

CHLORINATED HYDROCARBON LEVELS IN EGGS OF OSPREY NESTING NEAR PULP MILLS IN BRITISH COLUMBIA, CANADA.

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ABSTRACT: In 1991 and 1992, the eggs of Osprey (*Pandion haliaetus*) were collected from several nests upstream and downstream of pulp mills on the Fraser, Thompson and Columbia river systems in British Columbia (B.C.). 2378-TCDD and 2378-TCDF levels were significantly higher in eggs downstream of the pulp mills. Unusually high levels of HpCDDs and OCDDs were found upstream and downstream. Principal component analysis of contaminants suggests that osprey nesting in B.C. spend the winter in at least three areas in Central and South America.

INTRODUCTION: For several years the Canadian Wildlife Service has measured chlorinated hydrocarbon levels in heron and cormorant eggs, and established these species as indicators of pollution in coastal waters (Whitehead *et al.*, 1992¹; Elliott *et al.*, 1989²). In 1991 and 1992, we measured contaminant levels in osprey eggs collected from lakes and rivers in five geographically separated areas in B. C. A major goal of the study was to determine if the eggs of a migratory species like the osprey could be used as indicators of local industrial pollution.

METHODS: In 1991 and 1992, a single egg/nest was collected from 5-10 nests upstream and downstream of pulp mills on the Thompson River near Kamloops (T), and on the Kootenay and Columbia rivers near Castlegar (C). Additional samples were collected from nests upstream on the Nechako River (N), downstream of pulp mills at Quesnel on the Fraser River (Q) and Skookumchuck on the Kootenay River (S). Individual eggs were analyzed for PCDD/Fs, PCBs, several OC pesticides and chlorophenols. Detailed methods for the collection and storage of specimens, and analytical methods are given

elsewhere (Turle *et al.*, 1991³; Norstrom *et al.*, 1990⁴). Due to the skewed nature of the data, geometric means and 95% confidence intervals were calculated, and comparisons were made using nonparametric tests (Kruskal Wallis). Where multiple comparisons were made, multiple individual tests were done, and the individual p-values were adjusted using Bonferroni's technique.

RESULTS AND DISCUSSION: In 1991, 2378-TCDD levels were significantly higher in osprey eggs collected downstream of the pulp mills at Kamloops and Castlegar (table 1), ($p < 0.05$ for 3 comparisons, individual $p < 0.017$). 2378-TCDF levels were also significantly higher downstream at Castlegar, but not at Kamloops. In 1992, although 2378-TCDD levels were higher downstream of the mill at Kamloops the difference was not significant ($p = 0.14$) for three comparisons, individual $p < 0.047$). However, 2378-

YEAR LOCATION	RESIDUE LEVEL (ppt wet wt.), GEOMETRIC MEAN, 95% CONFIDENCE INTERVAL, (RANGE IN BRACKETS)						
	1991		1992		1991		1992
	KAMLOOPS		KAMLOOPS		CASTLEGAR		CASTLEGAR
N	Above mill	Below mill	Above mill	Below mill	Above mill	Below mill	Below mill
	6	5	5	5	10	9	5
2378-TCDD	12.3 3.2-40.6 (3.4-22.0)	46.7 14.3-147.2 (23.0-95.0)	3.9 0.3-17.7 (1.9-12.9)	28.6 5.5-133.5 (4.3-118.6)	0.9 0.0-5.7 (0.0-50.0)	19.5 6.7-53.1 (6.0-56.6)	17.4 3.5-75.0 (4.6-56.2)
12378-PnCDD	0.4 0.0-3.8 (0.0-7.0)	2.6 0.0-16.6 (0.0-13.0)	3.4 0.2-15.4 (0.0-7.1)	5.3 1.1-18.4 (2.1-12.5)	1.2 0.0-6.3 (0.0-29.0)	5.5 2.0-13.1 (2.4-16.2)	3.0 0.7-8.9 (1.5-4.9)
123678-HxCDD	14.5 5.1-38.1 (5.5-26.0)	21.5 6.7-64.1 (9.6-39.0)	15.0 5.2-40.3 (10.4-32.7)	11.8 2.3-48.2 (1.8-24.9)	8.2 1.3-35.9 (0.0-160.0)	6.5 1.5-21.3 (0.0-35.4)	6.0 1.0-24.3 (1.-17.2)
1234678-HpCDD	93.5 26.2-327.6 (18.0-210.0)	71.9 13.2-372.4 (9.7-250.0)	138.2 54.6-347.4 (95.3-260.9)	41.1 7.4-209.7 (3.5-100.3)	25.7 5.1-115.2 (0.0-680.0)	9.9 1.9-41.0 (0.0-247.9)	16.6 1.5-121.1 (1.7-187.6)
OCDD	374.4 76.3-1822.5 (22.0-1200.0)	91.5 7.8-972.0 (0.0-950.0)	472.1 167.0-1331.2 (229.7-837.2)	93.8 15.1-558.2 (6.1-303.0)	40.7 5.7-225.3 (0.0-4100.0)	16.8 2.4-91.4 (0.0-1339.2)	36.7 3.5-316.4 (3.3-1146.9)
2378-TCDF	0.7 0.0-4.4 (0.0-5.1)	1.5 0.0-11.5 (0.0-15.0)	0.9 0.0-2.9 (0.4-1.5)	3.9 1.1-10.4 (1.9-5.90)	0.3 0.0-2.7 (0.0-18.0)	15.9 4.9-47.0 (5.0-61.0)	34.5 12.8-90.2 (23.0-6.8)
OCDF	3.6 0.0-25.7 (0.0-44.0)	1.4 0.0-10.3 (0.0-9.1)	10.8 2.0-45.3 (1.6-24.8)	0.4 0.0-3.2 (0.0-2.6)	0.5 0.0-4.0 (0.0-63.0)	0.4 0.0-2.2 (0.0-3.4)	0.2 0.0-2.4 (0.0-2.0)

BOXED GROUPS SIGNIFICANTLY DIFFERENT ($p < 0.05$)

Table 1

TCDF levels were significantly higher downstream in 1992. No other significant differences in contaminant levels were found between upstream and downstream collections.

Muscle tissue of Largescale sucker, Mountain whitefish and Northern squawfish collected downstream of the mill at Kamloops in 1988, before PCDD/F abatement was implemented, was contaminated with up to 60 ppt of 2378-TCDD and 704 ppt of 2378-TCDF (Mah *et al.*, 1989⁵). Observations in 1992 showed that about half the fish delivered to the nest by osprey foraging in that area were either whitefish or sucker (Machmer and Steeger, 1992⁶). By early 1990, the Kamloops mill had completed a program aimed at reducing the level of PCDDs and PCDFs in its effluent. Similar programs in mills on the Fraser River cut 2378-TCDD output by 90% (Derksen, pers. comm.), and within a year there was a significant reduction in PCDD/F levels in juvenile chinook salmon (Servizi, 1993⁷). Although PCDD/F levels in the Thompson River have likely fallen considerably since early 1990, there were no significant changes in PCDD/F levels in osprey eggs collected below the mill between 1991 and 1992. The large (and old) fish taken by the osprey will likely be a source of contamination for some time to come.

Unlike the pulp mill at Kamloops, the mill near Castlegar has not implemented a PCDD/F reduction program and continues to discharge contaminated effluent into the Columbia River. Mah *et al.*, (1989⁵) reported 2378-TCDD levels in whitefish and suckers collected below the mill were lower than the levels found in the Thompson River. However, 2378-TCDF levels were higher. Those differences are reflected in the pattern of PCDDs and PCDFs found in the osprey eggs from the Columbia. These data show that the adult osprey have accumulated PCDD/Fs during the short interval between their arrival on the breeding ground and egg laying.

Principal component analysis of the log transformed PCDD/F, PCB and OC data indicate there are three distinct patterns of contaminants in the osprey eggs (fig. 1). The first two principal components explain 55.2% of the total variation. The first component grouped eggs on the basis of comparatively high proportions of higher chlorinated dioxins, the second component grouped eggs with elevated organochlorine pesticide residues. A third group contained only moderate to low levels of all contaminants. 2378-TCDD and TCDF data were not included in this analysis because of the influence of local pulp mills. This analysis raises the possibility that the osprey population breeding in British Columbia spends the winter in three areas of Central and South America where the patterns and levels of organochlorine contamination are quite different. Osprey are migratory, but careful analysis of the patterns of chlorinated hydrocarbons accumulated in the eggs can provide valuable information about both local and distant sources of environmental pollution.

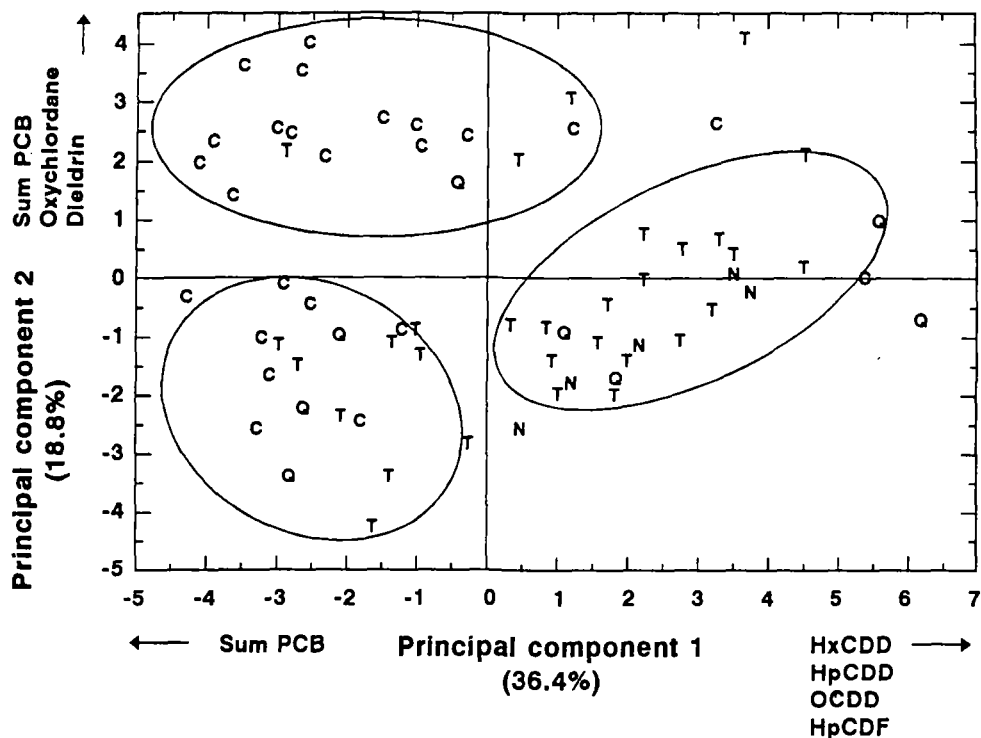


Figure 1

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