Evaluation of Risk to Onondaga Lake Bald Eagles Posed by PCB-Contaminated Prey

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SUMMARY

Elevated concentrations of polychlorinated biphenyls (PCBs) have been documented in animals that are likely to be consumed by Onondaga Lake bald eagles. To determine the potential risk to these birds from consumption of contaminated prey, the U.S. Fish and Wildlife Service (FWS) used measured concentrations of PCBs in Onondaga Lake fish to estimate Onondaga Lake bald eagles' dietary PCB exposure. Estimated dietary concentrations were compared to information in the peer-reviewed literature that reports avian dietary PCB concentrations and observed effects – or lack of effects – on endpoints such as reproductive success and survival. Based on this comparison, the range of estimated Onondaga Lake bald eagle dietary exposure is below levels where risk would be expected. However, there is some uncertainty associated with this conclusion.

ANALYSIS

To assess the potential risk to Onondaga Lake bald eagles from consumption of PCB-contaminated prey, the FWS: 1) estimated the likely range of Onondaga Lake bald eagle dietary PCB exposure, 2) conducted a literature review of the potential effects of PCBs on eagles, and 3) identified uncertainties associated with this analysis.

ESTIMATED ONONDAGA LAKE BALD EAGLE DIETARY PCB CONCENTRATIONS

This analysis estimates dietary PCB exposure to Onondaga Lake bald eagles using site-specific fish tissue PCB concentration data. Though Onondaga Lake bald eagles are known to feed heavily on fish, the exact species composition in the diet of Onondaga Lake bald eagles is unknown. To address this uncertainty, we evaluated high and low exposure scenarios, which represent the full range of mean PCB concentrations in Onondaga Lake fish species for which data are available. That is, the high scenario assumes that eagles consume only the fish species with the highest average PCB concentration (walleye), and the low scenario assumes that the eagles consume only the species with the lowest average PCB concentration (brown bullhead) (Table 1).

TABLE 1 **ONONDAGA LAKE BALD EAGLE EXPOSURE SCENARIOS AND CORRESPONDING DIETARY PCB CONCENTRATIONS**

EXPOSURE SCENARIO	MEAN PCB CONCENTRATION[1] (MG/KG WB WW)
Low Exposure – Assumes diet is 100% Brown Bullhead	0.31
High Exposure – Assumes diet is 100% Walleye	6.70

Note:
[1] Data Source: NYSDEC/TAMS Onondaga Lake Project Database.
WB WW = whole body wet weight.

LITERATURE STUDIES OF THE EFFECTS OF PCBS ON BALD EAGLES

To assess the potential for eagles to experience adverse effects from Onondaga Lake dietary PCB exposure, we conducted a search of the peer-reviewed literature. This search did not identify any studies that examined the relationship between dietary PCB concentrations alone and adverse effects on bald eagle reproductive success, overall productivity, or survival.[1] To fill this gap, we used a proxy species for which dietary PCB effects information is available – the pheasant (Dahlgren and Linder 1971). Farmahin et al. (2013) evaluated the relative sensitivity of avian species to dioxin-like compounds, including PCBs, categorizing the pheasant as a more sensitive species than the bald eagle. For this reason, its use as a proxy species is more likely to overestimate than underestimate risk to bald eagles.

Dahlgren and Linder (1971) find a pheasant lowest observable adverse effects dietary level (LOAEL) based on reproduction, behavior, and survival of 1.8 mg PCB/kg body weight/day. Assuming an average bald eagle weighs 4.5 kilograms, it could consume a daily dose of up to 8.1 milligrams of PCBs before experiencing adverse effects (see calculation below).

Adverse Effects Dose	=	LOAEL	x	Bodyweight
*(**8.1** mg PCBs/day)*		*(**1.8** mg PCB/kg bodyweight/day)*		*(**4.5** kg)*

Bald eagles consume approximately 0.09 kilograms of food per kilogram of bodyweight, meaning that a 4.5 kilogram eagle would consume 0.405 kilograms of food per day (Buehler 2000). To contain 8.1 milligrams of PCBs, 0.405 kilograms of food would need to have a PCB concentration of 20 mg/kg (see calculation below).

Adverse Effects Food Concentration	=	Adverse Effects Dose	/	Food Consumption Rate
*(**20** mg PCBs/kg)*		*(**8.1** mg PCBs/day)*		*(**0.405** kg/day)*

[1] Studies that evaluated PCB effects in bald eagles were generally confounded by co-contamination from highly toxic DDE, so they were not used in this evaluation.

20 mg/kg is higher than the fish-based dietary concentrations in either the high or low exposure scenarios, indicating that risk to bald eagles is unlikely at Onondaga Lake (Table 2).

TABLE 2 COMPARISON OF SCENARIO PCB CONCENTRATIONS TO ADVERSE EFFECTS CONCENTRATIONS

SCENARIO AND CORRESPONDING PREY ITEM	MEAN PCB CONCENTRATION[1] (MG/KG)	CALCULATED ADVERSE EFFECTS CONCENTRATION (MG/KG)
Low Exposure - Brown Bullhead	0.31	20.0
High Exposure - Walleye	6.70	

Note:
[1] Data Source: NYSDEC/TAMS Onondaga Lake Project Database.

UNCERTAINTIES

There is uncertainty associated with both this analysis' estimate of Onondaga Lake bald eagle dietary PCB concentrations and the conclusions that can be drawn from comparison of these concentrations to the literature. The analysis evaluates PCB exposure assuming that Onondaga Lake bald eagles consume a diet that ranges in PCB concentration between the most contaminated and least contaminated species of Onondaga Lake fish for which data are available. However, Onondaga Lake bald eagles are known to feed heavily on gizzard shad, a fish species for which data are not available, and on waterfowl such as the common merganser and mallard. Gizzard shad are expected to have PCB tissue concentrations between the range of Onondaga Lake brown bullhead and walleye, and therefore bald eagle consumption of gizzard shad is unlikely to result in exposure outside the range examined in this analysis. Waterfowl, such as mallards, feed on plants and invertebrtates and typically accumulate low concentrations of PCBs, whereas piscivorous waterfowl, such as mergansers, may accumulate greater concentrations of PCBs. If Onondaga eagles consume piscivorous waterfowl as a large proportion of their diet, dietary exposure to PCBs may be higher than estimated.

The relative lack of information available from the literature concerning the effects of PCBs on bald eagles also introduces uncertainty. There are no known toxicological studies that evaluate reductions in endpoints such as reproductive success or survival in bald eagles exposed to PCBs alone, so this analysis relies on comparison to effects observed in a more sensitive proxy species – the pheasant. However, this determination of relative sensitivity to PCBs is based on a single study – if eagles are in fact more sensitive to PCBs than pheasants, risk would be higher. Additionally, although modeled dietary PCB concentrations are lower than literature-based adverse effect thresholds, additional stressors such as other contaminants may increases eagles' susceptibility to PCB toxicity.

References

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