Chlorinated Contaminant Trends in Indicator Species, Great Blue Herons and Double-crested Cormorants, in the Strait of Georgia, 1973-2000

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Extended Abstract

Chlorinated chemicals are contaminants of ongoing concern to wildlife managers because many are poisonous and resistant to breakdown and therefore circulate through the food webs. Great blue herons (*Ardea herodias*) and double-crested cormorants (*Phalacrocorax auritus*) are near the end of the food chain and thus are useful as indicators of the exposure and effects of these contaminants on birds and of the degree of contamination of the Georgia Basin ecosystem.

Great blue heron eggs were collected from up to 23 colonies and double-crested cormorants eggs were collected from up to six colonies along south coastal British Columbia from 1973-2000. Eggs from 23 heron and six cormorant colonies were analyzed for organochlorine pesticides (OC) and polychlorinated biphenyls (PCBs). Eggs from a subset of 15 heron colonies and all six cormorant colonies were analyzed for polychlorinated dibenzo-*p*-dioxins (PCDDs) and dibenzofurans (PCDFs). Eggs from a subset of two heron colonies and one cormorant colony were analyzed for polybrominated diphenyl ethers (PBDE) flame retardants. A retrospective study on mercury burdens in archived cormorant eggs from one colony was also conducted.

In heron eggs, OC pesticides declined sharply in the late 1970s, after which there were minimal changes (Elliott et al. 1989; Harris et al. 2003). Heron colonies along the Fraser Delta had the highest levels of most pesticides, particularly *p,p'*-DDE and chlordanes. The higher OCs in the Fraser Delta heron are likely driven by estuarine processes such as greater bioaccumulation rates due to particulate deposition from watershed and higher biomagnification rates due to species differences at lower trophic levels, as well as past agricultural use (Harris et al. 2003). PCBs in herons showed similar marked decline over time (Harris et al. 2003). Urban heron colonies had higher PCBs compared to rural and pulp-mill influenced colonies. The congener pattern was not different between heron colonies suggesting urban sources contribute to background contamination. However, that trend for PCBs was not observed in cormorants, possibly due to differences in the degree of residency of the two species as cormorants may move into the Puget Sound area during some of the year.

The primary sources of PCDD/Fs were the pulp and paper mills that released effluent into the Strait and the Fraser River. In both herons and cormorants, dominant PCDD/F congeners fell markedly in the early 1990s after pulp mills changed from molecular chlorine bleaching, and use of chlorophenolic wood preservatives and anti-sapstains was restricted (Elliott et al. 2001; Harris et al. 2003).

Toxic equivalent concentrations (TEQs) sufficient to produce embyrotoxicity in heron chicks were measured in eggs from 1985-1991 at some colonies (Bellward et al. 1990; Hart et al. 1991; Sanderson et al, 1994; Henshel et al. 1995). Despite reduction in PCDD/Fs, estimated TEQs remained elevated throughout the 1980s at some urban heron colonies due to PCB contributions (Elliott et al. 2001). Based on total TEQs and effects in siblings of the cormorant eggs analyzed here, cormorants may have exhibited significantly elevated EROD activity and/or brain asymmetries at all colonies from 1973-1989 and even at some colonies during the 1990s (Sanderson et al. 1994; Henshel et al. 1997; Harris et al. 2003).

Mercury burdens in cormorant eggs declined about threefold between 1970 and 2000. Prior to about 1970, pulp and paper mills were major contributors of environmental mercury contamination along the British Columbia coast. Although those mills may continue to contribute to mercury loading, emissions were significantly reduced when the use of mercurial slimicides was banned in the early 1970s. Recent concerns focus on mobilization of mercury from man-made reservoirs (Hughes et al. 1997) and the widespread and apparently increasing deposition of atmospherically transported mercury from coal-fired utilities and municipal waste incineration (Swain et al. 1992; Fitzgerald et al. 1998). Based on the levels in cormorant eggs from coastal British Columbia, past mercury discharges from pulp mills have not had a lasting impact on local food chains.

Polybrominated diphenyl ethers (PBDEs) are flame retardants added to many household items. Recently they were placed on the Second Priority Substances List (PSL2) under the Canadian Environmental Protection Act (CEPA), thereby

mandating assessment of their toxicity to the environment and to human health. A retrospective study of PBDEs in heron eggs collected from the colony near the University of British Columbia and cormorant eggs collected from Mandarte Island showed that in both species, levels of these chemicals increased almost two-hundredfold from the early 1980s to 2000. The significance of these chemicals on resident wildlife and their ecosystems is presently unclear.

Long-term trend monitoring of persistent contaminants in local marine and estuarine food chains is valuable to a variety of government agencies and interest groups in assessing chemical risks to ecosystems. Continued monitoring of select avian species such as the great blue heron and double-crested cormorant should continue given the ongoing presence of industrial and municipal sources and the potential increase in atmospheric deposition of some pollutants in the Georgia Basin.

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