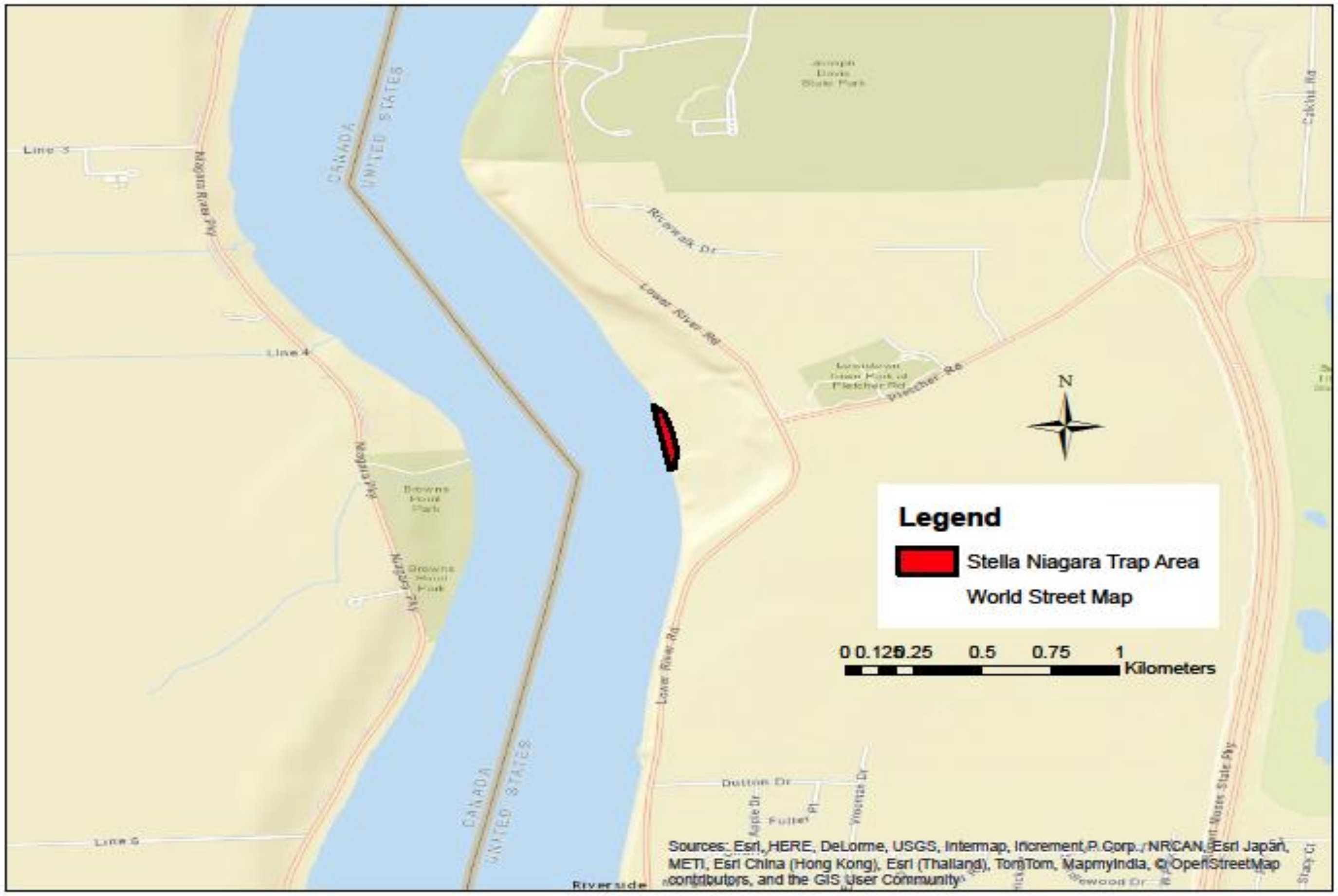
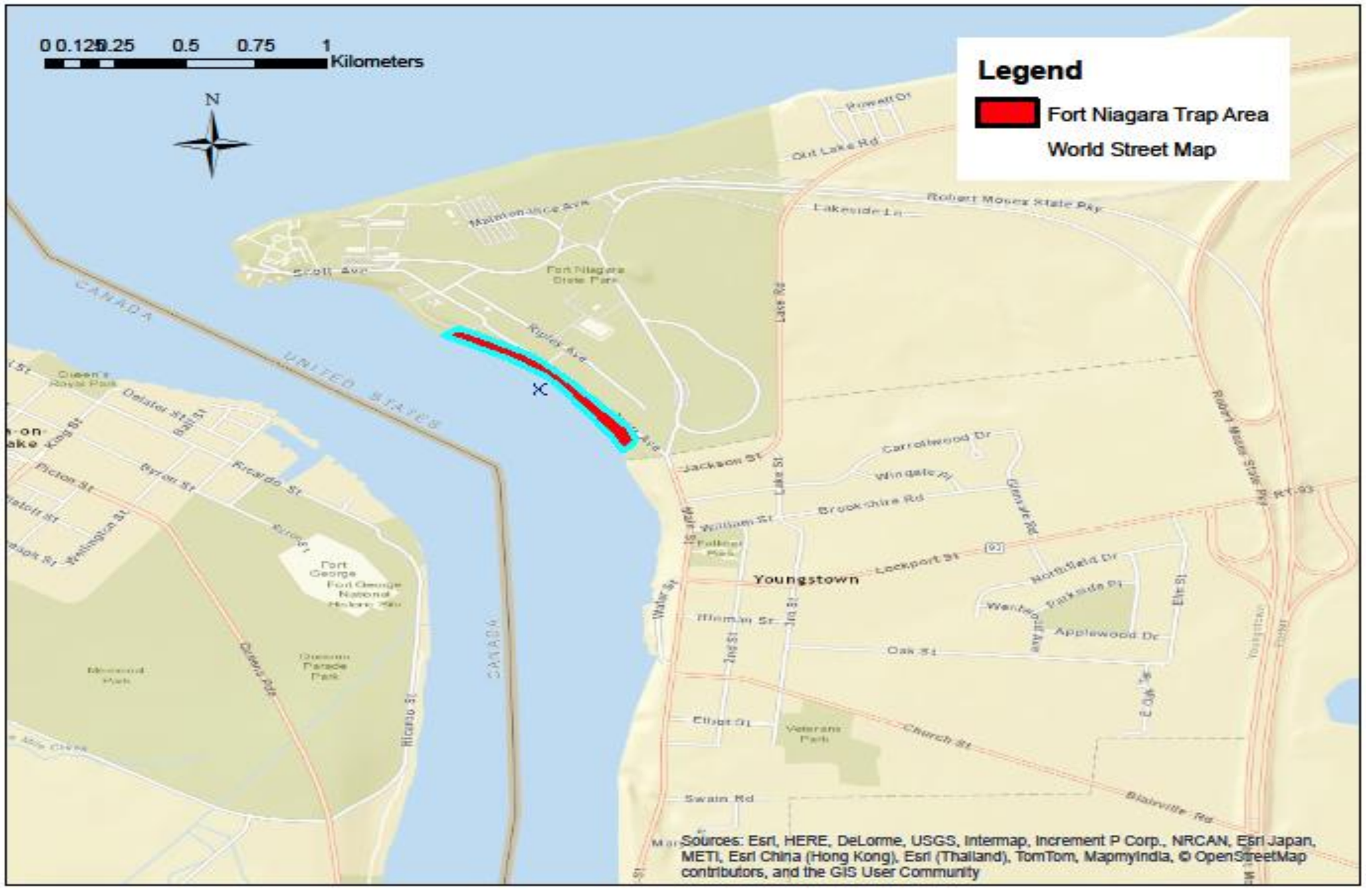


Figure 4: Mink trapping locations near Fort Niagara in the lower portion of the NR AOC downstream from Niagara Falls (A. Marsocci).



Appendix 1. Biological data for mink trapped in the Niagara River AOC below (lower river) and above (upper river) Niagara Falls.

ID Number	Capture Date	Sex	Length (mm) (body)	Length (mm) (body+tail)	Weight (g)	Tooth Age	Trophic Level
Lower River							
2014-LNR-MI-01	9/06/2014	M	44.0	68.4	1433	0-1	5.0
2014-LNR-MI-02	9/16/2014	F	33.0	52.0	657	0-1	4.9
2014-LNR-MI-03	9/25/2014	M	44.0	68.0	1427	1	4.8
2014-LNR-MI-04	9/27/2014	M	41.5	62.0	1192	0	5.1
2014-LNR-MI-05	9/30/2014	F	34.0	54.0	447	0-1	5.0
2014-LNR-MI-06	10/2/2014	M	38.0	60.0	817	1-2	4.9
2014-LNR-MI-07	10/4/2014	M	38.0	55.0	1114	0	4.6
2014-LNR-MI-08	10/4/2014	M	40.0	60.0	1166	1-2	3.9
2014-LNR-MI-09	10/7/2014	M	40.0	61.0	910	0	3.2
2014-LNR-MI-10	10/7/2014	M	37.0	59.0	626	2-3	1.3
2014-LNR-MI-11	10/9/2014	M	39.0	57.0	1259	2-3	4.1
2014-LNR-MI-12	10/30/2014	M	37.0	57.0	896	1-2	4.3
Upper River							
2013-UNR-MI-01	12/09/2013	F	31.5	43.6	464	2-3	2.7
2013-UNR-MI-02	12/10/2013	F	33.3	48.6	546	0-1	2.9
2013-UNR-MI-03	12/13/2013	M	42.1	61.4	992	2-3	3.4
2013-UNR-MI-04	12/15/2013	M	37.2	53.4	726	1-2	4.3
2014-UNR-MI-05	03/12/2014	F	30.4	35.2	341	3-4	4.7
2014-UNR-MI-06	03/14/2014	M	38.8	58.1	1624	1-2	3.3
2014-BUF-MI-01	10/28/2014	M	31.0	52.0	823	NR	3.0
2014-BUF-MI-02	11/04/2014	M	33.0	52.0	520	1-2	4.2
2014-UNR-MI-07	12/23/2014	M	36.0	56.7	849	NR	4.8
2014-UNR-MI-08	12/25/2014	M	40.2	60.8	1003	0	4.9
2014-UNR-MI-09	12/25/2014	F	31.5	51.5	524	2	3.6
2015-UNR-MI-12	04/06/2015	M	40.1	nd	985	1-2	4.6

Appendix 2. Summary results of chemical analyses for mink trapped in the NR AOC. Numbers in bold type exceed the LOAEL: 21,600 ng/g for total mercury (Haynes *et al.* 2007), 1,698 ng/g for total PCB, and 40.2 pg/g for TEQ and REP (Bursian *et al.* 2006b).

ID Number	Total Hg (ng/g)	Total PCB (ng/g)	PCB TEQ (pg/g)	PAH REP (pg/g)	CDD/CDF TEQ (pg/g)	Total TEQ/ REP (pg/g)
Lower River						
2014-LNR-MI-01	274	**2,280**	**116.9**	0.00	18.6	**135.5**
2014-LNR-MI-02	3,540	1,020	1.9	0.09	20.6	22.6
2014-LNR-MI-03	1,260	1,660	**176.8**	0.03	31.9	**207.7**
2014-LNR-MI-04	1,530	1,310	**89.9**	0.18	9.0	**99.1**
2014-LNR-MI-05	878	**19,300**	**715.0**	0.00	31.6	**746.7**
2014-LNR-MI-06	2,250	**1,810**	**61.8**	0.01	18.1	**79.8**
2014-LNR-MI-07	1,050	455	**50.5**	0.00	14.5	**64.9**
2014-LNR-MI-08	854	1,210	**75.5**	0.39	13.0	**88.9**
2014-LNR-MI-09	330	392	11.9	0.00	8.7	30.6
2014-LNR-MI-10	516	54.1	0.1	0.00	2.8	3.0
2014-LNR-MI-11	588	622	40.9	0.00	7.5	**48.5**
2014-LNR-MI-12	696	162	16.3	0.00	7.8	24.1
Upper River						
2013-UNR-MI-01	282	766	21.0	0.01	10.4	31.4
2013-UNR-MI-02	588	225	6.7	0.05	3.2	9.9
2013-UNR-MI-03	285	575	60.4	0.00	9.8	**70.1**
2013-UNR-MI-04	847	687	49.3	0.00	6.9	**56.2**
2014-UNR-MI-05	1,040	379	28.9	0.00	4.0	33.0
2014-UNR-MI-06	181	356	36.5	0.00	7.6	**44.1**
2014-BUF-MI-01	296	461	**130.2**	0.01	14.6	**144.7**
2014-BUF-MI-02	1,280	**2,050**	38.2	0.03	5.2	**43.5**
2014-UNR-MI-07	1,160	1,150	**82.8**	2.78	7.6	**93.2**
2014-UNR-MI-08	338	755	34.3	0.19	3.1	37.7
2013-UNR-MI-09	73.7	792	**64.4**	0.00	7.2	**71.6**
2015-UNR-MI-12	3,320	**8,160**	**904.8**	0.05	**71.3**	**976.1**

Appendix 3. Congener-specific results of chemical analyses for mink trapped in the NR AOC.

Appendix 3a1. Lower Niagara River

		LNR-MI-01	LNR-MI-02	LNR-MI-03	LNR-MI-04	LNR-MI-05	LNR-MI-06
	Sample ID	LNR-MI-01	LNR-MI-02	LNR-MI-03	LNR-MI-04	LNR-MI-05	LNR-MI-06
	ALS #	1706179-1	1413494-1	1413494-2	1413494-3	1706179-2	1413494-4
	δN	16.99	16.59	16.25	17.45	16.95	16.69
	Trophic level	**5.00**	**4.88**	**4.78**	**5.13**	**4.99**	**4.91**
Lipids (%/100)	**Brain**	0.0670	0.0664	0.0793	0.0738	0.0590	0.0395
	Liver	0.1480	0.0630	0.0350	0.0420	0.0270	0.1020
Compounds							
Mercury, total (ng/g)		274	3540	1260	1530	878	2250
Mink Brain LOAEL = 21,600 ng/g	**21.6 mg/g**						
(LOAEL from Haynes 2007)							
Total TEQ from PAH, CDD&F, PCB		**135.48**	**22.58**	**207.73**	**99.06**	**746.65**	**79.83**
Mink Liver TEQ LOAEL = 40.2 pg/g							
(LOAEL from Bursian et al. 2006b, TEFS from Van den Berg et al. 2006)							
PAHs (ug/kg=ng/g)	**REPs**						
Naphthalene		1.80	0.67				2.1
2-Methylnaphthalene		1.50	0.57			6.3	3.2
Acenaphthylene			1.2				0.5
Acenaphthene							1.2
Dibenzofuran		0.70	0.58				0.64
Fluorene		1.30	0.54	0.86			0.92
Phenanthrene		1.30	1			4.3	
Anthracene							
Fluoranthene							

Pyrene							
Benz(a)anthracene	1.90E-06				94		3.8
Chrysene	2.30E-06		3.1	14			
Benzo(b)fluoranthene	5.10E-06						
Benzo(k)fluoranthene	1.40E-04		0.62				
Benzo(a)pyrene	1.60E-06						
Indeno(1,2,3-cd)pyrene	1.50E-05						
Dibenz(a,h)anthracene	4.60E-06						
Benzo(g,h,i)perylene							
REPs from PAHs		**0.00**	**0.09**	**0.03**	**0.18**	**0.00**	**0.01**

Mink Liver TEQ LOAEL = 40.2 pg/g

(LOAEL from Bursian et al. 2006b,
TEFS from Villeneuve et al. 2002)

CDDs and CDFs (ng/kg = pg/g)	WHO TEFs						
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.01	2.73	5.73	2.17	1.54	6.81	8.94
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.01	25.90	9.47	11.4	5.69	12.9	40
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	0.01	ND	0.403	ND	0.142	ND	0.614
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	6.61	15.7	9.38	6.52	20.7	19.6
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	ND	0.451	1.2	0.358	ND	1.22
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	2.85	4.39	3.27	2.54	7.98	7.18
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	4.50	3.26	5.74	3.48	10	7.61
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.1	ND	ND	ND	ND	ND	ND
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	1.05	0.496	0.681	0.393	1.14	1.14
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	0.03	ND	0.299	0.958	0.183	ND	0.124
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	1	1.85	1.19	3.67	0.475	ND	1.05
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	2.43	4.76	2.69	2.53	9	4.39
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	0.3	18.00	21.3	31.4	11.4	43.6	21.9
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	0.1	3.68	0.358	1.61	0.51	ND	0.184
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1	8.89	9.85	16.2	3.37	13.4	5.73

Octachlorodibenzofuran (OCDF)	0.0003	7.68	8.62	2.74	2.61	32.5	9.06
Octachlorodibenzo-p-dioxin (OCDD)	0.0003	135.00	111	65.3	49.5	173	251
Heptachlorodibenzo-p-dioxins (HpCDD), Total		27.50	9.47	13.4	7.01	12.9	40
Heptachlorodibenzofurans (HpCDF), Total		2.73	5.73	2.17	1.54	8.67	8.94
Hexachlorodibenzo-p-dioxins (HxCDD), Total		ND	3.26	6.42	3.48	11.2	9.96
Hexachlorodibenzofurans (HxCDF), Total		9.47	25.2	13.7	12.4	37.7	31.2
Pentachlorodibenzo-p-dioxin (PeCDD), Total		ND	ND	ND	ND	ND	1.05
Pentachlorodibenzofurans (PeCDF), Total		18.00	22.2	35.5	14.2	43.6	22.3
Tetrachlorodibenzo-p-dioxins (TCDD), Total		8.89	9.85	16.2	3.37	ND	5.73
Tetrachlorodibenzofurans (TCDF), Total		3.68	0.422	1.86	0.527	ND	0.264
Total Dioxins and Furans		**212.95**	**195.75**	**157.29**	**94.64**	**319.57**	**379.50**
TEQs from Dioxins and Furans		**18.58**	**20.57**	**31.93**	**8.99**	**31.62**	**18.06**

Mink Liver TEQ LOAEL = 40.2 pg/g

**(LOAEL from Bursian et al. 2006b,
TEFS from Van den Berg et al. 2006)**

PCBs (ng/kg = pg/g)	**WHO TEFs**						
Monochlorobiphenyls, Total		11	ND	ND	ND	26.8	ND
Dichlorobiphenyls, Total		74	121	36.8	41.1	186	21
Trichlorobiphenyls, Total		1490	744	931	1060	322	804
Tetrachlorobiphenyls, Total		40400	12200	23900	26000	37800	20300
Pentachlorobiphenyls, Total		235000	76500	141000	146000	951000	122000
Hexachlorobiphenyls, Total		897000	405000	513000	492000	8080000	608000
Heptachlorobiphenyls, Total		832000	381000	727000	502000	7060000	753000
Octachlorobiphenyls, Total		218000	88000	192000	116000	2530000	236000
Nonachlorobiphenyls, Total		34700	33700	38300	18400	536000	45400
Decachlorobyphenyls, Total		23800				116000	
Sum PCBS (STW)		2282475	997265	1636168	1301501	19311335	1785525
Total PCBs reported by ALS		**2280000**	**1020000**	**1660000**	**1310000**	**19300000**	**1810000**

Mink Liver TPCB LOAEL = 1,698,000 pg/g 1,668 ng/g

(LOAEL from Bursian et al. 2006b)

PCB 105	2,3,3',4,4'-Pentachlorobiphenyl	0.00003	32800.00	16300	23100	23100	160000	20100
PCB 114	2,3,4,4',5-Pentachlorobipheny	0.00003	1380.00	617	1100	1090	6930	964
PCB 118	2,3',4,4',5-Pentachlorobipheny	0.00003	68300.00	26100	44300	49700	336000	42200
PCB 123	2,3',4,4',5'-Pentachlorobiphenyl	0.00003	824.00	ND	220	145	48	ND
PCB 126	3,3',4,4',5-Pentachlorobiphenyl	0.1	1100.00	ND	1520	831	6500	591
PCB 167	2,3',4,4',5,5'-Hexachlorobiphenyl	0.00003	6890.00	1910	4540	3630	47300	4150
PCB 169	3,3',4,4',5,5'-Hexachlorobipheny	0.03	100.00	ND	700	133	1150	ND
PCB 189	2,3,3',4,4',5,5'-Heptachlorobiphenyl	0.00003	2040.00	1450	1790	1130	60100	1930
PCB 77	3,3',4,4'-Tetrachlorobiphenyl	0.0001	58.50	14	45.6	19.8	82.3	ND
PCB 81	3,4,4',5-Tetrachlorobiphenyl	0.0003	85.90	39.5	38.3	ND	1	28.1
PCBs 156 + 157		0.00003	16700.00	17100	16700	14400	407000	19300
TEQs from PCBs			**116.90**	**1.92**	**175.77**	**89.89**	**715.03**	**61.77**

Mink Liver TEQ LOAEL = 40.2 pg/g

(LOAEL from Bursian et al. 2006b,
TEFS from Van den Berg et al. 2006)

Appendix 3a2. Lower Niagara River

	Sample ID	LNR-MI-07	LNR-MI-08	LNR-MI-09	LNR-MI-10	LNR-MI-11	LNR-MI-12
	ALS #	1413494-5	1413494-6	1413494-7	1413494-8	1413494-9	1413494-10
	δN	15.56	13.33	10.79	4.57	13.91	14.58
	Trophic level	**4.58**	**3.92**	**3.17**	**1.34**	**4.09**	**4.29**
Lipids (%/100)	**Brain**	0.0200	0.0571	0.0658	0.0677	0.0839	0.0277
	Liver	0.0650	0.0750	0.1010	0.0720	0.0900	0.0340
Compounds							
Mercury, total (ng/g)		1050	854	330	516	588	696

Mink Brain LOAEL = 21,600 ng/g 21.6 mg/g

(LOAEL from Haynes et al. 2007)

Total TEQ from PAH, CDD&F, PCB		**64.93**	**88.87**	**20.58**	**2.97**	**48.48**	**24.08**
Mink Liver TEQ LOAEL = 40.2 pg/g **(LOAEL from Bursian et al. 2006b, TEFS from Van den Berg et al. 2006)**							
PAHs (ug/kg=ng/g)	**REPs**						
Naphthalene		0.52		2.2	0.74	1	0.56
2-Methylnaphthalene		0.71	1.6	1.9	1.1	1.4	0.7
Acenaphthylene		0.75		0.5	0.21	0.19	0.13
Acenaphthene		0.32		0.8	0.25		0.24
Dibenzofuran		0.26		1.3	0.32	0.27	0.25
Fluorene		0.21		1.9	0.4	0.3	0.24
Phenanthrene		0.76		43	0.56	0.67	0.63
Anthracene		0.3		9.3	0.11		
Fluoranthene		0.3		17			
Pyrene		0.16		15	0.35		0.22
Benz(a)anthracene	1.90E-06	0.25	190	1.2	0.12	1.5	0.15
Chrysene	2.30E-06	0.53	11				
Benzo(b)fluoranthene	5.10E-06						
Benzo(k)fluoranthene	1.40E-04						
Benzo(a)pyrene	1.60E-06						
Indeno(1,2,3-cd)pyrene	1.50E-05						
Dibenz(a,h)anthracene	4.60E-06						
Benzo(g,h,i)perylene							
REPs from PAHs		**0.00**	**0.39**	**0.00**	**0.00**	**0.00**	**0.00**
Mink Liver TEQ LOAEL = 40.2 pg/g **(LOAEL from Bursian et al. 2006b, TEFS from Villeneuve et al. 2002)**							

CDDs and CDFs (ng/kg = pg/g)	WHO TEFs						
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.01	4.32	0.881	1.14	0.651	1.73	0.999
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.01	18.7	4.72	67	8	9.59	10.5
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	0.01	0.381	ND	0.494	0.118	0.214	0.144
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	13.4	5.85	3.56	0.909	4.1	4.42
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	0.478	0.501	1.37	0.383	0.586	0.214
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	4.58	1.96	4.17	0.898	1.9	1.55
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	3.8	2.64	10.4	1.58	3.17	2.12
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.1	ND	ND	ND	ND	ND	ND
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	0.58	0.386	1.19	0.327	0.456	0.374
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	0.03	0.133	0.198	ND	ND	ND	ND
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	1	0.518	1.5	0.751	0.361	0.622	0.368
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	2.85	1.42	3.71	0.952	3.01	1.43
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	0.3	17.4	15.1	10	2.74	8.68	11.2
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	0.1	0.175	0.294	0.03	0.047	0.14	0.068
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1	5.87	5.61	1.67	1.05	2.85	2.9
Octachlorodibenzofuran (OCDF)	0.0003	7.28	1.38	1.63	0.937	2.29	2.38
Octachlorodibenzo-p-dioxin (OCDD)	0.0003	143	44.9	352	28	47.2	115
Heptachlorodibenzo-p-dioxins (HpCDD), Total		19.1	5.53	67.4	8.1	9.59	10.7
Heptachlorodibenzofurans (HpCDF), Total		4.7	ND	0.494	0.769	1.73	0.999
Hexachlorodibenzo-p-dioxins (HxCDD), Total		4.86	3.02	11.8	2.29	3.62	2.33
Hexachlorodibenzofurans (HxCDF), Total		20.9	10.1	12.2	2.85	10.2	7.41
Pentachlorodibenzo-p-dioxin (PeCDD), Total		ND	ND	ND	0.361	ND	ND
Pentachlorodibenzofurans (PeCDF), Total		18.3	16.8	10.8	2.82	8.68	11.2
Tetrachlorodibenzo-p-dioxins (TCDD), Total		5.87	5.61	1.67	1.05	2.85	2.9
Tetrachlorodibenzofurans (TCDF), Total		0.281	0.506	0.061	0.0946	0.114	0.141
Total Dioxins and Furans		**224.29**	**87.85**	**458.06**	**47.27**	**86.27**	**153.06**
TEQs from Dioxins and Furans		**14.48**	**13.02**	**8.66**	**2.84**	**7.54**	**7.80**

Mink Liver TEQ LOAEL = 40.2 pg/g
(LOAEL from Bursian et al. 2006b,
TEFS from Van den Berg et al. 2006)

PCBs (ng/kg = pg/g)	WHO TEFs						
Monochlorobiphenyls, Total		ND	ND	ND	ND	ND	ND
Dichlorobiphenyls, Total		15.5	27	27.9	ND	ND	ND
Trichlorobiphenyls, Total		101	638	ND	ND	128	ND
Tetrachlorobiphenyls, Total		5420	18200	747	310	2340	2280
Pentachlorobiphenyls, Total		35300	83700	21400	4660	26300	16100
Hexachlorobiphenyls, Total		159000	318000	152000	24500	187000	67000
Heptachlorobiphenyls, Total		174000	557000	143000	17800	290000	54600
Octachlorobiphenyls, Total		65400	181000	57600	4250	78300	16000
Nonachlorobiphenyls, Total		10700	35000	11500	1630	26500	3670
Decachlorobyphenyls, Total							
Sum PCBS (STW)		449936.5	1193565	386274.9	53150	610568	159650
Total PCBs reported by ALS		**455000**	**1210000**	**392000**	**54100**	**622000**	**162000**
Mink Liver TPCB LOAEL = 1,698,000 pg/g	**1,668 ng/g**						
(LOAEL from Bursian et al. 2006b)							
PCB 105 2,3,3',4,4'-Pentachlorobiphenyl	0.00003	6350	12100	3510	1020	6470	3380
PCB 114 2,3,4,4',5-Pentachlorobipheny	0.00003	306	637	135	ND	308	187
PCB 118 2,3',4,4',5-Pentachlorobipheny	0.00003	12100	25700	5250	1900	10600	6380
PCB 123 2,3',4,4',5'-Pentachlorobiphenyl	0.00003	ND	103	ND	ND	ND	ND
PCB 126 3,3',4,4',5-Pentachlorobiphenyl	0.1	478	738	114	ND	385	150
PCB 167 2,3',4,4',5,5'-Hexachlorobiphenyl	0.00003	1040	2260	857	191	1100	527
PCB 169 3,3',4,4',5,5'-Hexachlorobipheny	0.03	62	ND	ND	ND	47.3	29.5
PCB 189 2,3,3',4,4',5,5'-Heptachlorobiphenyl	0.00003	473	1800	822	65.8	1420	179
PCB 77 3,3',4,4'-Tetrachlorobiphenyl	0.0001	ND	ND	ND	ND	ND	ND
PCB 81 3,4,4',5-Tetrachlorobiphenyl	0.0003	ND	ND	ND	ND	ND	ND
PCBs 156 + 157	0.00003	6090	12700	6770	1050	13900	2670
TEQs from PCBs		**50.45**	**75.46**	**11.92**	**0.13**	**40.93**	**16.28**

Mink Liver TEQ LOAEL = 40.2 pg/g
(LOAEL from Bursian et al. 2006b, TEFS from Van den Berg et al. 2006)

Appendix 3b1. Upper Niagara River

		BUF-MI-01	BUF-MI-02	UNR-MI-01	UNR-MI-02	UNR-MI-03	UNR-MI-04
	Sample ID	BUF-MI-01	BUF-MI-02	UNR-MI-01	UNR-MI-02	UNR-MI-03	UNR-MI-04
	ALS #	1413494-17	1413494-18	1413494-11	1413494-12	1413494-13	1413494-14
	δN	9.24	9.69	11.58	14.75	15.96	11.34
	Trophic level	**2.72**	**2.85**	**3.41**	**4.34**	**4.69**	**3.34**
Lipids (%/100)	**Brain**	0.0684	0.0523	0.0767	0.0604	0.0649	0.0774
	Liver	0.1380	0.1220	0.0420	0.0813	0.1320	0.0270
Compounds							
Mercury, total (ng/g)		**283**	**588**	**285**	**847**	**1040**	**181**
Mink Brain LOAEL = 21,600 ng/g	**21.6 mg/g**						
(LOAEL from Haynes 2007)							
Total TEQ from PAH, CDD&F, PCB		**31.39**	**9.89**	**70.15**	**56.24**	**32.96**	**44.08**
Mink Liver REP/TEQ LOAEL = 40.2 pg/g							
(LOAEL from Bursian et al. 2006b, TEFS from Van den Berg et al. 2006)							
PAHs (ug/kg=ng/g)	**REPs**						
Naphthalene		1	0.83	0.73	1.00	0.62	0.93
2-Methylnaphthalene		1.5	1.4	0.76	3.40	1.10	3.40
Acenaphthylene		0.28	0.21	0.13	0.19	0.35	0.21
Acenaphthene		0.3	0.27	0.31	0.37	0.47	0.48
Dibenzofuran		0.36	0.47	0.33	0.46	0.30	0.48
Fluorene		0.38	0.37	0.36	0.44	0.44	0.36
Phenanthrene		0.86	0.98	0.65	1.10	0.52	0.73
Anthracene		0.15	0.18			0.21	0.14
Fluoranthene		0.55		0.28	0.52	0.21	
Pyrene		0.61	0.48	1.50	0.66	0.22	0.43
Benz(a)anthracene	1.90E-06		0.32	0.83	0.28	0.18	0.30
Chrysene	2.30E-06		0.31	0.69		0.43	0.27

Benzo(b)fluoranthene	5.10E-06	2.7	0.19				
Benzo(k)fluoranthene	1.40E-04		0.37				
Benzo(a)pyrene	1.60E-06					0.33	
Indeno(1,2,3-cd)pyrene	1.50E-05						
Dibenz(a,h)anthracene	4.60E-06						
Benzo(g,h,i)perylene							
REPs from PAHs		**0.01**	**0.05**	**0.00**	**0.00**	**0.00**	**0.00**
Mink Liver REP LOAEL = 40.2 pg/g							
(LOAEL from Bursian et al. 2006b, TEFS from Villeneuve et al. 2002)							
CDDs and CDFs (ng/kg = pg/g)	**WHO TEFs**						
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.01	8.84	1.99	4.87	1.78	0.827	2.43
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.01	59.2	23.1	34	11.2	7.68	40.7
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	0.01	0.713	0.21	0.595	0.168	0.107	0.325
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	5.73	2.1	4.82	3.63	2.34	1.92
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	1.58	0.59	0.639	0.431	0.269	1.37
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	7.56	1.72	4.99	1.58	1.08	3.17
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	8.31	2.76	7	2.74	2.24	8.94
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.1	ND	0.0312	0.074	0.114	ND	0.0355
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	1.36	0.442	1.01	0.5	0.4	1.34
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	0.03	ND	ND	0.127	0.0525	ND	0.0793
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	1	0.945	0.242	0.864	0.534	0.382	1.06
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	10.8	2.24	8.86	2.08	1.4	4.86
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	0.3	15	4.1	16.3	14.5	7.28	9.27
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	0.1	ND	ND	0.123	0.209	0.0656	0.344
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1	0.695	0.423	0.834	0.737	0.534	1.06
Octachlorodibenzofuran (OCDF)	0.0003	6.59	3.96	7.3	1.92	1.31	4.04
Octachlorodibenzo-p-dioxin (OCDD)	0.0003	217	96.2	174	62	163	96
Heptachlorodibenzo-p-dioxins (HpCDD), Total		59.2	23.1	34.3	11.4	8.08	40.9
Heptachlorodibenzofurans (HpCDF), Total		9.55	1.99	5.49	1.78	0.827	2.54
Hexachlorodibenzo-p-dioxins (HxCDD), Total		9.9	3.79	8	3.67	2.64	11.6

Hexachlorodibenzofurans (HxCDF), Total		24.1	6.06	18.7	7.38	4.82	9.98
Pentachlorodibenzo-p-dioxin (PeCDD), Total		0.945	0.242	0.864	ND	0.382	1.06
Pentachlorodibenzofurans (PeCDF), Total		15	4.1	16.8	14.5	7.59	9.61
Tetrachlorodibenzo-p-dioxins (TCDD), Total		ND	ND	0.834	ND	0.534	1.06
Tetrachlorodibenzofurans (TCDF), Total		ND	0.111	0.207	ND	0.0908	0.344
Total Dioxins and Furans		**342.29**	**139.55**	**266.50**	**102.65**	**189.27**	**177.13**
TEQs from Dioxins and Furans		**10.43**	**3.17**	**9.79**	**6.90**	**4.01**	**7.57**
Mink Liver TEQ LOAEL = 40.2 pg/g **(LOAEL from Bursian et al. 2006b, TEFS from Van den Berg et al. 2006)**							
PCBs (ng/kg = pg/g)	**WHO TEFs**						
Monochlorobiphenyls, Total		ND	ND	ND	ND	ND	ND
Dichlorobiphenyls, Total		88	16.7	19.5	ND	ND	ND
Trichlorobiphenyls, Total		ND	130	195	522	ND	184
Tetrachlorobiphenyls, Total		787	1080	6950	11000	1490	3680
Pentachlorobiphenyls, Total		9770	6230	64600	59000	27200	17800
Hexachlorobiphenyls, Total		55900	69200	273000	306000	148000	90700
Heptachlorobiphenyls, Total		133000	68000	191000	221000	144000	176000
Octachlorobiphenyls, Total		316000	60700	32100	71400	42600	57900
Nonachlorobiphenyls, Total		236000	16600	5690	13400	11600	7220
Decachlorobyphenyls, Total							
Sum PCBs (STW)		751545	221956.7	573555	682322	374890	353484
Total PCBs reported by ALS		**766000**	**225000**	**575000**	**687000**	**379000**	**356000**
Mink Liver TPCB LOAEL = 1,698,000 pg/g **(LOAEL from Bursian et al. 2006b)**	**1,668 ng/g**						
PCB 105 2,3,3',4,4'-Pentachlorobiphenyl	0.00003	2960	1530	11700	12000	6770	4010
PCB 114 2,3,4,4',5-Pentachlorobipheny	0.00003	157	77.4	458	465	329	142
PCB 118 2,3',4,4',5-Pentachlorobipheny	0.00003	5320	3510	19900	20700	12900	5370
PCB 123 2,3',4,4',5'-Pentachlorobiphenyl	0.00003	ND	ND	ND	ND	ND	41.3
PCB 126 3,3',4,4',5-Pentachlorobiphenyl	0.1	169	63.4	573	422	255	285
PCB 167 2,3',4,4',5,5'-Hexachlorobiphenyl	0.00003	827	569	1570	1560	1370	524

PCB 169	3,3',4,4',5,5'-Hexachlorobipheny	0.03	120	ND	58.4	189	84.4	255
PCB 189	2,3,3',4,4',5,5'-Heptachlorobiphenyl	0.00003	995	410	530	633	599	139
PCB 77	3,3',4,4'-Tetrachlorobiphenyl	0.0001	ND	ND	ND	ND	ND	ND
PCB 81	3,4,4',5-Tetrachlorobiphenyl	0.0003	ND	ND	9.62	ND	ND	ND
PCBs 156 + 157		0.00003	4800	4990	9150	13600	8450	1910
TEQs from PCBs			**20.95**	**6.67**	**60.35**	**49.34**	**28.94**	**36.51**

Mink Liver TEQ LOAEL = 40.2 pg/g
(LOAEL from Bursian et al. 2006b, TEFS from Van den Berg et al. 2006)

Appendix 3b2. Upper Niagara River

	Sample ID	UNR-MI-05	UNR-MI-06	UNR-MI-07	UNR-MI-08	UNR-MI-09	UNR-MI-12
	ALS #	1413494-15	1413494-16	1507705-5	1507705-6	1507705-7	1507705-8
	δN	10.30	14.43	16.21	16.50	12.14	15.50
	Trophic level	**3.03**	**4.24**	**4.77**	**4.85**	**3.57**	**4.56**
Lipids (%/100)	**Brain**	0.0928	0.0719	0.0740	0.0740	0.0740	0.0740
	Liver	0.0970	0.1030	0.0970	0.1410	0.1580	0.1720
Compounds							
Mercury, total (ng/g)		**296**	**1280**	**1160**	**338**	**73.7**	**3320**

Mink Brain LOAEL = 21,600 ng/g **21.6 mg/g**
(LOAEL from Haynes 2007)

Total TEQ from PAH, CDD&F, PCB	**144.72**	**43.47**	**93.22**	**37.65**	**71.62**	**976.12**

Mink Liver TEQ LOAEL = 40.2 pg/g
(LOAEL from Bursian et al. 2006b, TEFS from Van den Berg et al. 2006)

PAHs (ug/kg=ng/g)	**REPs**						
Naphthalene				ND	0.88	4.50	ND
2-Methylnaphthalene		2.10	1.20	ND	ND	1.50	0.92
Acenaphthylene		1.90		ND	ND	0.22	ND

Acenaphthene		1.60		ND	ND	0.78	ND
Dibenzofuran		1.50		ND	ND	0.41	ND
Fluorene		3.10	1.10	ND	ND	0.70	ND
Phenanthrene		41.00		3.80	1.10	2.20	ND
Anthracene		3.90		10.00	1.60	0.40	ND
Fluoranthene		13.00		ND	ND	0.79	ND
Pyrene		10.00		ND	ND	0.43	ND
Benz(a)anthracene	1.90E-06	2.70	11.00	230.00	1.00	ND	26.00
Chrysene	2.30E-06	1.30	2.30	ND	2.80	ND	ND
Benzo(b)fluoranthene	5.10E-06			13.00	1.30	ND	ND
Benzo(k)fluoranthene	1.40E-04			14.00	1.10	ND	ND
Benzo(a)pyrene	1.60E-06	2.10		12.00	0.90	ND	ND
Indeno(1,2,3-cd)pyrene	1.50E-05			15.00	1.20	ND	ND
Dibenz(a,h)anthracene	4.60E-06			15.00	1.30	ND	ND
Benzo(g,h,i)perylene				17.00	1.30	ND	ND
REPs from PAHs		**0.01**	**0.03**	**2.78**	**0.19**	**0.00**	**0.05**

Mink Liver REP LOAEL = 40.2 pg/g

(LOAEL from Bursian et al. 2006b, TEFS from Villeneuve et al. 2002)

CDDs and CDFs (ng/kg = pg/g)	**WHO TEFs**						
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.01	21.9	5.84	5.49	4.34	10.9	29.6
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.01	104	19	22.3	64.8	36.4	159
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	0.01	1.43	0.673	0.406	0.403	0.813	1.96
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	3.92	1.63	4.27	1.22	5.39	52.2
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	2.5	0.436	0.559	ND	0.597	5.16
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	6.21	1.71	1.41	0.711	3.86	14.9
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	13.9	4.04	3.95	2.86	4.38	43.6
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.1	ND	ND	ND	ND	ND	ND
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	3.12	0.834	1.28	ND	0.978	4.67
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	0.03	ND	0.125	1.04	ND	ND	0.399

1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	1	1.41	0.469	1.36	0.303	0.457	ND
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	7.17	3.25	2.25	1.41	6.69	15.2
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	0.3	21.5	7.66	7.46	3.09	11.1	134
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	0.1	ND	0.537	9.55	ND	ND	0.861
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1	1.64	0.872	1.36	0.323	0.681	15.2
Octachlorodibenzofuran (OCDF)	0.0003	24.1	96.4	18.5	27.2	18.7	55.3
Octachlorodibenzo-p-dioxin (OCDD)	0.0003	326	110	144	909	148	865
Heptachlorodibenzo-p-dioxins (HpCDD), Total		104	21	49.7	79.2	49.7	175
Heptachlorodibenzofurans (HpCDF), Total		23.6	9.99	22.1	15.2	21.3	42.7
Hexachlorodibenzo-p-dioxins (HxCDD), Total		17	5.31	11	4.1	4.58	54.8
Hexachlorodibenzofurans (HxCDF), Total		17.4	6.74	11.8	4.75	17.3	83.8
Pentachlorodibenzo-p-dioxin (PeCDD), Total		1.41	ND	2.51	ND	0.457	ND
Pentachlorodibenzofurans (PeCDF), Total		21.5	8.52	18.4	3.09	11.4	135
Tetrachlorodibenzo-p-dioxins (TCDD), Total		ND	0.872	ND	0.323	0.681	15.2
Tetrachlorodibenzofurans (TCDF), Total		ND	0.204	12.7	0.801	0.556	0.861
Total Dioxins and Furans		**535.01**	**259.04**	**290.71**	**1043.66**	**272.67**	**1427.66**
TEQs from Dioxins and Furans		**14.56**	**5.20**	**7.65**	**3.15**	**7.19**	**71.25**
Mink Liver TEQ LOAEL = 40.2 pg/g **(LOAEL from Bursian et al. 2006b,** **TEFS from Van den Berg et al. 2006)**							
PCBs (ng/kg = pg/g)	**WHO TEFs**						
Monochlorobiphenyls, Total		ND	ND	ND	ND	ND	ND
Dichlorobiphenyls, Total		ND	58	ND	ND	ND	ND
Trichlorobiphenyls, Total		376	544	312	ND	320	200
Tetrachlorobiphenyls, Total		4790	20400	8180	3860	16600	14200
Pentachlorobiphenyls, Total		100000	178000	97600	45400	86400	397000
Hexachlorobiphenyls, Total		171000	853000	899000	457000	362000	3900000
Heptachlorobiphenyls, Total		129000	787000	316000	174000	272000	2440000
Octachlorobiphenyls, Total		38600	169000	117000	46500	42600	1090000
Nonachlorobiphenyls, Total		12600	34100	40300	17700	7910	238000
Decachlorobyphenyls, Total				28600	10000	3410	84500

Sum PCBs (STW)			456366	2042102	1506992	754460	791240	8163900
Total PCBs reported by ALS			**461000**	**2,050,000**	**1,510,000**	**755000**	**792000**	**8,160,000**
Mink Liver TPCB LOAEL = 1,698,000 pg/g (LOAEL from Bursian et al. 2006b)		**1,668 ng/g**						
PCB 105	2,3,3',4,4'-Pentachlorobiphenyl	0.00003	20500	35300	22800	11200	14900	89300
PCB 114	2,3,4,4',5-Pentachlorobipheny	0.00003	1220	1310	1060	433	619	5300
PCB 118	2,3',4,4',5-Pentachlorobipheny	0.00003	50600	71100	50700	19200	23200	228000
PCB 123	2,3',4,4',5'-Pentachlorobiphenyl	0.00003	ND	ND	147	ND	79.5	176
PCB 126	3,3',4,4',5-Pentachlorobiphenyl	0.1	1250	337	698	284	630	8880
PCB 167	2,3',4,4',5,5'-Hexachlorobiphenyl	0.00003	2400	4300	7230	1980	1670	44400
PCB 169	3,3',4,4',5,5'-Hexachlorobipheny	0.03	86.9	ND	322	144	0	0
PCB 189	2,3,3',4,4',5,5'-Heptachlorobiphenyl	0.00003	597	2260	2730	960	384	21500
PCB 77	3,3',4,4'-Tetrachlorobiphenyl	0.0001	ND	16.9	ND	ND	ND	ND
PCB 81	3,4,4',5-Tetrachlorobiphenyl	0.0003	ND	ND	ND	ND	ND	78.8
PCBs 156 + 157		0.00003	9490	37000	26400	19200	6870	171000
TEQs from PCBs			**130.15**	**38.24**	**82.79**	**34.31**	**64.43**	**904.81**
Mink Liver TEQ LOAEL = 40.2 pg/g (LOAEL from Bursian et al. 2006b, TEFS from Van den Berg et al. 2006)								