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

James M. Haynes and Sara T. Wellman
The College at Brockport, SUNY
350 New Campus Drive
Brockport, NY 14420-2973

May 16, 2016

Executive Summary

1. Only two mink were caught during 4,157 trap-days of effort in the BR AOC during the fall of 2014. This result led to changing the focus of the study to determining mink habitat suitability and analysis of BUI chemicals of concern in mink prey.

2. According to the USFWS Habitat Suitability Index Model, habitat in the BR AOC is poorly suited for mink. On a scale of 0 to 1, the HSI for mink is 0.38.

3. No amphibians were observed in riparian habitats along the Buffalo River in the AOC during ~300 h of searching for them in August, October & November 2014 and April & July 2015.

4. During 35 minnow trap-days in mid-November 2015 and ~6 h of snorkeling to overturn rocks in June and November 2015 combined, far too few crayfish to create three 70 g samples for chemical analyses were caught in the BR AOC.

5. Lower trophic level (bluegill, pumpkinseed and yellow perch) and upper trophic level (largemouth bass) fish samples were composited and analyzed for total mercury, total PCB and total TEQ (sum of PAH REP, PCB TEQ and CDD/CDF TEQ).

6. Among the six composited prey samples analyzed (three each of lower and upper trophic level fish) for BUI chemicals of concern, only three of the 24 analyses (4 chemicals * 6 samples) exceeded dietary LOAELs for mink: two upper trophic level fish samples for total PCB (by 8.4 and 20.1%) and one upper trophic level fish sample for PCB TEQ (by 1.4%).

7. Mink are one of the most sensitive mammals to the chemicals analyzed, especially to TEQ concentrations of CDD/CDF and co-planar PCB congeners which have similar toxic effects. If mink living in the BR AOC ate only largemouth bass from the Buffalo River (the upper trophic level fish analyzed in this study), on average they would exceed the dietary LOAEL for total PCB by 3.6% and not exceed the dietary LOAELs for any of total mercury, PAH REP and TEQ for CDD/CDF and PCB. Since mink eat prey from multiple trophic levels, many at lower levels than largemouth bass, it is very unlikely that mink and other predatory wildlife and birds in the BR AOC are adversely affected by any of the BUI chemicals of concern.

8. We estimated the potential dietary exposures of BR AOC mink to BUI chemicals of concern for both “worst-case” (trophic level 3.7 diet) and “typical-case” (trophic level 2.4 diet) dietary scenarios. Neither diet exceeded any of the dietary LOAELS for BUI contaminants in mink. The trophic levels of mink trapped in our previous RE AOC study, and the two mink trapped in this study, suggest that mink in the BR AOC are consuming diets with trophic levels well below that of our estimated “worst-case” diet, putting them at no increased risk for either deformities or reproductive problems.
9. For the “*Bird or Animal Deformites or Reproductive Problems*” BUI, it would be reasonable to consider the delisting criteria relating to mink to be unimpaired in BR AOC because using a worst case diet scenario for mink and the analytically-determined mean concentrations of BUI contaminants in potential prey a hazard assessment showed that the dietary LOAELs for the contaminants of concern would not be exceeded for mink. Because mink are highly sensitive to mercury and CDD/CDF/PCB TEQ, it is unlikely that other piscivorous wildlife and birds in the BR AOC would be adversely affected by consuming a worst-case mink diet.

Introduction

The Buffalo River Area of Concern (BR AOC) is located on the southwestern side of the City of Buffalo, NY. The AOC extends from the mouth of the river at the confluence of eastern Lake Erie and the upper Niagara River to the farthest point upstream at which backwater conditions exist during Lake Erie’s highest monthly average lake level, or 6.2 miles up-river in the Buffalo River and its Cazenovia Creek tributary. The AOC also includes the 1.4-mile City Ship Canal, located adjacent to the river and to the south along the shore of Lake Erie (Figure 1).

The initially known or suspected causes of the beneficial use impairment (BUI) “*Bird or Animal Deformities or Reproductive Problems*” listed for the BR AOC were polychlorinated biphenyls (PCB) and DDT and its metabolites (Table 1). To maintain consistency with concurrent studies in the Rochester Embayment of Lake Ontario AOC (RE AOC, Table 2) and the Niagara River (NR) AOC (Table 1) the project management team from the DEC and SUNY Brockport decided to study PCB, PAH, CDD/CDF (chlorinated dibenzo-dioxins and dibenzo-furans) and total mercury (Hg) in the BR AOC as well. We aligned the three BUI delisting studies because:

1. Mink (*Neovison vison*) are one of the most sensitive mammals to dioxin-like chemicals but they are not particularly sensitive to pesticides (Giesey et al. 1994; Bursian et al. 2006). Accordingly, DDT and its metabolites (Table 1) are unlikely to cause “*Bird or Animal Deformities or Reproductive Problems*,” in mink, while some chemicals not listed in Table 1 (e.g., CDD/CDF) are likely to cause these problems.

2. Haynes et al. (2007) and Haynes and Wellman (2015) studied exposures of mink and their prey, respectively, to Hg, CDD/CDF, PCB and PAH (2015 prey study only) in the RE AOC and inland areas of western New York. Because these chemicals were likely to be the important hazards with regard to "*Bird or Animal Deformities or Reproductive Problems*" in the BR AOC, focusing on the same chemicals in mink in the BR AOC allowed us to compare results from the BR AOC to mink living in nearby inland "control" areas (Haynes et al. 2007).

During the fall and early winter of 2014 only two mink were captured in the BR AOC during intense trapping efforts. Subsequently, the project management team from the DEC and SUNY Brockport decided to change the study design for the BR AOC again, from a mink study like the one in the Niagara River AOC (QAPP 2013) to a mink prey study (QAPP 2015) like the one in the RE AOC (Haynes and Wellman 2015).

Research questions

1. Are mink present in the BR AOC?
2. What is the extent and quality of mink habitat in the BR AOC?
3. Are concentrations of PCB, CDD/CDF, PAH and total mercury measured in the tissue of resident prey below those known to be associated with mink reproductive failure?

Methods

Mink and their prey in the BR AOC

The BR AOC is an urban landscape. From 4 to 15 August 2014 an experienced mink trapper and the project field crew leader searched for mink signs and identified a few potentially fruitful locations for mink trapping in the Buffalo River riparian zone (Figure 2). Up to 72 conibear traps per day were set among those locations from 25 October to 23 December 2014.

We attempted to capture likely mink prey in the BR AOC using methods identical to those employed in the RE AOC portion of the overall study (Haynes and Wellman 2015).

1. Amphibians were looked for in riparian habitats along the Buffalo River in the AOC for a total of ~300 h in August, October & November 2014 and April & July 2015.
2. Crayfish were looked for by flipping rocks while snorkeling for a total of ~6 h on 15 June and 17 & 21 November 2015 and setting baited minnow traps for a total of 35 trap-days from 14-21 November 2015.
3. On 18 September 2014, 22 April 2015 and 8 July 2015 lower (N=10 per date) and upper (N=5 per date) trophic level fish were captured by boat electrofishing. Each of the six fish samples was composited in a labeled ziplock plastic bag, placed on ice in the field, and frozen in the lab for later chemical analysis.

Extent and quality of mink habitat in the BR AOC

From 9 to 25 September 2015 an experienced mink trapper and the project field crew leader evaluated habitat suitability for mink at 41 sites along the Buffalo River using the U.S. Fish and Wildlife Service's (USFWS) Habitat Suitability Index (HSI) model for mink (Allen 1986). In addition, the trapper gave an experience-based HSI for mink (i.e., likelihood of successfully trapping mink) for each site. Both indices were on scales of 0 (low suitability) to 1 (high suitability), and the same two individuals also did HSI evaluations for the RE AOC.

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).

Trophic levels vary from 1 (herbivores) to 6 (apex predators.) Mink in riparian areas often eat amphibians, crayfish and, predominately, fish (USEPA 1993). Frozen, composited samples of muscle tissue from lower trophic level fish (10 fish*1 g/fish) and upper trophic level fish (5 fish*2 g/fish) were analyzed by the Cornell Stable Isotope Laboratory (COIL) for isotopic ratios of $^{15}N/^{14}N$ (δN) to determine average prey trophic levels.

PCB, CDD/CDF, PAH and mercury concentrations in the tissues of potential mink prey

Frozen, composited, >70g samples of each prey group sample (N=6: 2 prey types*3 samples each) were sent to ALS Global Environmental. Each of the six prey samples was homogenized, and separate aliquots were analyzed for total mercury (USEPA Method 1631app) and PAH congeners (USEPA Method 8270D) in Kelso, WA; CDD/CDF congeners (USEPA Method1613B) in Houston, TX; and PCB congeners (USEPA Method 1668A) by Pace Analytical Services in Minneapolis, MN.

Mink hazard assessment

Concentrations of total mercury, total PCBs and total toxic equivalents (TEQ for PAHs, CDDs/CDFs and co-planar PCBs combined) found in mink prey were used to estimate the maximum potential dietary exposure of mink in the BR AOC. TEQ (where 2,3,7,8-TCDD = 1) for CDD/CDF and PCB congeners was calculated using values from Van den Berg *et al.* (2006).

TEQ for PAH congeners was calculated using relative potency (REP) values from Villeneuve *et al.* (2002). TEQ was summed separately for CDD/CDF, PCB and PAH then all categories were summed to yield total TEQ for each prey group sample.

USEPA (1993) reported the results of 17 studies of mink diet at 25 different locations where the portion of the diet from aquatic sources ranged from 13.4% to 92%. The maximum potential exposure of mink to BUI contaminants in BR AOC water would be represented by the study on a river in lower Michigan (Alexander 1977 cited by USEPA 1993), consisting of 57.5% upper trophic level fish, 27.5% lower trophic level fish, 4% crustaceans and 3% amphibians (total 92% aquatic), and 8% "other" (birds, mammals, vegetation, and unidentified). We used these dietary percentages to represent a realistic "worst-case" dietary exposure to total mercury, total PCBs and total TEQ for mink in the BR AOC. However, since we could find few crayfish and no amphibians, we assumed that they would not make up a significant portion of the mink diet in the BR AOC. We divided the aquatic portion of the diet between upper and lower trophic level fish, in the same relative proportions as in Alexander (1977 cited by USEPA 1993). This resulted in a diet of 30.8% lower trophic level fish, 61.2% upper trophic level fish, and 8% terrestrial prey as our "worst-case" riparian mink diet.

We then averaged the results from the six most relevant diet studies (for riparian mink living along rivers and streams) cited by USEPA (1993: studies averaged were Hamilton 1940; Korschgen 1958; Cowan and Reilly 1973; Alexander 1977a, b; and Burgess and Bider 1980). For each prey category, we averaged the proportion of that category from all six studies to get a "typical" proportion of the diet for that category. A "typical" riparian mink's diet consists of 33.3% upper trophic level fish, 13.5% lower trophic level fish, 10.2% crustaceans and 8.1% amphibians, with a total of 65% from aquatic sources. Once again, we had to allow for the lack of crayfish and amphibians in the BR AOC; in this case we allotted those portions of the diet to terrestrial prey. This resulted in a "typical" diet of 33.3% upper trophic level fish, 13.5% lower trophic level fish, and 53.2% terrestrial prey.

Dietary exposures of mink in the BR AOC were estimated by multiplying the average concentration of each BUI contaminant in each of the two aquatic prey groups by the corresponding portion of mink diet, and summing the results. We did these calculations twice: 1) for the worst-case diet, and 2) for the typical diet. Maximum estimated dietary exposures were then compared to published lowest observed adverse effect levels (LOAEL) reported by Haynes *et al.* (2007). The trophic levels calculated for each prey group were multiplied by that prey group's proportion in the diet (the non-aquatic portion of each diet was assumed to be trophic level 1 and, therefore, with minute amounts of the BUI contaminants), and the results were summed to estimate the trophic levels of diets 1 and 2 above. The estimated dietary trophic levels were then used in a hazard estimate by comparison with known trophic levels of mink (hence diet) determined in the western RE AOC by Haynes *et al*. (2007) and with the two mink that we did catch in the BR AOC.

Results

Mink in the BR AOC

Up to 72 traps per day were set in potential mink-producing habitats (Figure 2) from 25 October to 23 December 2014, for a total of 4,157 trap-days (number of traps set * number of days set). Single mink were caught (Figure 2) on 28 October and 4 November 2014 during 629 trap-days. Both were male with total lengths including tails of 52.0 cm; they weighed 823 g and 520 g. No more mink were trapped during 3,528 trap-days between 5 November and 23 December 2014. Low mink catches per trap day during good weather from 25 October to 4 November (0.0032 mink/d) followed by no captures after 4 November necessitated refocusing the BR AOC study toward mink prey.

Extent and quality of mink habitat in the BR AOC

Little of the area on both the right and left descending banks of the river (Figures 3 & 4) appeared to be suitable mink habitat (Appendix A) according to two (percent vegetation cover within 100m of the shoreline; percent shoreline cover within 1m of surface water) of the three (percent of surface water) criteria used in the USFWS HSI model,). HSI model values averaged 0.38 $\pm$ 0.27 (standard deviation), with 1.0 as optimum habitat. Based on long experience the professional trapper rated average mink habitat suitability for trapping success at 0.14 $\pm$ 0.15. The trapper's lower scores ($P<0.0001$, Paired T-Test; Statistix 2013) were based on the mostly human-constructed character of the Buffalo River shoreline (e.g., vertical concrete walls, rip rap, abandoned and active industrial and commercial buildings) and frequent $\pm$0.5 m water level fluctuations in the river caused by seiches (wind-induced lake level changes) from Lake Erie.

Species composition and trophic levels of samples

Two mink were caught. No amphibians were seen and only a handful of crayfish were caught; therefore, no composited samples were taken for analysis. Fish species caught for the lower trophic level composited samples were bluegill (*Lepomis macrochirus*), pumpkinseed (*L. gibbosus*) and yellow perch (*Perca flavescens*), while upper trophic level fish in each composited sample were all largemouth bass (*Micropterus salmoides*) (Table 3). Fish were sampled by boat electrofishing at regular intervals throughout the entire 6.2-mi extent of the Buffalo River within the AOC and in the City Ship Canal.

Mean trophic level ($\delta N \pm SD$) was 3.50 $\pm$ 0.18 for lower trophic level fish (LF, range: 3.39-3.70), and 4.18 $\pm$ 0.12 for upper trophic level (UF, range: 4.11-4.32) fish (Table 4; Appendix B). The trophic levels of the two groups were significantly different ($P<0.004$, two sample T-Test; Statistix 2013). The trophic level of the two mink caught averaged 2.78 $\pm$ 0.09.

Mercury, PCB, CDD/CDF and PAH concentrations in the tissue of potential mink prey

<u>Total Mercury</u>

Concentrations of total mercury in the three samples of lower trophic level fish (range: 76.20-93.80 ng/g) averaged (84.40 $\pm$ 8.86 ng/g) 83% lower than the dietary LOAEL (500 ng/g; Dansereau *et al.* 1999). Concentrations of mercury in the three samples of upper trophic level fish (range: 183.00-392.00 ng/g) averaged (265.00 ± 111.53 ng/g) 47% lower than the dietary LOAEL for mercury. None of the lower and upper trophic level composited fish samples from the BR AOC exceeded the dietary LOAEL for total mercury (Table 4, Appendix B).

Total PCB

Concentrations of total PCB in the three samples of lower trophic level fish (range: 184,215-658,408 pg/g) averaged (380,689 ± 247,316 pg/g) 60% lower than the dietary LOAEL (960,000 pg/g; Bursian *et al.* 2006). Concentrations of total PCB in the three samples of upper trophic level fish (range: 790,076-1,152,640 pg/g) averaged (994,372 ± 185,613 pg/g) 3.6% higher than the dietary LOAEL for total PCB. Two of the upper trophic level fish samples exceeded the dietary LOAEL for total PCB, but no other fish samples did (Table 4, Appendix B).

PCB TEQ

Data were reported for PCB congeners, including two with TEQ≥0.01 (Appendix B). Concentrations of TEQ from PCBs (calculated using World Health Organization TEFs from Van den Berg *et al.* 2006) in the three samples of lower trophic level fish (range: 0.24-0.70 pg/g) averaged (0.44 ± 0.24 pg/g) 95% lower than the dietary LOAEL (9.2 pg/g; Bursian *et al.* 2006). PCB TEQ in the three samples of upper trophic level fish (range: 2.66-9.33 pg/g) averaged (6.15 ± 3.34 pg/g) 33% lower than the dietary LOAEL for PCB TEQ. One upper trophic level sample exceeded the dietary LOAEL for PCB TEQ by 1.4% but no other fish samples exceeded this LOAEL (Table 4, Appendix B).

CDD/CDF TEQ

Data were reported for CDD/CDF congeners, including 15 with TEQ≥0.01 (Appendix B). Concentrations of CDD/CDF TEQ (calculated using World Health Organization TEFs from Van den Berg *et al.* 2006) in the three samples of lower trophic level fish (range: 0.23-2.72 pg/g) averaged (1.07 ± 1.43 pg/g) 88% lower than the dietary LOAEL (9.2 pg/g; Bursian *et al.* 2006). CDD/CDF TEQ in the three samples of upper trophic level fish (range: 0.18-0.52 pg/g) averaged (0.40 ± 0.19 pg/g) 96% lower than the dietary LOAEL for CDD/CDF TEQ. None of the lower and upper trophic level composited fish samples from the BR AOC exceeded the dietary LOAEL for CDD/CDF TEQ (Table 4, Appendix B).

PAH Relative Potencies (REP=TEQ)

Data were reported for 18 PAH congeners, none of which had a relative potency factor >0.00014 (RPF is similar to toxic equivalency factor, TEF, for CDD/CDF and co-planar PCB). Toxic equivalent concentration (TEQ) from PAHs (expressed as relative potencies, REP, from Villeneuve *et al.* 2002) in the three samples of lower trophic level fish (range: 0.03-0.62 pg/g) averaged (0.31 ± 0.30 pg/g) 97% lower than the dietary LOAEL for PAHs (9.2 pg/g; Bursian *et al.* 2006). Total REP for upper trophic level fish (range: 0.02-0.62 pg/g) averaged (0.29 ± 0.30 pg/g) 97% lower than the dietary LOAEL for PAHs. None of the lower and upper trophic level composited fish samples exceeded the dietary LOAEL for PAH REP (Table 4, Appendix B).

Total TEQ

Concentrations of total TEQ from PCB, CDD/CDF and PAH in the three samples of lower trophic level fish (range: 0.50-3.72 pg/g) averaged (1.82 $\pm$ 1.69 pg/g) 80% lower than the dietary LOAEL (9.2 pg/g; Bursian *et al.* 2006). Total TEQ in the three samples of upper trophic level fish (range: 2.86-10.07 pg/g) averaged (6.83 $\pm$ 3.66 pg/g) 26% lower than the dietary LOAEL for total TEQ. One upper trophic level sample exceeded the LOAEL by 9.5%, a result almost entirely due to PCB TEQ, (93% of total TEQ; Table 4, Appendix B) but none of the other fish samples exceeded this LOAEL.

Mink hazard assessment

Assuming the "worst case" mink diet (in which amphibians and crayfish are replaced by fish): The maximum estimated dietary exposure of mink in the BR AOC would be 188 ng/g (38% of the dietary LOAEL—500 ng/g) for total mercury, 4.7 pg/g (51% of the dietary LOAEL—9.2 pg/g) for total TEQ, and 725,515 pg/g (76% of the dietary LOAEL—960,000 pg/g) for total PCBs. The trophic level of the "worst case" diet (using average trophic levels for each prey group) would be 3.7 (Table 5).

Assuming the "typical" mink diet (in which amphibians and crayfish are replaced by terrestrial prey): The estimated actual dietary exposure in the BR AOC would be 100 ng/g (20% of the dietary LOAEL) for total mercury, 2.5 pg/g (27% of the dietary LOAEL) for total TEQ, and 382,519 pg/g (40% of the dietary LOAEL) for total PCBs. The trophic level of the typical mink diet (using average trophic levels for each prey group) would be 2.4 (Table 5).

Discussion

Too few mink (N=2) were caught during 4,157 trap-days in the fall of 2014 to continue with the original proposal for evaluating the BUI "*Bird or Animal Deformities or Reproductive Problems*" in the BR AOC using mink. This outcome occurred because mink habitat quality in the residential/commercial/industrial BR AOC is low as estimated by the USFWS HSI for mink (0.38/1.0).

To assess potential exposure of mink to BUI contaminants in the BR AOC, we began a mink prey study like the one conducted in the Genesee River portion of the RE AOC (Haynes and Wellman 2015). Likely due to poor riparian habitat, plus channelization and dredging of the Buffalo River in the AOC, no amphibians and few crayfish were seen but lower and upper trophic level fish were caught and analyzed for BUI contaminants.

Trophic levels of potential mink prey

Mean trophic levels of lower (3.50) and upper (4.18) trophic level fish from the BR AOC both were significantly lower ($P<0.0001$; one-way ANOVA, Tukey's HSD) than lower (4.45) and upper (4.88) trophic level fish from the Genesee River portion of the RE AOC (Haynes and Wellman 2015).

Differences in trophic level results between the RE and BR AOCs are explained partially by differences in species composition of the composite prey samples collected in the two AOCs. In addition to largemouth and smallmouth (*M. dolomieu*) bass, one northern pike (*Esox lucius*) was included in each upper trophic level composite sample from the RE AOC (Haynes and Wellman 2015), while only largemouth bass were caught for inclusion the upper trophic level composite samples from the BR AOC. Esocids are exclusively piscivores (higher trophic status) whereas *Micropterus* spp. eat invertebrates and fish (lower trophic status). Similarly, in addition to bluegill and pumpkinseed (*Lepomis* spp.), yellow perch comprised 10-20% of each RE AOC composite sample but were caught for inclusion in only one BR AOC composite (30%). Yellow perch are more piscivorous than *Lepomis* spp. which likely contributed to the higher average trophic status of lower trophic level prey composite samples from the RE AOC than from the BR AOC, and to the higher trophic status of the single BR AOC lower trophic level prey composite which contained yellow perch (Table 4, Appendix B).

Differences in species composition of prey composite samples do not entirely explain the lower trophic status of lower and upper level fish in the BR AOC, however. Using the same sampling gears and methods we caught enough amphibians and crayfish in the RE AOC to form three composite samples of each for the full suite of chemical analyses, whereas no amphibians and few crayfish were seen in the BR AOC. While sufficient lower and upper trophic level prey fish were caught in the BR AOC for subsequent chemical analysis, many more hours of effort were required to capture them. We found greater fish abundance and diversity in the lower Genesee River portion of the RE AOC than in the Buffalo River portion of the BR AOC, likely reflecting poorer habitat quality in the riparian zone of the BR AOC (mostly human-constructed) than in the lower Genesee River portion of the RE AOC (mostly natural riparian zone).

Estimated mink diets

The trophic level of the “worst-case” mink diet in the BR AOC, using the weighted mean of the trophic levels of mink prey captured in the Buffalo River, would be 3.7. The trophic level of mink in our previous study in the western portion of the RE AOC (Haynes *et al*. 2007) ranged from 2.71 to 4.97 with an average of 3.5, corresponding to dietary trophic levels between 1.71 and 3.97 with an average of 2.5. These data indicate it is possible but unlikely that mink actually consume the worst-case diet in the BR AOC. This conclusion is supported by the fact that the average trophic level of the two mink actually caught in the BR AOC was 2.78, corresponding to an average dietary trophic level of 1.78, indicating a high proportion of herbivorous terrestrial prey in their diets.

The trophic level of the” typical” mink diet in the BR AOC, using the trophic levels of Buffalo River prey, would be 2.4. This is just below estimates found in USEPA (1995) for typical mink prey trophic levels which ranged from 2.5 to 2.9. Furthermore, this “typical” estimate for the BR AOC agrees with the results of our previous study (Haynes *et al.* 2007), which had a dietary trophic level of 2.5 for mink prey. Again, the two mink actually caught in the BR AOC had diets well below this trophic level, indicating that even this "typical" diet is a conservative estimate of the BUI contaminant hazard to mink in the BR AOC.

BUI: Bird or Animal Deformities or Reproductive Problems

Mercury, PAH REP (TEQ) and CDD/CDF TEQ

Concentrations of total mercury in the six composite samples of lower and upper trophic level fish from the BR AOC ranged from 15-78% (76.20-392.00 ng/g) of the 500 ng/g dietary LOAEL (Appendix B). Even if mink in the BR AOC ate a diet of only upper trophic level fish with the highest concentration of total mercury found in this study they would have ~390 ng/g of mercury in their diet, 22% less than the dietary LOAEL. Assuming that mink consume the "worst-case" diet, the maximum potential dietary exposure to total mercury would be 188 ng/g, or 38% of the dietary LOAEL. Assuming that mink consume the "typical" diet, the estimated dietary exposure to total mercury would be 20% of the dietary LOAEL. Total mercury does not appear to pose a risk to mink and other wildlife consuming aquatic prey in the BR AOC.

Concentrations of PAH REP in the six composite samples of lower and upper trophic level fish from the BR AOC ranged from 0.2-7% (0.02-0.62 pg/g) of the 9.2 pg/g dietary LOAEL (Appendix B). Even if mink in the BR AOC ate a diet of only fish with the highest concentration of PAH REP found in this study they would have ~0.62 pg/g of PAH REP in their diet, 93% less than the dietary LOAEL. Assuming that mink consume the "worst-case" diet, the maximum potential dietary exposure to PAH REP would be 0.3 pg/g, or 3% of the dietary LOAEL. Assuming that mink consume the "typical" diet, the estimated dietary exposure to PAH REP would be 1% of the dietary LOAEL. PAH REP does not pose a risk to mink and other wildlife consuming aquatic prey in the BR AOC.

Concentrations of CDD/CDF TEQ in the six composite samples of lower and upper trophic level fish from the BR AOC ranged from 2-30% (0.18-2.72 pg/g) of the 9.2 pg/g dietary LOAEL (Appendix B). Even if mink in the BR AOC ate a diet of only fish with the highest concentration of CDD/CDF TEQ found in this study they would have ~2.7 pg/g of CDD/CDF TEQ in their diet, 70% less than the dietary LOAEL. Assuming that mink consume the "worst-case" diet, the maximum potential dietary exposure to CDD/CDF TEQ would be 0.6 pg/g, or 7% of the dietary LOAEL. Assuming that mink consume the "typical" diet, the estimated dietary exposure to CDD/CDF TEQ would be 3% of the dietary LOAEL. It is unlikely that CDD/CDF TEQ poses a risk to mink and other wildlife consuming aquatic prey in the BR AOC.

Total PCB, PCB TEQ and Total TEQ

Concentrations of total PCB in lower trophic level fish from the BR AOC ranged from 19-69% (184,215-658,408 pg/g) of the 960,000 pg/g dietary LOAEL, while concentrations of total PCB in two of the three (range: 790,076-1,152,640 pg/g) samples of upper trophic level fish exceeded the 960,000 pg/g dietary LOAEL by 8.4 and 20.1% (Appendix B). Because the mean concentration of total PCB in upper trophic levels was 994,372 pg/g, or 3.6% higher than the dietary LOAEL, a mink consuming a diet of entirely upper trophic level fish in the BR AOC potentially could be at risk for adverse effects. Assuming that mink consume the “worst-case” diet, the maximum potential dietary exposure to total PCB would be 725,515 pg/g, or 76% of the dietary LOAEL. Assuming that mink consume the “typical” diet, the estimated dietary exposure to total PCB would be 40% of the dietary LOAEL. Based on the trophic levels of mink trapped in both the RE AOC (Haynes *et al*. 2007) and the BR AOC, we believe that total PCB is not likely to pose a risk to mink in the BR AOC.

Concentrations of PCB TEQ in lower trophic level fish from the BR AOC ranged from 3-12% (0.24-0.70 pg/g) of the 9.2 pg/g dietary LOAEL, while concentrations of total PCB in one (9.33 pg/g) of the three samples of upper trophic level fish exceeded the 9.2 pg/g dietary LOAEL by 1.4% (Appendix B). Because the mean concentration of PCB TEQ in upper trophic levels was 6.15 pg/g, or 33% lower than the dietary LOAEL, a mink consuming a diet of entirely upper trophic level fish in the BR AOC probably would not be at risk for adverse effects. Assuming that mink consume the “worst-case” diet, the maximum potential dietary exposure to PCB TEQ would be 3.9 pg/g, or 42% of the dietary LOAEL. Assuming that mink consume the “typical” diet, the estimated dietary exposure to PCB TEQ would be 22% of the dietary LOAEL. Based on the trophic levels of mink trapped in both the RE AOC (Haynes *et al*. 2007) and the BR AOC, we believe that PCB TEQ is not likely to pose a risk to mink in the BR AOC.

Concentrations of total TEQ in lower trophic level fish from the BR AOC ranged from 6-40% (0.50-3.72 pg/g) of the 9.2 pg/g dietary LOAEL, while concentrations of total TEQ in one (10.07 pg/g) of the three composite samples of upper trophic level fish exceeded the 9.2 pg/g dietary LOAEL by 9.5% (Appendix B). Because the mean concentration of total TEQ in upper trophic levels was 6.83 pg/g, or 26% lower than the dietary LOAEL, a mink consuming a diet of entirely upper trophic level fish in the BR AOC probably would not be at risk for adverse effects. Assuming that mink consume the “worst-case” diet, the maximum potential dietary exposure to total TEQ would be 4.7 pg/g, or 51% of the dietary LOAEL. Assuming that mink consume the “typical” diet, the estimated dietary exposure to PCB TEQ would be 27% of the dietary LOAEL. Based on the trophic levels of mink trapped in both the RE AOC (Haynes *et al*. 2007) and the BR AOC, we believe that total TEQ is not likely to pose a risk to mink in the BR AOC.

Hazard analysis

While two of the samples of upper trophic level fish from the BR AOC exceeded the dietary LOAEL for total PCB, and one of those samples exceeded the LOAEL for PCB TEQ, we believe that it is unlikely that any of the chemicals of concern in this report pose a hazard to mink in the BR AOC. The trophic levels of mink trapped in the RE AOC study, and the two mink trapped in this study, suggest that mink in the BR AOC are consuming diets with trophic levels well below those of our estimated “worst-case” and "typical-case" diets, neither of which exceeded any dietary LOAELs.

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 "Deformities or reproductive problem rates are not statistically different from inland background levels as reported by wildlife officials or trained observers conducting tree swallow, mink, and wildlife surveys within the AOC."

This study used published mink diet composition assessments to design a "worst-case diet" (trophic level 3.7) and a "typical diet" (trophic level 2.4) for mink in the Buffalo River AOC, and conducted a hazard assessment for each diet using the analytically-determined mean concentrations of BUI contaminants in the potential mink prey sampled in the AOC. Even the worst-case estimated dietary exposure did not exceed dietary LOAELs for total mercury, total PCB, CDD/CDF, PAH, and total TEQ. If mink living in BRAOC ate *only* largemouth bass from the Buffalo River (the upper trophic level fish analyzed for this study), they would exceed the LOAEL for total PCB by 3.6%. Since mink eat prey from multiple trophic levels, many at lower levels than largemouth bass, it is very unlikely that mink and other predatory wildlife in the BR AOC are adversely affected by any of the BUI chemicals of concern.

Although this study did not provide a direct comparison to inland background levels of reproductive problems or deformities as stated in the BUI delisting criteria, the assessment of mink diet trophic levels and dietary contaminant exposure will enable comparisons with previous studies of inland and lakeshore (Lake Ontario) mink within and outside of the Rochester AOC (Haynes et al. 2007). These comparisons could be evaluated in a future BUI delisting document.

This study did not address the delisting criteria for the "*Loss of Fish and Wildlife Habitat*" BUI in the BR AOC, but the results of the mink Habitat Suitability Index (HSI) analysis indicate that there is habitat impairment due to development, and support the need for the habitat restoration work that is ongoing in this AOC.

Acknowledgments

We thank Anthony Marsocci who led all field activities, tabulated data collected for the BR AOC project and created Figures 2-4; expert mink trapper Randall Baase who evaluated mink habitat quality in the study area; and the people who assisted field collections: Kingdon Barrett, Christopher Hayes, Justin Hulbert, Jeremy Kraus, Chelsea Lipp, Nicholas Marsocci, Kelly Owens, Matthew Pavilaitis, Brendan Ryan, David Sanderson-Kilchenstein, Alexander Silva, Tanner Squires (especially), and Anthony Tornatore.

Literature Cited

Allen, A. W. 1986. Habitat Suitability Index Models: Mink, revised. U. S. Fish and Wildlife Service, Biological Report 82 (10.127). 23 pp.

Bursian, S. J., C. Sharma, R. J. Aulerich, B. Yamini, R. R. Mitchell, C. E. Orazio, D. R. J. Moore, S. Svirsky, and D. E. Tillit. 2006. Dietary exposure of mink (*Mustela vison*) to fish from the Housatonic River, Berkshire County, Massachusetts, USA: Effects on reproduction, kit growth, and survival. Environmental Toxicology and Chemistry 25(6): 1533-1540.

Cabana, G., and J. B. Rasmussen. 1994. Modeling food chain structure and contaminant bioaccumulation using stable nitrogen isotopes. Nature 372: 255-257.

Dansereau, M., N. Lariviere, D. Du Tremblay, and D. Belanger. 1999. Reproductive performance of two generations of female semidomesticated mink fed diets containing organic mercury contaminated freshwater fish. Archives of Environmental Contamination and Toxicology 36: 221-226.

DeNiro, M. J., and S. Epstein. 1978. Influence of diet on the distribution of carbon isotopes in animals. Geochemica et Cosmochemica Acta 42: 495-506.

Ecology & Environment. 2016. Summary of Delisting Criteria and Status for New York State Areas of Concerns (Update). Albany, NY

Ecology & Environment. 2009. Rochester Embayment Area of Concern Beneficial Use Impairment Delisting Criteria Report. Ecology & Environment, 368 Pleasant View Drive, Lancaster, NY 14086.

Fry, B. 1991. Stable isotope diagrams of freshwater food webs. Ecology 72(6): 2293-2297.

Giesy, J. P., D. A. Verbrugge, R. A. Othout, W. W. Bowerman, M. A. Mora, P. D. Jones, J. L. Newstead, C. Vandervoot, S. N. Heaton, R. J. Aulerich, S. J. Bursian, J. P.Ludwig, G. A.Dawson, T. J. Kubiak, D. A. Best, and D. E. Tillitt. 1994. Contaminants in fishes from Great Lakes-influenced section and above dams of three Michigan rivers. II: Implications for health of mink. Archives of Environmental Contamination and Toxicology 27:213-223.

Haynes, J. M., and S. T. Wellman. 2015. BUI Delisting Studies in the Rochester Embayment AOC, 2013-2014. NYS Department of Environmental Conservation. Albany, NY.

Haynes, J. M., S. T. Wellman, and J. J. Pagano. 2007. RAP Progress in the Rochester Embayment of Lake Ontario: Population Monitoring, Trophic Relationships, and Levels of Bioaccumulative Chemicals of Concern in Mink, a Sentinel Species. Final report to the NYS Great Lakes Protection Fund. NYS Department of Environmental Conservation: Buffalo, NY. 146 pp.

Peterson, B. J., and B. Fry. 1987. Stable isotopes in ecosystem studies. Annual Review of Ecology and Systematics 18: 293-320.

NYSDEC. 1994. Niagara River Remedial Action Plan Summary. Albany. NY.

NYSDEC. 1989. Buffalo River Remedial Action Plan. Albany, NY.

QAPP 2013. Quality Assurance Project Plan for Research Needed to Delist BUIs in Three NYS AOCs (GL-97218901-0): Rochester Embayment (Genesee River portion only), Buffalo River and Niagara River Areas of Concern (original). NYS Department of Environmental Conservation, Division of Water, Albany, NY.

QAPP 2015. Quality Assurance Project Plan for Research Needed to Delist BUIs in Three NYS AOCs (GL-97218901-0): Rochester Embayment (Genesee River portion only), Buffalo River and Niagara River Areas of Concern (revision 1). NYS Department of Environmental Conservation, Division of Water, Albany, NY.

Statistix 10. 2013. Analytical Software. Tallahassee, FL.

USEPA. 1993. Wildlife exposure factors handbook: Appendix: Literature review database. U. S. Environmental Protection Agency, Office of Research and Development. Washington, D.C. EPA/600/R-93/187b.

USEPA. 1995. Great Lakes water quality criteria documents for the protection of wildlife. U. S. Environmental Protection Agency, Office of Research and Development. Washington, D.C. EPA/820/B-95/008.

Van den Berg, M., L. S. Birnbaum, M. Denison, M. De Vito, W. Farland, M. Feeley, H. Fiedler, H. Hakansson, A. Hanberg. L. Haws, M. Rose, S. Safe, D. Schrenk, C. Tohyama, A. Tritscher, J. Tuomisto, M. Tysklind, N. Walker, and R. E. Peterson. 2006. The 2005 World Health Organization reevaluation of human and mammalian toxic equivalency factors for dioxins and dioxin-like compounds. Toxicological Sciences 93(2): 223-241.

Villeneuve, D. L., J. S. Khim, K. Kannan and J. P. Giesy. 2002. Relative potencies of individual polycyclic aromatic hydrocarbons to induce dioxin-like and estrogenic responses in three cell lines. Environmental Toxicology 17: 128-137.

Table 1: Niagara River AOC and Buffalo River AOC "Bird or Animal Deformities or Reproductive Problems" BUI information (NYSDEC 1989, 1994; Ecology & Environment 2016).

	Niagara River AOC	**Buffalo River AOC**
Contaminants of Concern	PCBs, BHC, dioxin, dieldrin, chlordane, DDT and DDE, hexachlorobenzene	PCBs, DDT and metabolites
Status of "Bird or Animal Deformities or Reproductive Problems" BUI	Impaired	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.	1) Deformities or reproductive problem rates are not statistically different from inland background levels as reported by wildlife officials or trained observers conducting tree swallow, mink, and wildlife surveys within the AOC; AND 2) Whole body tissue concentrations of contaminants of concern in small mid-trophic level prey fish identified in the AOC are not statistically different than Lake Erie.

Table 2: Rochester Embayment AOC BUI Delisting Criteria related to mink (Ecology & Environment 2009).

BUI	**BUI Status**	**Delisting Criteria**
Bird or Animal Deformities or Reproductive Problems	Impaired	Mink are present and are reproducing, **OR** Levels of PCBs, dioxins/furans, mirex and mercury measured in the tissue of resident prey are below those known to be associated with mink reproductive failure.
Degradation of Fish and Wildlife Populations	Impaired	SAME as above
Loss of Fish and Wildlife Habitat	Impaired	Mink inhabit and reproduce within areas contiguous to the Genesee River and streams within a defined area, **OR** Physical and biological habitat is suitable for mink.

Table 3: Sampling dates and number of potential mink prey species caught in the BR AOC and used for analysis of BUI chemicals of concern.

		18 September 2014	**22 April 2015**	**8 July 2015**
Lower Trophic Level Fish				
Bluegill	*Lepomis macrochirus*	6	5	5
Pumpkinseed	*Lepomis gibbosus*	4	2	5
Yellow perch	*Perca flavescens*	0	3	0
Upper Trophic Level Fish				
Largemouth bass	*Micropterus salmoides*	5	5	5

Table 4. Summary results [mean (standard deviation) of three samples] of mink prey chemical analysis for the BR AOC. Dietary LOAELs (lowest observed adverse effect levels) from Villeneuve *et al*. 2002 and Van den Berg *et al*. 2006.

	Dietary LOAEL	Lower Tropic Level Fish (SD)	Upper Tropic Level Fish (SD)
Trophic Level (δN)		3.50 (0.18)	4.18 (0.12)
Total Mercury (ng/g)	500	84.40 (8.86)	265.00 (111.53)
Total PAH REP (pg/g)	9.2	0.31 (0.30)	0.29 (0.30)
Total CCD/CDF TEQ (pg/g)	9.2	1.07 (1.43)	0.40 (0.19)
Total PCB (pg/g)	960,000	380,689 (247,316)	994,372 (185,613)
Total PCB TEQ (pg/g)	9.2	0.44 (0.24)	6.15 (3.34)
Total REP/TEQ (pg/g)	9.2	1.82 (1.69)	6.83 (3.66)

Table 5: Trophic levels and estimated dietary exposures based on average BUI contaminant concentrations in each prey group compared to the dietary LOAEL for each BUI contaminant.

Chemical	Worst-case diet	Typical diet	LOAEL
Mercury, total, ng/g	188	100	500
TEQ, total, pg/g	4.7	2.5	9.2
REP, PAH, pg/g	0.3	0.1	
TEQ, CDD/CDF, pg/g	0.6	0.3	
TEQ, PCB, pg/g	3.9	2.1	
PCB, total, pg/g	725,515	382,519	960,000
Trophic level	3.7	2.4	

Figure 1: Buffalo River Area of Concern (http://www.epa.gov/buffalo-river-aoc/buffalo-river-aoc-boundary-map)

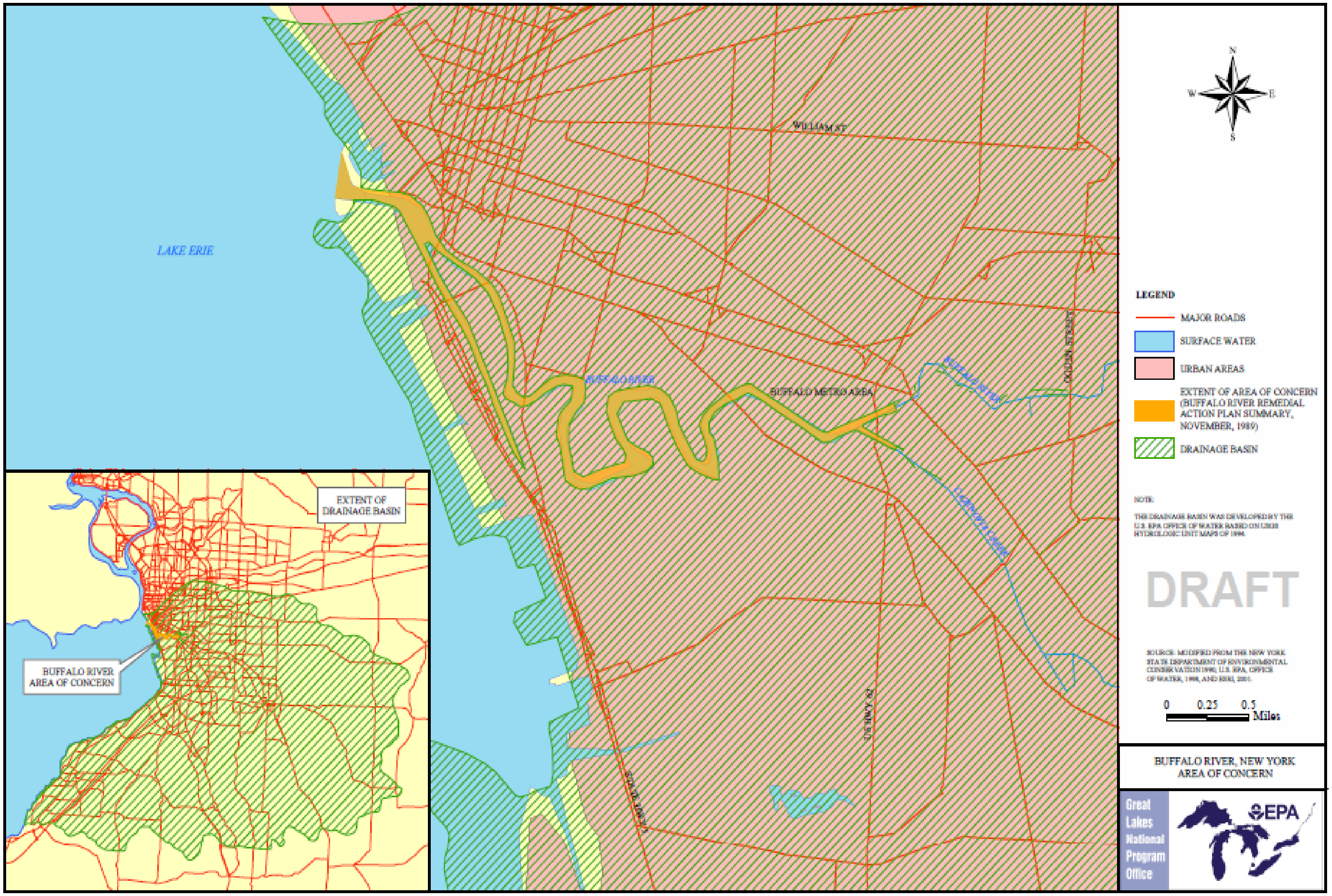

Figure 2: Mink trapping locations in the BR AOC.

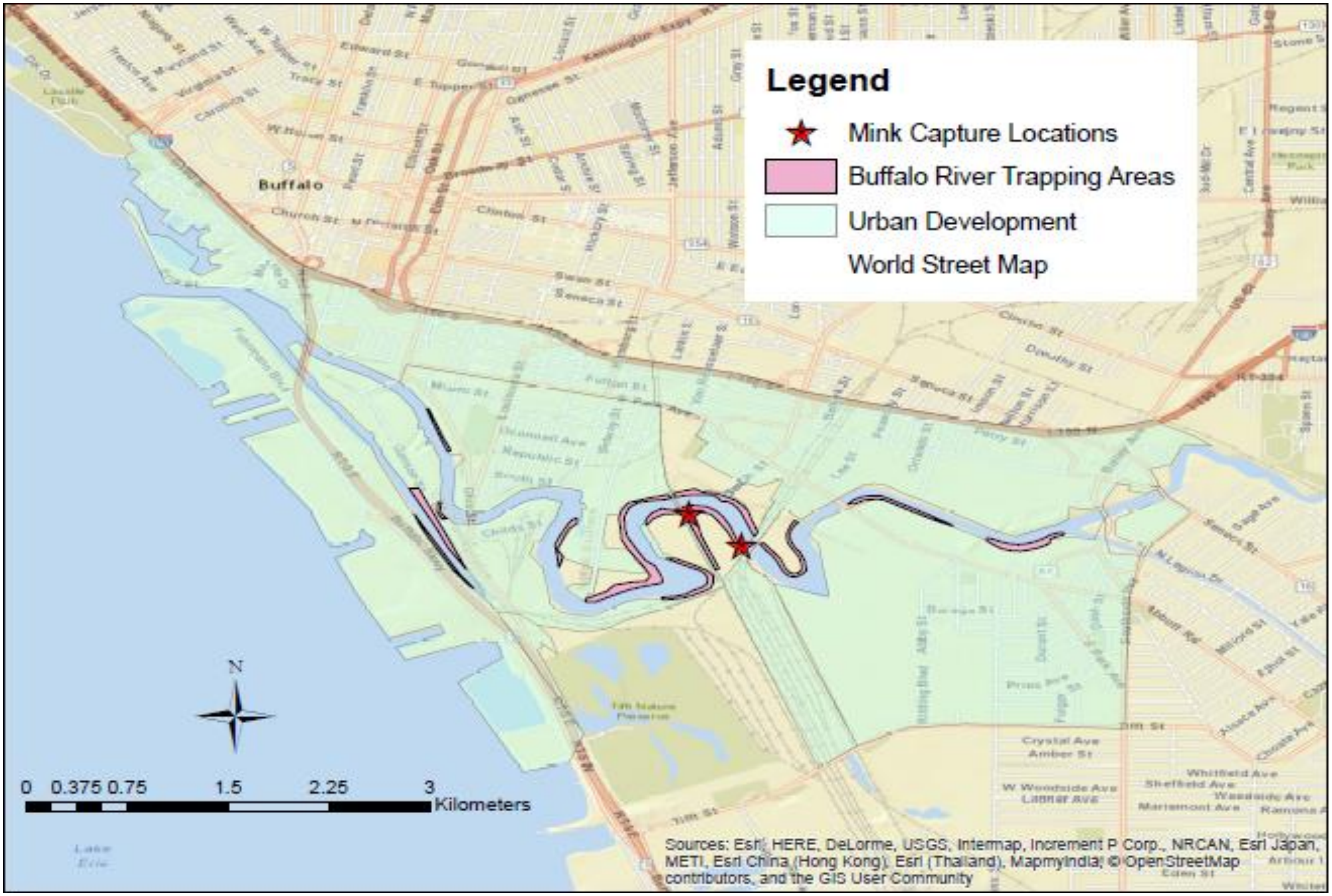

Figure 3: Western end of the BR AOC showing locations where habitat suitability for mink was assessed and areas of marginally suitable habitat for mink trapping. See Appendix A for details.

Figure 4: Eastern end of the BR AOC showing locations where habitat suitability for mink was assessed and areas of marginally suitable habitat for mink trapping. See Appendix A for details.

Appendix A: Habitat suitability for mink in the Buffalo River AOC. See Figures 3 & 4 for locations. Facing upstream: R=right shoreline and L=left shoreline.

Latitude	Longitude	% Surface Water	% Canopy Cover (100m)	% Shoreline Cover (1m)	USFWS HSI	Trapper HSI	Locations and Notes
42.878057	-78.889471	100%	5%	0%	0.13	0.10	R1: Concrete rip-rap and retaining wall. Sparse vegetation growing concrete blocks.
42.877605	-78.884362	100%	5%	5%	0.17	0.00	R2: Boat docks
42.864202	-78.872337	100%	5%	90%	0.41	0.30	R3: Ship Canal. Lots of shrub vegetation. Sandy, rocky shoreline. Some industrial areas. Reconstructed Wetland areas
42.878057	-78.889471	100%	5%	0%	0.32	0.30	R4: Same as above. Lots of constructed wetland areas backed up by light industrial.
42.857409	-78.867598	100%	0%	80%	0.15	0.10	R5: General Mills facility. Heavy industrial area, concrete walls, giant buildings, and parking areas.
42.864097	-78.871723	100%	0%	10%	0.10	0.10	R6: General Mills facility. Concrete walls and Buildings
42.874296	-78.879852	100%	0%	0%	0.18	0.10	R7: Labatt Ice Plex. Restaurant and bar area with large deck and boat dock areas.
42.871368	-78.872754	100%	0%	20%	0.26	0.10	R8: Intermittent concrete and steel walled areas mixed with small shrubby vegetation and rip-rap
42.868600	-78.870487	100%	5%	25%	1.00	0.25	R9: Outside bend of river. Large overhanging trees with brushy vegetation underneath, small areas of rocky beach.
42.863038	-78.869323	100%	80%	90%	0.15	0.00	R10: Beginning of Silo City. Concrete and steel walls with huge abandoned warehouses / silos.
42.862016	-78.869407	100%	0%	10%	0.53	0.20	R11: Very dense brushy vegetation with rough rocky beach.
42.860373	-78.862658	100%	15%	95%	0.47	0.00	R12: Concrete wall 8ft high. Vegetation overhanging retaining wall. Light industry behind.
42.858811	-78.862589	100%	10%	95%	0.47	0.30	R13: Brushy vegetation, concrete, rip-rap. Backed up by rail yard.
42.855892	-78.861888	100%	10%	90%	0.15	0.00	R14: Large concrete warehouse / silo.

42.855563	-78.857999	100%	10%	0%	0.62	0.40	R15: Large overhanging trees, brushy vegetation with lots of woody debris. Rocky beach areas interspersed.
42.856165	-78.854231	100%	80%	25%	0.15	0.00	16: Concrete silo / Warehouse
42.858623	-78.853673	100%	10%	0%	0.62	0.40	17: Brushy vegetation with large overhanging trees. Small rocky beach areas. Large grassland area ~10 acres in size backed up by silos and railroad.
42.861725	-78.855785	100%	25%	90%	0.62	0.40	R18: Thin ~5m area of cattail vegetation with large overhanging trees. Backed up by grassland area.
42.861634	-78.850357	100%	25%	95%	0.47	0.25	R19: Abandoned dock area with thick overgrown vegetation. Backs up to open field with light industrial area.
42.859868	-78.849144	100%	10%	95%	0.13	0.00	R20: Large 12ft tall concrete and steel break wall. Heavy construction equipment and large manufacturing plant.
42.857751	-78.847541	100%	0%	5%	0.22	0.00	R21: Small shrubby vegetation with few trees. Construction area without a break wall. Attempt at wetland conservation area.
42.859774	-78.844628	100%	5%	10%	0.13	0.00	R22: Large steel break wall. Continuation of construction area.
42.86165	-78.844586	100%	0%	5%	0.57	0.25	R23: Short brushy vegetation with moderate tree cover. Wetland conservation are backed up by grassland field. Some large rip-rap piles and concrete.
42.862939	-78.842409	100%	20%	90%	0.88	0.60	R24: Dense vegetation with lots of overhanging tree cover. Very shallow, intermittent muddy beach area.
42.860502	-78.833003	100%	60%	100%	0.13	0.05	L2: Large rip-rap, barbed wire fence and massive fuel storage containers.
42.860807	-78.83239	100%	0%	5%	0.10	0.00	L3: Tall concrete break wall. Fuel storage containers right by water’s edge.
42.863267	-78.837924	100%	0%	0%	0.57	0.20	L4: Thick vegetation and short trees with large chemical processing facility behind tree line. Two outlet pipes to river.
42.863755	-78.841931	100%	20%	90%	0.10	0.00	L5: Concrete break wall, bridge infrastructure and small buildings.

42.862914	-78.843534	100%	0%	0%	0.32	0.10	L6: Rip-rap and short dense vegetation. Storage facility and parking area.
42.861634	-78.845493	100%	0%	75%	0.45	0.10	L7: Tall shrubby vegetation with large grassland area. Some wetland conservation areas.
42.860689	-78.848706	100%	10%	80%	0.76	0.25	L8: Thick shrubby vegetation with large overhanging trees. City park area with lots of people / parking. Beach covered with woody debris.
42.863274	-78.854048	100%	40%	90%	0.76	0.25	L9: Similar vegetation. Chemical processing plant right behind tree line.
42.862457	-78.856945	100%	40%	90%	0.83	0.25	L10: Rough woody / shrubby vegetation. Rocky / rip-rap shoreline with lots of woody debris. Primarily open abandoned industrial area behind.
42.856176	-78.858256	100%	50%	90%	0.41	0.10	L11: Broken docks, new construction. Lots of woody debris and large concrete remnants of abandoned projects.
42.859806	-78.861895	100%	10%	60%	1.00	0.25	L12: Heavily wooded area with huge chunks of broken concrete and large boulders. Lots of woody debris. Backs up to propane storage facility.
42.861883	-78.860503	100%	80%	80%	0.13	0.00	L13: Large dock area with tugboats, high steel and rock retaining walls, and private boat launch areas.
42.864086	-78.862097	100%	5%	0%	0.10	0.00	L14: Heavy industrial area with silos / warehouses. Concrete and steel dock areas.
42.862162	-78.867554	100%	0%	0%	0.10	0.00	L15: Concrete retaining wall, boat dock and mooring area. Large part of property under construction.
42.865185	-78.868625	100%	0%	0%	0.35	0.10	L16: Small city park area, Buffalo State Rowing Club facilities, and a large inlet canal. Large rocks, shrubby vegetation, and developed areas.
42.867411	-78.869354	100%	20%	25%	0.29	0.10	L17: Old abandoned dock areas falling into river, new dock construction, and large rip-rap retaining walls. Lots of construction behind shoreline.
42.871776	-78.871996	100%	10%	25%	0.22	0.00	L18: Large concrete and steel retaining walls the entire way along the downtown harbor. Large boat docks, navy yard, trolley station, and boardwalk.

Appendix B: Results of chemical analyses for mink prey captured in the BR AOC.

	Sample ID	BUF-LF-1	BUF-LF-2	BUF-LF-3	BUF-UF-1	BUF-UF-2	BUF-UF-3
	ALS #	1507699-2	1507699-4	1507699-6	1507699-1	1507699-3	1507699-5
	δN	12.57	11.51	11.57	13.99	14.70	13.96
	Trophic level	**3.70**	**3.39**	**3.40**	**4.11**	**4.32**	**4.11**
Lipids, percent/100	**Prey Composite**	0.0320	0.0190	0.0290	0.0180	0.0450	0.0290
LOAEL levels taken from Haynes *et al*. (2007) Appendix A							
Compounds							
Mercury, total (ng/g)		**76.20**	**93.80**	**83.20**	**392.00**	**183.00**	**220.00**
Dietary Hg LOAEL = 500 ng/g							
Mink Brain LOAEL = 21,600 ng/g							
Total TEQ from PAH, CDD&F, PCB		**3.72**	**1.24**	**0.50**	**10.07**	**7.56**	**2.86**
Dietary (Prey) TEQ LOAEL = 9.2 pg/g							
Mink Liver TEQ LOAEL = 40.2 pg/g							
PAHs (ug/kg=ng/g)	**REPs**						
Naphthalene				1.00		4.40	1.00
2-Methylnaphthalene		2.10	1.40	1.70	2.40	6.10	2.50
Acenaphthylene		1.00	0.93	0.31	1.20	3.90	0.69
Acenaphthene		4.00	2.40	2.10	6.30	10.00	4.00
Dibenzofuran		2.80	1.70	1.70	3.20	11.00	2.80
Fluorene		4.00	2.10	3.20	67.00	14.00	4.90
Phenanthrene		8.20	6.40	18.00	6.90	44.00	17.00
Anthracene		8.90	4.10	4.60	7.20	10.00	1.40
Fluoranthene		9.90	7.90	8.50	3.80	22.00	7.40
Pyrene		12.00	6.50	1.90	5.10	6.70	1.90
Benz(a)anthracene	1.90E-06	43.00	13.00	16.00	9.60	43.00	10.00
Chrysene	2.30E-06						

Benzo(b)fluoranthene	5.10E-06	3.10	1.60		1.40	2.50	
Benzo(k)fluoranthene	1.40E-04	3.30	1.60		1.20	3.30	
Benzo(a)pyrene	1.60E-06	2.80	1.50		0.88	3.60	
Indeno(1,2,3-cd)pyrene	1.50E-05	2.90	1.50		1.40	2.70	
Dibenz(a,h)anthracene	4.60E-06	3.10	1.30		1.30	2.80	
Benzo(g,h,i)perylene		3.40	1.40		1.70	3.00	
REPs from PAHs		**0.62**	**0.29**	**0.03**	**0.22**	**0.62**	**0.02**
Dietary (Prey) TEQ LOAEL = 9.2 pg/g							
Mink Liver TEQ LOAEL = 40.2 pg/g							
CDDs and CDFs (ng/kg = pg/g)	**WHO TEFs**						
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.01	6.11	1.80	2.94	1.99	1.88	2.01
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.01	7.12	5.71	10.40	6.11	5.61	7.04
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	0.01	0.61			ND	ND	
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	**2.07**	0.18		ND	0.13	0.12
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	0.29			0.126	ND	
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	**1.51**	0.12		ND	0.08	0.11
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	0.56	0.30	0.53	0.518	0.41	0.36
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.1	0.47			ND	ND	
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	0.1	0.23	0.13	0.17	0.129	0.11	
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	0.03	1.16			ND	ND	
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	1	**0.28**			0.185	0.23	
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.1	**2.73**	0.11		ND	ND	0.13
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	0.3	**4.17**	0.20		ND	0.23	
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	0.1	**2.14**	0.22		ND	0.32	
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	1	ND			0.167	ND	
Octachlorodibenzofuran (OCDF)	0.0003	9.66	7.39	13.10	8.16	0.78	8.20
Octachlorodibenzo-p-dioxin (OCDD)	0.0003	40.50	34.70	73.10	36.2	35.90	40.00
Heptachlorodibenzo-p-dioxins (HpCDD), Total		19.50	15.70	27.80	17.1	16.10	19.10
Heptachlorodibenzofurans (HpCDF), Total		17.20	9.42	16.70	9.99	9.66	10.50
Hexachlorodibenzo-p-dioxins (HxCDD), Total		4.62	0.89	3.88	2.25	1.57	1.62

Hexachlorodibenzofurans (HxCDF), Total		17.30	1.35	2.08	1.43	1.31	1.84
Pentachlorodibenzo-p-dioxin (PeCDD), Total		1.14			ND	0.23	
Pentachlorodibenzofurans (PeCDF), Total		27.10			0.228	ND	0.13
Tetrachlorodibenzo-p-dioxins (TCDD), Total		ND		0.40	ND	ND	
Tetrachlorodibenzofurans (TCDF), Total		32.80	0.22		ND	0.82	0.61
Total Dioxins and Furans		**169.82**	**69.68**	**137.06**	**75.36**	**66.37**	**82.00**
TEQs from Dioxins and Furans		**2.72**	**0.25**	**0.23**	**0.52**	**0.49**	**0.18**
Dietary (Prey) TEQ LOAEL = 9.2 pg/g	OCDD/Total=						
Mink Liver TEQ LOAEL = 40.2 pg/g							
PCBs (ng/kg = pg/g)	**WHO TEFs**						
Monochlorobiphenyls, Total		ND	ND	ND	ND	110	ND
Dichlorobiphenyls, Total		1160	1100	ND	1640	2850	79
Trichlorobiphenyls, Total		32900	52500	1790	54800	67400	8260
Tetrachlorobiphenyls, Total		83300	155000	12800	165000	208000	62100
Pentachlorobiphenyls, Total		64500	119000	24000	253000	217000	120000
Hexachlorobiphenyls, Total		87800	219000	93000	467000	353000	379000
Heptachlorobiphenyls, Total		23500	90500	37600	148000	143000	174000
Octachlorobiphenyls, Total		4950	18800	13200	48600	40000	40800
Nonachlorobiphenyls, Total		1140	2290	1570	13600	8290	5390
Decachlorobyphenyls, Total		195	218	255	1000	750	447
Sum of PCBs		**299,445**	**658,408**	**184,215**	**1,152,640**	**1,040,400**	**790,076**
Dietary (Prey) TPCBs LOAEL = 960,000 pg/g							
Mink Liver TPCBs LOAEL = 1,698,000 pg/g							
PCB 105 2,3,3',4,4'-Pentachlorobiphenyl	0.00003	2900	565	1610	14600	10200	5930
PCB 114 2,3,4,4',5-Pentachlorobipheny	0.00003	198	410	102	1080	760	412
PCB 118 2,3',4,4',5-Pentachlorobipheny	0.00003	7840	15600	4330	41800	28600	15700
PCB 123 2,3',4,4',5'-Pentachlorobiphenyl	0.00003	108	262	74	725	472	289
PCB 126 3,3',4,4',5-Pentachlorobiphenyl	0.1	ND	ND	ND	ND	50	ND
PCB 167 2,3',4,4',5,5'-Hexachlorobiphenyl	0.00003	488	1300	461	3520	2170	2640

PCB 169	3,3',4,4',5,5'-Hexachlorobipheny	0.03	ND	ND	ND	240	ND	57
PCB 189	2,3,3',4,4',5,5'-Heptachlorobiphenyl	0.00003	100	445	239	845	564	1030
PCB 77	3,3',4,4'-Tetrachlorobiphenyl	0.0001	ND	567	ND	ND	561	258
PCB 81	3,4,4',5-Tetrachlorobiphenyl	0.0003	ND	ND	ND	ND	49	ND
PCBs 156 + 157		0.00003	1030	2980	1160	8330	5080	5220
TEQs from PCBs			**0.38**	**0.70**	**0.24**	**9.33**	**6.46**	**2.66**

Dietary (Prey) TEQ LOAEL = 9.2 pg/g

Mink Liver TEQ LOAEL = 40.2 pg/g