RESTORATION OF THE LAKE MICHIGAN ECOSYSTEM: A 33-YEAR STUDY OF DECLINES IN POLLUTANTS IN RED-BREASTED MERGANSER EGGS

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INTRODUCTION

Fish-eating birds have been used to monitor organochlorine pollution for many decades. One of the species used for the longest span of time is the red-breasted merganser (*Mergus serrator*). Faber and Hickey (1973) reported egg concentrations of organochlorines in a population of mergansers nesting on the Sister Islands in Green Bay in 1969. Severe restrictions on use and release of these chemicals were imposed in the early 1970s. White and Cromartie (1977) reported egg concentrations from the same location in 1975 and levels had declined dramatically. Haseltine et al. (1981) and Heinz et al. (1983) studied both egg concentrations and reproductive success of the merganser population at nearby Lake Michigan islands in 1977 and 1978; no reproductive impairment was documented, and concentrations continued a rapid decline, prompting a follow up study in 1990 (Heinz et al. 1994). In 2002, we repeated the egg residue monitoring portion of these studies on two of the Lake Michigan islands used in the 1977/78 and 1990 studies in order to determine if contamination continued to decline, and to ascertain whether or not the rate of decline was decreasing.

METHODS

Red-breasted merganser nests were located on the nesting islands and a single egg was removed from each nest. The eggs were transported to the laboratory where they were opened and their contents placed in chemically clean glass jars which were then kept frozen until analysis.

Chemical analysis was done at the WARF Institute, Madison, WI in 1969. The 1975, 1977/78, 1990, and 2002 analyses were all conducted under the Quality Assurance/Quality Control program of the Patuxent Analytical Control Facility (PACF) in Laurel, MD.

Egg residues were reported as wet weight concentrations and were adjusted for moisture loss caused by partial incubation and evaporation prior to processing (Stickel et al. 1973). All residues were log transformed to normalize variances. Unanalyzed materials from a subset of eggs collected in 1977/78 were still available for analysis in 1990 and we randomly selected 12 samples to compare the original results with those obtained using improved chemical methods available in 1990. We used 2-tailed paired t-tests to compare results obtained a decade apart. There were no appreciable changes between the results of the original analyses and the reruns.

RESULTS

Eggs were analyzed for 22 organochlorines, but only 14 were present above the detection limit (0.05ppm for PCBs and Toxaphene, 0.01 for all others). Of those 14, 4 were present at levels that might be of toxicological significance.

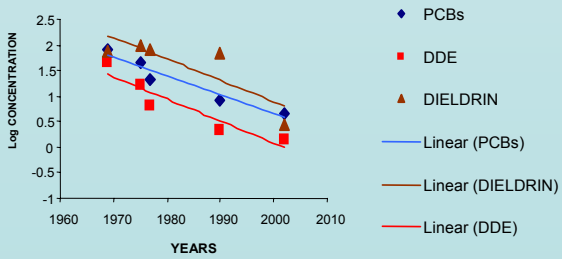
	1977-78	1990	2002
PCBs	21[a] (10-34)[b] A[c]	8.5 (4.0-14) B	4.6 (1.8-13) C
p,p'-DDE	6.5 (3.3-11) A	2.2 (1.1-3.3) B	1.4 (0.7-2.6) C
DIELDRIN	0.82 (0.46-1.4) A	0.69 (0.35-1.4) A	0.03 (ND-0.26) B
TOXAPHENE	2.6 (1.6-3.6) A	0.71 (0.25-1.2) B	ND (ND-ND) C

[a]Geometric Mean
[b]Extremes
[c]Means followed by the same letter were not different between years (P<0.05)

All detected organochlorines declined significantly (P<0.05) between 1977/78 and 2002. Of the four major organochlorines, only toxaphene declined to non-detectable levels by 2002.

Long term trends

When mean log concentrations were plotted against time for the entire span of data, the two predominant organochlorines, PCBs and DDE, appeared to be declining at a decreasing rate. This might be the result of nearing a long term equilibrium for these contaminants in higher trophic level biota like mergansers. On the other hand, dieldrin concentrations seemed to be relatively constant until a precipitous decline between 1990 and 2002.



SUMMARY

- Major organochlorine contaminants have decreased >95% following restrictions on environmental releases in the 1970s
- The rate of decrease seems to be decreasing
- No reproductive effects were detected, even when egg concentrations were high
- Current chemical techniques give comparable results with older methods, except for toxaphene
- Long term archival storage of samples does not degrade the repeatability of residue measurements

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LITERATURE CITED
Faber, R.A., and Hickey, J.J. 1973. Pestic. Monit. J. 7:27-36.
Haseltine, S.D., G.H. Heinz, W.L. Reichel, and J.F. Moore. 1981. Pestic. Monit. J. 15:90-97.
Heinz, G.H., D.S. Miller, B. Ebert, and K.L. Stromborg. 1994. Envrion. Monit. Assess. 33:175-182.
Stickel, L.F., S.N. Wiemeyer, and L.J. Blus. 1973. Bull. Environ. Contam. Toxicol. 9:193-196.
White, D.H., and E. Cromartie. 1977. Wilson Bull. 89:532-542.