

MEMORANDUM

TO: A. Brouillet and S. Kaelber-Matlock
FROM: Hector Galbraith
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SUBJECT: Review of recently published studies on effects of dioxin-like contaminants on tree swallows and mink.

1. INTRODUCTION

GES (2003) and GES (2004) detail the results of studies performed to evaluate the risks posed by organochlorine contaminants to ecological resources inhabiting the aquatic and floodplain ecosystems of the Tittabawassee River, Michigan. These studies utilized both site-specific data and available information from the scientific literature. Subsequent to the GES (2003) and GES (2004) reports being finalized, another three studies that have bearings on the results of the ecological risk assessments have become available. The purposes of this memorandum are to describe the results of these studies (on tree swallows and mink), and to discuss implications for the results of the existing ecological risk assessments.

2. TREE SWALLOWS

During the three-year period 1998-2000, Custer *et al.* (2003) performed studies of the potential effects of organochlorines on the reproduction of tree swallows nesting along the Housatonic River in western Massachusetts. Beginning in the 1930's, this river and its floodplain became contaminated with high levels of PCBs. Trace amounts of PCDDs and PCDFs have also contaminated the riverine and riparian environments.

Custer *et al.* (2003) erected groups of nest boxes at 5 contaminated sites along the river and at one reference site with only background levels of PCH contamination. Reproductive performance was studied in these study populations. PCB contamination in the eggs and nestlings were also quantified at each site. Concentrations of PCDDs and PCDFs were also quantified, though largely as an additional check, since it was thought at the commencement of the study that PCBs would be responsible for any effects found. Sample sizes (i.e., numbers of nesting attempts) at the six sites varied from 25 to 95. TCDD-EQ in the eggs and nestlings were calculated using WHO avian and Kennedy TEFs.

Total PCB concentrations in eggs and nestlings from the non-reference study sites (up to 190 ppm) generally exceeded those from reference sites by factors of 5 - 10. PCBs contributed about 90% of the total TCDD-EQs in the samples. 2,3,7,8-TCDF, 2,3,4,7,8-PeCDF, 1,2,3,7,8-PeCDF,

and 1,2,3,4,6,7,8-HpCDF were found above detection limits in >50% of the non-reference area samples; 2,3,7,8-TCDF contributed most of the TCDD-EQ due to PCDDs and PCDFs. The effects of the contaminants on tree swallow reproduction were analyzed using logistic regression models. When entered separately into the models, both total PCBs and PCDFs had significant adverse effects on reproduction (reduced hatching success). This was also the case for the TCDD-EQs attributable to PCDDs/PCDFs, though not to PCBs. However, when entered simultaneously into the model, neither PCBs nor their TCDD-EQ had a significant adverse effect on hatching success, though PCDDs/PCDFs and their TCDD-EQ did. This result led Custer *et al.* (2003) to speculate that, contrary to their original assumptions and despite the fact that the vast majority of the total TCDD-EQ were contributed by PCBs, the reduced hatching success at the non-reference sites may have been largely due to PCDDs/PCDFs and that the apparent contribution by PCBs may be an artifact of the fact that concentrations of both contaminants in eggs and nestlings are highly correlated.

Custer *et al.* (*in press*) explored further the potential effects of PCDDs/PCDFs on tree swallow reproduction by carrying out nest box studies at a site in Rhode Island, Woonasquatucket, highly contaminated by TCDD but not by PCBs. The TCDD contamination in the sediments at this site exceeds 5,000 ppt, and results from the local manufacture of the pesticide Hexachlorophene. Custer *et al.* (*in press*) worked at this site for two breeding seasons (2000 and 2001) and found that hatching success was negatively correlated with TCDD egg concentrations and was significantly lower at the impact site (about 50%) than at a reference site (77-92%). The mean concentration of TCDD in tree swallow eggs from the impact site was 826 ppt, compared with <30 ppt at the reference site. From these data, Custer *et al.* (*in press*) were able to estimate an egg hatching success LC50 of 1,700 ppt TCDD (WHO avian TEFs).

Custer *et al.* (*in press*) also were able to quantify TCDD and TCDF uptake factors from the invertebrate diet to the nestling tree swallows by collecting food samples from their ligatured throats. This showed that the TCDF concentrations in the nestlings were generally 6-9 times higher than in the diet. 2,3,4,7,8-PeCDF concentrations in the nestlings were generally 1.5-8.7 times higher than in the diet. TCDD concentrations in the nestlings were generally 5-8 times higher than in the diet.

3. MINK

This study by Bursian *et al.* (2003) has not yet been published in the scientific literature but has been made available on the Internet at: <http://www.epa.gov/region1>. Like the Custer *et al.* (2003) tree swallow study, this investigation was carried out using materials from the PCB-contaminated Housatonic River in western Massachusetts. The aim of the Bursian *et al.* (2003) study was to determine the extent to which PCB-contaminated fish from the Housatonic River might pose risks to mink, an organism known to be sensitive to organochlorines.

Carp and goldfish caught from the contaminated area of the Housatonic were fed to captive mink in the laboratory, as was a control diet of Atlantic Ocean herring. The average total PCB concentrations in the two samples were 113.3 and 0.05 ppm, respectively. By varying the proportion of Housatonic River fish in the diet, 6 PCB dose levels varying from 0.03 to 3.7 ppm

(1 - 68.5 ppt TCDD-EQ) were fed to the mink. 90% of the TCDD-EQ in the Housatonic River fish was contributed by PCBs. Each dose group comprised 12 individual female mink and, after >2 months of dosing, the female mink were mated and their reproduction observed.

No effects of dosing by contaminated fish were found for: duration of gestation period, fertility among females, litter size, adult survival or organ weights. However at the highest dose level (68.5 ppt TCDD-EQ in the diet), kit body masses and survival at 3 and 6 weeks after being born were significantly reduced relative to the controls. From the kit survival results, Bursian *et al.* (2003) estimated dietary NOAELs and LOAELs of 16.1 and 68.5 ppt TCDD-EQ. However, sub-acute effects of dosing the captive mink were observed at dose levels lower than these thresholds: a significantly increased incidence of jaw lesions was found among the kits of female mink fed a dietary level of only 9.2 ppt TCDD-EQ. Thus, the threshold for this effect is, apparently, considerably lower than the kit survival thresholds.

4. IMPLICATIONS FOR MDEQ ECOLOGICAL RISK ASSESSMENTS

Tree Swallow Results

Four results that have implications for the MDEQ ecological risk assessments emerge from the two Custer *et al.* studies:

- Under field conditions on at least two contaminated sites dioxins and furans have been shown to adversely impact the reproductive success of tree swallows, a species hitherto regarded as not being particularly sensitive to dioxin-like contaminants. Previous studies of organochlorines and tree swallows have focused on PCBs. These two studies are the first that have focused on dioxins and furans.
- At the Housatonic River where PCBs are the main contaminants and dioxins and furans are present at relatively low concentrations, contrary to what might be expected from the relative TCDD-EQ contributions, dioxins and furans may have been the main causes of reproductive impairment. PCB, dioxin, and furan concentrations are typically correlated in biological samples and relatively few studies have focused on the latter two contaminants. This raises the possibility that some of the effects attributed to PCBs in previous studies may have been due to dioxins and/or furans.
- Custer *et al.* (in press) calculated an egg TCDD-EQ LC50 of 1,700 ppt. This result may be translated into hatching success thresholds using extrapolation factors between LC50 and NOAEL/LOAEL values. If values of 10 are used to extrapolate from the LC50 to the LOAEL and NOAEL (a total uncertainty factor of 100), the estimated NOAEL value is 17 ppt TCDD-EQ. If less protective extrapolation factors of 5 are used (a total uncertainty factor of 10) the estimated NOAEL is 170 ppt TCDD-EQ. These estimated values straddle the ranges for Most and Less Sensitive species developed in MDEQ (2003), providing further support for the validity of these ranges.

- Previous studies have predicted that 2,3,7,8-TCDF may not be passed up food chains and accumulated by vertebrates to the extent that TCDD is. This is based on the assertion that 2,3,7,8-TCDF may be more readily metabolized and excreted by vertebrates. However, the wood duck and hooded merganser egg data in GES (2003) do not support these assumptions and suggest that 2,3,7,8-TCDF may be bioaccumulated as readily as TCDD. The Custer *et al* (2003) study also provides support for this: the TCDD uptake factor (diet-nestling) was 5-8, compared with 6-9 for 2,3,7,8-TCDF, and 1.5-8.7 for 2,3,4,7,8-PeCDF. In GES (2003) it was assumed that the uptake factor for 2,3,7,8-TCDF was a factor of 29 lower than that of TCDD. This, if the Custer *et al.* (2003) results are more generally applicable, may have resulted in underestimating the risks posed by this congener. Also, in MDEQ's terrestrial risk assessment (GES, 2004) the uptake factor for TCDF was assumed to be between 2 and 50 times less than that for TCDD. This, again, may also result in an underestimation of risk.

Mink Results

The dietary toxicity reference value used in GES's (2003) aquatic ecological risk assessment for mink was 1 ppt TCDD-EQ. This was based on empirical results reported in the scientific literature (where reported values were generally lower than 10 ppt TCDD-EQ). Bursian *et al.* (2003) suggest that their results support a dietary LOAEL of 68.5 ppt TCDD-EQ and a NOAEL of 16.1 ppt. However, Bursian *et al.* (2003) also found that morphological lesions among mink kits occurred at dose levels as low as 9.2 ppt TCDD-EQ. Since these mink were raised in the laboratory, rather than in the wild, the subsequent survival implications of these lesions could not be assessed. To be adequately protective in an ecological risk assessment, it should be assumed that a relevant NOAEL should be based on, but lower than, this latter (9.2 ppt) value. Using an uncertainty factor of 10, this reduces the threshold value to 0.92 ppt TCDD-EQ, which provides support for the value used in GES (2003).

5. REFERENCES

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