



National Food Safety and Toxicology Center

Great Horned Owl Dietary Exposure to PCDF/Ds in the Tittabawassee River Floodplain in Midland, MI



ENTRIX



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ABSTRACT

The Tittabawassee River, located in central Michigan, contains elevated concentrations of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in sediments, floodplain soils, and fish downstream of Midland, MI. The potential impacts of these compounds on wildlife inhabiting the terrestrial ecosystem was investigated, with the Great Horned Owl (GHO) as an indicator species. The site-specific GHO dietary composition was determined by analyzing prey remains found in occupied nests and egested pellets collected from the base of nest and roosting trees. Rabbits comprised approx. 83% of the GHO dietary intake (based on biomass). Passerine birds, meadow voles, mice, and shrews completed the 2005 GHO diet. To predict exposure of GHO to PCDF/Ds along the Tittabawassee River small mammals were sampled at two locations upstream and four locations downstream of Midland, MI. Rabbits were sampled at one location upstream and two locations downstream of Midland, MI. The average daily intake (ADI) of PCDF/DF was predicted by use of a weighted average dietary concentration expressed as 2,3,7,8-tetrachlorodibenzo-p-dioxin equivalents (TEQ).

INTRODUCTION

The elevated PCDF/DD levels in the Tittabawassee River floodplain soils and sediments has prompted an examination of its impact on the terrestrial ecosystem.

As top predators great horned owls have the potential to be exposed to high contamination levels via bioaccumulation. By taking advantage of the owls' practice of egesting the undigestible fur and bones of its prey, researchers can reconstruct the owls' diet on a site-specific basis. This data can then be used to determine the GHO's dietary exposure to contaminants.

This study was designed to evaluate the great horned owl's site-specific dietary exposure to furans and dioxins by analyzing PHAH levels in identified prey items.

METHODS AND MATERIALS

- Dietary items were collected from great horned owl nests in the study area and identified to the lowest taxonomic level possible.
- Prey items were collected from the study area in locations adjacent to identified GHO nests. Small mammals were sampled at two locations upstream and four locations downstream of Midland, MI. Rabbits were sampled at one location upstream and two locations downstream of Midland, MI.
- After homogenization prey items were analyzed for PCDF/D concentrations.
- Chemical extraction followed EPA method 3540C and 3541.
- Congener-specific PCDF/DD analysis was conducted with GC/high resolution MS following EPA method 8290.
- Results are corrected based on recoveries and non-detect congeners = 1/2 detection limit
- Great horned owl food intake rate is based on literature values.
- Great horned owl average potential daily dose estimated based on avian-specific World Health Organization (WHO_{avian}) TCDD equivalency factors.



Great horned owl prey remain analysis



Eastern Cottontail Rabbit

Deer Mouse

ACKNOWLEDGEMENTS

This project would not have been possible without the extraordinarily dedicated personnel who gave months of their lives to the process of scraping fur from bones and identifying the results.

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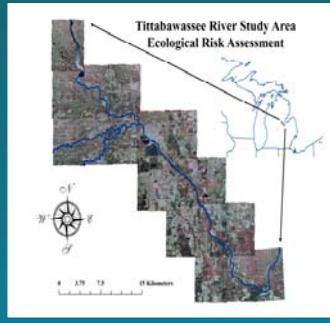
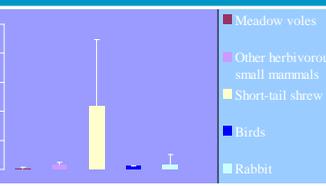
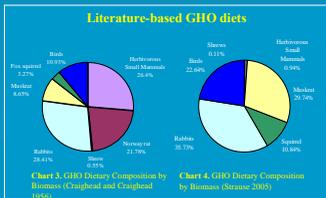
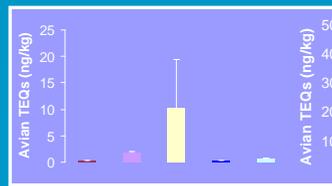
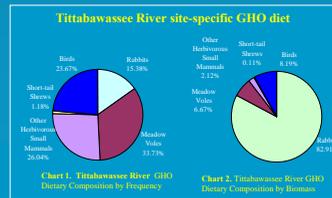


Table 1. Mean (SD) avian TEQ concentrations (ng/kg ww) for GHO dietary components in the Tittabawassee River floodplain and the estimated GHO potential daily dietary exposure (ADD_{pot}).

Species	% of GHO diet (by biomass)	UPSTREAM		DOWNSTREAM	
		TEQs (ng/kg ww)	GHO Add _{pot} (ng/kg/day)	TEQs (ng/kg ww)	GHO Add _{pot} (ng/kg/day)
Meadow voles	6.67	0.263 (.05) n=2	0.001	26 (35.5) n=3	0.125
Other herbivorous small mammals	2.12	1.889 (.06) n=39	0.003	162 (88.9) n=101	0.253
Short-tail shrews	0.11	10.2 (9.2) n=14	0.001	2170 (2300) n=33	0.172
Birds*	8.19	0.295	0.002	127	0.749
Rabbits	82.91	0.669 (0.095) n=5	0.038	168 (338) n=11	10.03
TOTAL GHO ADD _{pot} (ng/kg/day)			0.045		11.329

*Bird TEQs extrapolated from literature values



RESULTS AND DISCUSSION

Prey remains and egested pellets were collected from 5 nests in the study area. Analysis of the dietary items (n=169) shows a preponderance of meadow voles, birds, and rabbits in the GHO diet (see chart 1). The site-specific GHO diet varies considerably from literature-based diets from the Michigan area (charts 3 and 4). Determining the GHO's site-specific diet eliminates the levels of uncertainty that would result from utilizing literature-based diets in this dietary exposure analysis. While meadow voles numerically dominate the Tittabawassee River GHO diet, it is important to note that rabbits constitute the majority of biomass consumed by the owls (chart 2) and as a result contribute the highest fraction of the GHO's daily dietary exposure to PCDF/Ds (table 1). The two major congeners in the dietary items are 2,3,4,7,8-PeCDF and 2,3,7,8-TCDF.

The GHO potential daily dietary exposure to PCDF/Ds (table 1) was calculated using the daily wildlife dose equation for dietary exposure (the GHOs normalized ingestion rate is 72g/kg/day).

$$ADD_{pot} = \sum_{k=1}^m C_k \times FR_k \times NIR_k$$

The avian TEQ concentrations for birds were estimated using tree swallow data from the Custer *et al* study in Rhode Island and sediment concentrations from the Tittabawassee River. The actual TEQ concentrations in birds along the Tittabawassee River may vary from the listed values.

Analysis of the GHO ADD_{pot} shows that GHO dietary exposure to PCDF/Ds is significantly higher in the floodplain downstream of Midland, MI (11.329ng/kg/day versus 0.045 ng/kg/day upstream). However, the concentration of PCDF/Ds in the GHO diet is in the range of TCDD concentrations considered safe for avian consumption (10-12 ng/kg ww) and would not be expected to induce adverse effects. The relatively low dose stems from the owls' tendency to consume herbivores, which are exposed to a minimal amount of contamination in their own diets. If the owls were to heavily predate animals with higher trophic status (such as the shrew) their estimated dietary dose would be expected to increase. The data from this study highlight the importance of dietary composition in understanding and predicting contaminant exposure.

Future efforts will broaden the understanding of the site-specific GHO diet as prey items are collected from nests in the coming years. Data from these efforts may impact the current predicted GHO exposure.

CONCLUSIONS

- The site-specific Tittabawassee River GHO diet differs from literature-based GHO diets.
- Rabbits comprise the primary route of GHO exposure to PCDF/Ds.
- GHOs in the Tittabawassee Floodplain may receive a potential average daily dose of 11.329 ng TEQ_{WHOavian}/kg/day, which falls within "safe" dietary doses.
- The predicted GHO dietary exposure to PCDF/Ds may change as birds from the floodplain are analyzed for contaminant concentrations.
- These data are based on one year's analysis of GHO diet and may change as the study progresses and the GHO diet is further quantified.

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Mean upstream PCDF/D concentrations in GHO dietary components

Mean downstream PCDF/D concentrations in GHO dietary components