

PCDF and PCDD accumulation rates for three passerine species as part of a site-specific risk assessment on the Tittabawassee River

MP203

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ABSTRACT

Dietary accumulation of both polychlorinated dibenzofurans (PCDFs) and dibenzo-p-dioxins (PCDDs) in passerine birds nesting in the Tittabawassee and Chippewa River floodplains near Midland, Michigan was examined in both the aquatic and terrestrial food webs. Historical chemical production around the turn of the century is a possible source of the PCDF/PCDD compounds currently occurring downstream of Midland. Mean concentrations of PCDF/PCDDs in soil and sediment were 10- to 20-fold greater downstream (target sites) and downstream (n=133) of Midland as one part of a large scale site-specific ecological risk assessment of the Tittabawassee River floodplain during the 2005 and 2006 breeding seasons. Soil, sediment, and local insect samples were collected from selected grids at both upstream and downstream sites that corresponded with specific nest box locations for contaminant analyses. Seventeen 2,3,7,8 (PCDF/PCDD) congeners were measured in all samples and converted to TEQs using WHO_{Avian} TEQ values. Concentrations of TEQs in eastern bluebird, house wren, and tree swallow eggs, nestlings and dietary items along with soil and sediment were used to estimate site-specific accumulation rates. WHO_{Avian} TEQs for house wren, tree swallow, and eastern bluebird eggs ranged from 107-2290 (n=22), 15.1-451 (n=15), and 31.0-1050 (n=11) pg/g wet weight (ww) downstream of Midland while nestling concentrations of TEQs for nestlings ranged from 70.8-1190 (n=23), 225-963 (n=8), and 47.6-865 (n=12) pg/g ww, respectively. Site specific congener profiles were dominated (80-90%) by 2,3,4,7,8-PeCDF and 2,3,7,8-TCDF at target compared to reference areas. Avian TEQ concentrations for nestlings were better indicators of local contamination compared to egg concentrations due to restricted foraging ranges of adults during brood rearing.

INTRODUCTION

- Site located in Midland Co, Michigan, USA on the Tittabawassee River (Fig. 1.)
- Elevated concentrations of PCDFs and PCDDs downstream of Midland, MI [1]
- Upstream ("reference", RAs) and downstream ("target", TAs) areas identified
- Receptor species of interest: tree swallow (*Tachycineta bicolor*, TS), house wren (*Troglodytes aedon*, HW), and eastern bluebird (*Sialia sialis*, EB)
- Results are representative of only a preliminary dataset

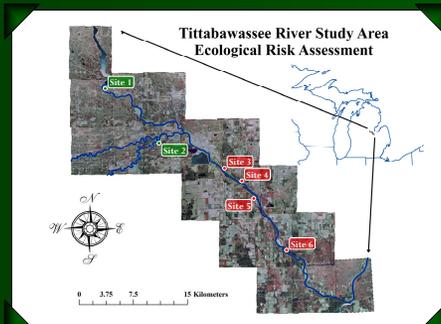


Fig. 1. Tittabawassee River study area in Midland Co, Michigan, USA. Upstream reference areas (1 & 2) and downstream target areas (3-6) are indicated, all study sites were located within the Tittabawassee, Chippewa, and Pine River 100-yr floodplains.

METHODS

- Nest boxes placed at 2 reference areas (n=69) and 4 target areas (n=133) in 2004 and monitored during the 2005, 2006, and 2007 breeding seasons
- Egg and nestling samples collected April-August (2005 and 2006)
 - Fresh eggs collected within 4 days of incubation
 - Added eggs salvaged opportunistically
 - HW nestlings were sampled on day 10 post hatch
 - EB and TS nestlings were sampled on day 14 post hatch
- Processed eggs were lyophilized
- Concentrations are based on mass at laying minus eggshell
- Nestlings were homogenized whole minus beak, stomach contents, legs, and feathers
- Chemical extraction followed EPA method 3540C & 3541
- Chemical analyses followed EPA method 8290
- Results were corrected based on recoveries and non-detected congeners equal 1/2 detection limit
- TEQ concentrations are based on avian-specific World Health Organization (WHO_{Avian}) TCDD equivalency factors [2]
- Predicted average daily intake [3] of WHO_{Avian} TEQs (pg/g body weight/day) was calculated by species using site specific diets using a resampling approach for concentration data to determine dietary intake centiles
- Accumulation rates and accumulation ratios were calculated based on total mass (pg) of contaminant in the sample

RESULTS AND DISCUSSION

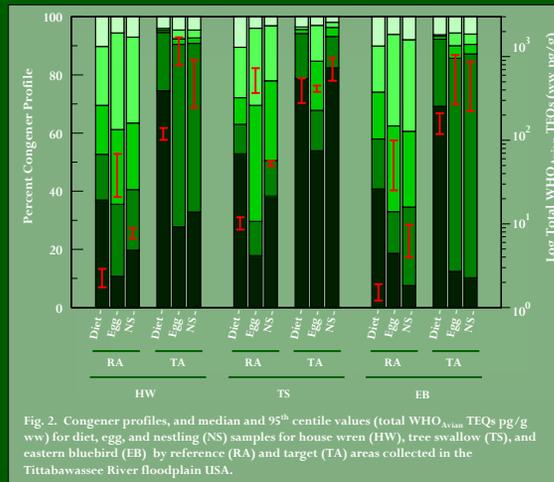
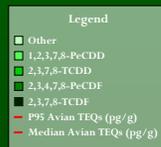


Fig. 2. Congener profiles, and median and 95th centile values (total WHO_{Avian} TEQs pg/g ww) for diet, egg, and nestling (NS) samples for house wren (HW), tree swallow (TS), and eastern bluebird (EB) by reference (RA) and target (TA) areas collected in the Tittabawassee River floodplain USA.



- WHO_{Avian} TEQs at target areas are made up of 80-90% PCDF congeners (2,3,4,7,8-PeCDF / 2,3,7,8-TCDF) (Fig. 2.)
- Tree swallow egg WHO_{Avian} TEQs are similar at reference and target areas, while congener profiles at target areas are composed of greater percentages of PCDF congeners

- Egg WHO_{Avian} TEQs in this study are similar to those measured in Custer *et al.* [4], which were correlated with decreased hatching success for tree swallows at 2,3,7,8-TCDD contaminated areas compared to a reference area
- Accumulation rates at reference areas for tree swallows and eastern bluebirds are negative due to elevated total amounts (pg) of PCDFs and PCDDs in eggs relative to nestlings (Table 1.)
- Accumulation rates (when normalized to nestling body mass at collection) were lesser than predicted average daily intakes (Table 1.)
- Corresponding nest productivity analyses for samples from these areas are reported on an accompanying poster (MP178 - Reproductive success of three passerine species as part of a site-specific risk assessment on the Tittabawassee River.)

Table 1. 50th and 95th centile accumulation rates (pg ww WHO_{Avian} TEQ/day) and ratios of accumulation between life stages (nestling/egg) of house wren, tree swallow, and eastern bluebird by reference area (RA) and target area (TA) on the Chippewa and Tittabawassee Rivers, Midland, MI, USA.

	Accumulation rate				Accumulation ratio			
	RA		TA		RA		TA	
	P50	P95	P50	P95	P50	P95	P50	P95
House wren	6.14	3.17	242	635	1.50	1.11	2.84	2.15
Tree swallow	-27.9	-136	308	659	0.695	0.352	5.68	5.33
Eastern bluebird	-8.32	-2.54	220	685	0.617	0.944	3.08	3.73

CONCLUSIONS

- Concentrations of PCDFs in HW, TS, and EB eggs and nestlings in this study are some of the greatest recorded regardless of species' trophic level
- Concentration ranges of WHO_{Avian} TEQs in egg samples at reference areas are expanded and likely due more to parental exposure during migration or on wintering areas than site specific exposure
- WHO_{Avian} TEQs, composed mostly of two PCDF congeners at target areas in nestlings collected from the flood plain, are indicative of site specific local exposure
- Actual accumulation rates are 2-21 times lesser than predicted by percent daily intake equations, which would be expected (i.e. <100% assimilation rate)
- All data presented represent the currently available data and should be considered preliminary

Still to come...

- Continued site specific residue analyses of nestling samples is recommended to determine any temporal trends in congener bioavailability and accumulation from possible remedial actions
- Additional data analyses including box specific accumulation rates and actual dietary ingestion rates based on site specific bolus samples will be possible when analytical sample analyses are completed
- Future research will include residue analyses of additional egg and nestling samples (including egg screens for possible co-contaminants) and site specific dietary bolus samples

LITERATURE CITED

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