To:	Project File
Client:	Minnesota DNR, Northmet Project
From:	Laura Judd
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Subject:	Effects of mercury (Hg) and methylmercury (MeHg) on bald eagle (*Haliaeetus leucocephalus*) populations in the Great Lakes region

Bald eagles have been used as sentinel species indicative of environmental contaminant exposure by piscivorous wildlife for decades, and the effects of mercury (Hg) on bald eagle populations have been studied since the 1980s (Wierda et al., 2009). In the Great Lakes region (Michigan, Minnesota, Wisconsin, Ohio and Ontario), routine monitoring of Hg in the blood and feathers of nestling and adult bald eagles is on-going; with particular focus on the Voyageurs National Park (VNP) in northeastern Minnesota. Numerous studies have been conducted since the mid-1980s to determine whether Hg is having detrimental effects to eagle reproduction and/or mortality, and to date, no study has found a relationship between mercury body burdens and diminished reproductive success or other adverse effects in bald eagles (Bowerman et al, 1994; Grim and Kallemeyn, 1995; Chan et al, 2003; Pittman, 2010; Pittman et al, 2011).

Bald eagles have been shown to have an inherent ability to metabolically demethylate methylmercury (MeHg, the most toxic form of mercury) in critical organs such as the brain and liver, thus rendering the MeHg to less toxic forms. There is also evidence in the scientific literature which suggests that dietary selenium can mitigate the neurotoxic effects of MeHg in bald eagles (Scheuhammer et al, 2008). Furthermore, bald eagle feathers are thought to act as a Hg sink, sequestering 49%-93% of the total Hg body burden, which is then eliminated from the body with each molt (Pittman, 2010). In one case study, Hg mining-related wastes were deposited directly into Pinchi Lake in British Columbia, Canada, where Hg in sediment was measured at levels up to several thousand ug/kg (ppb). Although blood levels of Hg in bald eagle chicks and adults from Pinchi Lake were significantly greater than Hg blood levels in eagles from reference lakes, over two seasons, nesting success was not significantly different on Pinchi Lake compared to reference lake data, nor was there

any evidence of physical abnormalities, abnormal behavior or lack of coordination in eagles with elevated Hg in blood (Chan et al, 2003).

The ability to demethylate MeHg and the toxicodynamics of MeHg and selenium appear to be species-specific, however. While river otter have been found to be able to metabolize Hg and increase selenium in their brains similar to bald eagles, species such as the common loon and mink appear to lack these detoxification mecahnisms (Scheuhammer et al, 2008). Recent studies have also indicated that Hg exposure in bald eagles produces subclinical neurochemical changes with unknown consequences (Rutkiewicz et al, 2011).

Hg levels in eagles are currently below levels observed in the 1980s in the Great Lakes region (Wierda et al, 2009), including VNP. Since 1989, annual geometric mean mercury concentrations in the feathers of nestling bald eagles at VNP decreased by 77.4% from 1989 to 2010. Some portion of this decline has been attributed to impounded lake level stabilization that was implemented in 1999 (Pittman et al, 2011). However, recent sampling at VNP (Pittman, 2010) and elsewhere in the Great Lakes (Wierda et al, 2009) indicates that mercury levels in bald eagle feathers may be beginning to rise again. This increase is consistent with other vertebrate monitoring programs in Michigan as well. The consensus in the literature attributes this rise to increased coal consumption in Asia and resulting atmospheric deposition (Pittman, 2010; Wierda et al, 2009).

In summary, bald eagles are relatively insensitive to the toxic effects of mercury in the environment, and are unlikely to show population-level effects via exposure through mercury in food items such as fish. Regionally, mercury exposure to eagles and other wildlife is significantly lower today compared with exposures in the past, when eagle populations were in decline due to unrelated factors such as pesticide exposure.

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