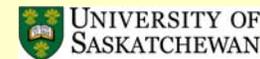


Predicted Average Daily Intakes of PCDFs and PCDDs in American Robins (*Turdus migratorius*) in the Tittabawassee River Floodplain.



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ENTRIX

ABSTRACT

Previous studies have indicated that the Tittabawassee River, located in central Michigan, USA, has elevated levels of polychlorinated dibenzofurans (PCDFs) and polychlorinated dibenzo-*p*-dioxins (PCDDs) in the sediments, floodplain soils, and biota downstream of the city of Midland. A site-specific dietary assessment of American robins (*Turdus migratorius*) residing in the Tittabawassee River floodplain was conducted. Dietary exposure was estimated using site-specific concentrations of representative dietary items as determined by literature-based dietary compositions. Concentrations of the seventeen 2,3,7,8 substituted PCDFs and PCDDs were quantified in select dietary items and normalized to 2,3,7,8 dibenzo-*p*-dioxin equivalents (TEQ) by use of WHO avian TEFs. The upper 95% confidence interval (UCL) for predicted average daily intakes for adults ranged from 2.32 ng/kg body weight/day to 623 ng/kg body weight/day in reference and target locations, respectively, during the spring. 95% UCL predicted average daily intakes for adults during the summer ranged from 1.60 ng/kg body weight/day in reference areas and 265 ng/kg body weight/day in target areas. Nestling/fledgling 95% UCL predicted average daily intakes are as little as 1.64 ng/kg body weight/day in reference locations and 326 ng/kg body weight/day in target areas.

INTRODUCTION

This study was designed to predict average daily intakes of polychlorinated dibenzofuran and polychlorinated dibenzo-*p*-dioxin levels of American robins. The American robin is a useful receptor for the ecological risk assessment of study areas contaminated with bioaccumulative contaminants of concern (COCs) (Henning et al., 2003). American robins have an intimate relationship with soil as a nest building material and soil ingesting invertebrates as dietary components, including earthworms. American robins have a widespread distribution and a limited foraging range. Potential daily intakes are calculated using site-specific dietary data and literature based dietary compositions.

METHODS AND MATERIALS

- Soil and terrestrial invertebrate samples collected from the Tittabawassee River floodplain during 2003, 2004, and 2005.
- Soil samples are collected from 1 x 1 m² plots from which earthworms are collected. Half of the earthworms collected are allowed to depurate prior to preservation.
- Insects are sampled by mercury vapor lamp, aerial and sweep nets, and hand-picking. All are sorted to taxonomic order for order-specific analysis.
- Chemical extraction EPA methods 3540C and 3541
- Analyses of the seventeen 2,3,7,8 substituted PCDF/D congener concentrations in samples are conducted at AgriQuality Limited (Lower Hutt, New Zealand) using EPA method 8290
- All TEQ values based on avian World Health Organization toxicity equivalency factors (Van den Berg et al. 1998)
- The TEQ concentrations are calculated by assigning a proxy value of 1/2 the detection limit (DL) for congeners below the DL.
- Concentrations of TEQ in soil are expressed as ng/kg on a dry weight basis and all biota are expressed as ng/kg on a wet weight basis.
- Literature based dietary compositions calculated for adult robins in the spring and summer (Wheelwright, 1986) and for nestling/fledgling robins (Howell, 1942).



Predicted average daily intake is 200 times greater in target areas.

Figure 1. Literature based dietary compositions for adults in the spring and summer (Wheelwright, 1986) and nestlings/fledglings (Howell, 1942).

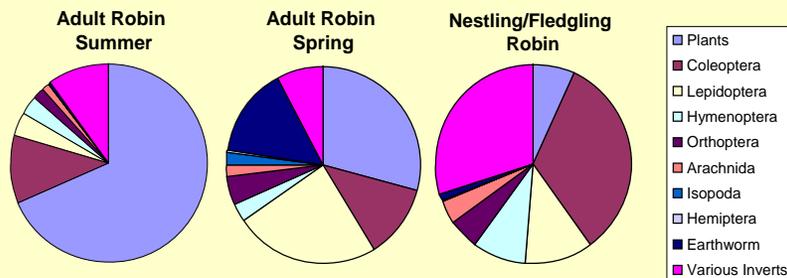


Table 1. Concentrations of TEQ (ng/kg) measured in soil, plants, and terrestrial invertebrates of the Tittabawassee River.

| prey item | Upstream Reference | | Tittabawassee Twp Park | | Imerman Park | |
|---------------|--------------------|---------|------------------------|---------|--------------|---------|
| | mean | 95% UCL | mean | 95% UCL | mean | 95% UCL |
| Plants | 0.65 | 0.96 | 1.91 | 3.01 | 6.66 | 9.95 |
| Soil | 10.9 | 15.4 | 8750 | 12600 | 6980 | 8900 |
| Coleoptera | 4.20 | - | 1900 | - | 391 | 742 |
| Lepidoptera | 1.10 | - | 85.2 | - | 10.9 | - |
| Hymenoptera | 1.84 | - | 22.9 | - | 33.2 | - |
| Orthoptera | 1.25 | 2.58 | 14.4 | - | 14.4 | - |
| Arachnida | 1.76 | - | 42.9 | - | 42.9 | - |
| Isopoda | 1.32 | - | 167 | - | 284 | - |
| Hemiptera | 2.15 | - | 10.4 | - | 5.26 | - |
| Other | 1.32 | 3.07 | 227 | - | 240 | 378 |
| Fresh worm | 1.52 | - | 280 | 465 | 333 | 428 |
| Depurate worm | 1.29 | 1.95 | 194 | 315 | 319 | 461 |

* All samples are a composites of multiple grabs. N = 1 for dietary items with "-" in the 95% UCL column.

Table 2. Predicted average daily intake of TEQs (ng/kg body weight/day) for robins in the Tittabawassee River floodplain.

| Dietary Composition | Upstream Reference | | Tittabawassee Twp Park | | Imerman Park | |
|---------------------|--------------------|---------|------------------------|---------|--------------|---------|
| | mean | 95% UCL | mean | 95% UCL | mean | 95% UCL |
| Adult (Spring) | 1.81 | 2.32 | 597 | 623 | 206 | 340 |
| Adults (Summer) | 1.17 | 1.60 | 239 | 265 | 105 | 160 |
| Nestling/fledgling | 1.27 | 1.64 | 287 | 326 | 143 | 213 |

* 95% UCL predicted average daily intake is calculated using 95% UCL values for items with N>1 and the total TEQs for items with N=1.

Figure 1. Predicted average daily intake calculation.

$$\text{Predicted average daily intake (ngWHOavian / kg BW / d)} = \sum \frac{m}{k} (C_k \times FR_k \times NIR_k)$$

* Normalized Ingestion Rate (NIR) = 1.36 g / g BW/day, food intake = 110g/d, and body mass = 81g.

Funding was provided through an unrestricted grant from The Dow Chemical Company to Michigan State University

RESULTS AND DISCUSSION

95% upper confidence limit (UCL) toxic equivalency (TEQ) concentrations in soil and dietary items are higher in target areas than in reference areas. 95% UCL TEQ concentrations measured in reference area soils are as low as 15.4 ng/kg (dry weight) while target location soils exhibit 95% UCL TEQ concentrations as high as 12600 ng/kg (dry weight). TEQ concentrations of dietary items ranges from 1.10 ng/kg (wet weight) in lepidoptera in reference areas to 1900 ng/kg (wet weight) in coleoptera in target areas. (Table 1). In reference areas, 95% UCL predicted average daily intakes for adult robins are 2.32 ng/kg body weight/day during the spring and 1.60 ng/kg body weight/day during the summer. In target locations, 95% UCL predicted average daily intakes are as high as 623 and 265 ng/kg body weight/day in the spring and summer, respectively. Nestling/fledgling 95% UCL predicted average daily intakes range from 1.64 ng/kg body weight/day in reference areas and 326 ng/kg body weight/day in target locations. (Table 2).

CONCLUSIONS

- 95% UCL soil TEQ concentrations are as much as 800 times greater in target locations than in reference locations.
- 95% UCL fresh earthworm TEQ concentrations are as much as 200 times greater in target locations than in reference locations.
- 95% UCL Predicted average daily intake for American robins is greater in target areas than in reference areas for both adults and nestlings/fledglings.
- 95% UCL Predicted average daily intake for American robin adults is greater during the spring than in the summer.
- 95% UCL predicted average daily intake for American robin adults is over 200 times greater in target areas than in reference areas during the spring.
- Mean predicted TEQs of pooled diet samples are as high as 347 ng/kg in robin nestling/fledgling diet in target areas which is higher than TEQs in pooled diet samples of tree swallows of the Woonasquatucket River, 226 ng/kg, where nest success was 30-41% lower than reference areas. (Custer 2005).

REFERENCES

- Henning et al. (2003) *Environ. Toxic. and Chem.* 11: 2783-2788.
- Van den Berg et al. (1998) *Environ. Health Perspect.* 106: 775-79.
- Howell (1942) *American Midland Naturalist*. 28: 529-603.
- Wheelwright (1986) *Auk* 103: 710-725.
- Custer et al. (2005) *Environ. Toxic. and Chem.* 24: 93-109



Target area earthworm TEQs over 100 times greater.