PCB CONCENTRATIONS IN PLASMA OF NESTLING BALD EAGLES FROM THE GREAT LAKES BASIN, NORTH AMERICA

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ABSTRACT

Concentrations of PCBs were measured in blood plasma from nestling bald eagles (Haliaeetus leucocephalus) throughout the Great Lakes Basin. Nestling bald eagles from nest sites that were within 8.0 km of the Great Lakes had concentrations of PCBs which were six times greater than those in nestlings from interior nest sites which were farther from the lakes. Adult bald eagles that nest within 8.0 km of the Great Lakes have lesser productivity (0.71 young/occupied nest) than eagles that nest in interior areas (1.05 young/occupied nest). Productivity is negatively correlated with concentrations of PCBs and DDE.

INTRODUCTION

Concentrations of polychlorinated biphenyls (PCBs) and other lipophilic substances in bald eagles have traditionally been measured by collecting and analyzing abandoned eggs (1-2). Problems associated with this method include the inability to collect samples from areas of interest and the small number of eggs collected due to scavenging prior to collection. It has been argued that blood plasma collection could be used to supplement this method (3). Determining PCB concentrations in blood plasma has several advantages as compared to the collection of eggs of endangered wildlife. These include the fact that the birds are not sacrificed, multiple

samples from the same bird can be taken over time, and specific areas of interest can be sampled to establish exposure patterns and changes among time periods(3). Concentrations of PCBs in blood plasma from bald eagles have previously been determined in other areas of North America (4-7). We used this method to determine PCB concentrations in nestling bald eagles in the Great Lakes Basin.

METHODS

Blood was collected from 46 nestling bald eagles in Michigan during 1987 and 1988, and from 121 nestlings in Michigan, Minnesota, Ohio, Ontario and Wisconsin in 1989 (Fig. 1). Blood was collected using sterile techniques from the brachialus vein with heparinized glass syringes fitted with 22 or 24 gauge needles. The syringes had previously been washed with hexanes and acetone. Samples of whole blood were transferred to heparinized vacuum tubes, kept on ice in coolers, and centrifuged within 48 h of collection. Blood plasma was decanted and transferred to vacuum tubes and frozen (8). Concentrations of PCBs were determined by GC/MS (9-10).

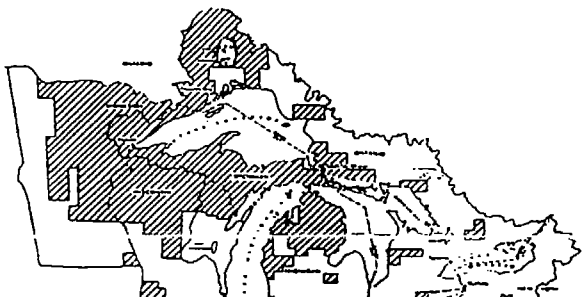

Figure 1. Bald eagle breeding areas in the Great Lakes Basin.

RESULTS

Mean concentrations of PCBs were greater in nestling bald eagles from nests within 8.0 km of the Great Lakes (hereafter referred to as Great Lakes nests) than in nestlings from nests farther than 8.0 km from the Great Lakes (hereafter referred to as interior nests) and those that were downstream from a pulp mill on the Menominee River (Table 1).

Table 1. Mean concentrations and ranges (ug/L) of PCBs from nestling bald eagles in the Great Lakes Basin.

Nesting Area	n	Mean	Range
Great Lakes	42	183.3	33.0-520.0
Interior	79	23.7	5.0-200.0
Menominee River	5	140.4	96.0-217.0

DISCUSSION

Concentrations of PCBs in blood plasma from nestling bald eagles from Great Lakes nests were greater than from those nestlings in Oregon and Washington (Table 2).

Table 2. Mean concentrations and ranges (ug/L) of PCBs in whole blood of nestling bald eagles from Oregon and Washington (5,6). Concentrations have been corrected by a conversion factor of two to be equivalent to blood plasma values.

Nesting Area	n	Mean	Range
Lower Columbia River	14	129.0	0.0-351.0
Outer Klamath Basin	24	22.0	0.0-580.0
Upper Klamath Lake	17	0.0	nd-280.0
Cascade Lakes	34	0.0	nd-280.0
			nd=not detected

PCBs and DDE are known to be related to decreased productivity in bald eagles (2). Reproduction of bald eagles is considered to be impaired when productivity, measured as young/occupied nest, is less than 1.0. A productivity of 0.7 is necessary to maintain population stability (11). Bald eagles using Great Lakes nests are less productive (0.71 young/occupied nest) than eagles using interior nests (1.05 young/occupied nest). Bald eagles fail to reproduce within five years of nesting near Lakes Michigan and Huron. Greater mortality of adult bald eagles has been observed in these areas. The concentration of total PCBs and TCDD equivalents (converted from congener specific data) in two addled bald eagle eggs collected near Lakes Michigan and Huron were respectively, 83 and 98 ug/g total PCBs and 21,369 and 30,894 pg/g as TCDD equivalents (12,13). In an examination of chicken feeding studies, conversion of Aroclor/congener concentrations in feed explained the toxic reproductive effects on laying hens (13). Concentrations in bald eagle eggs are far greater than known effect levels in poultry experiments, either by total PCB concentration or by conversion of individual PCB congeners (12,14,15). Bald eagle productivity is negatively correlated with concentrations of PCBs and DDE in addled eggs (2).

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REFERENCES

1. Weimeyer, S.N., B.M. Mulhern, F.J. Ligas, R.J. Hensel, J.E. Mathisen, F.C. Robards, and S. Postupalsky, Pestic. Monit. J. 19, 50-55 (1972).
2. Wiemeyer, S.N., T.G. Lamont, C.M. Bunk, C.R. Sindelar, F.J. Gramlich, J.D. Fraser, and M.A. Byrd, Arch. Environ. Contam. Toxicol. 13, 529-549 (1984).
3. Henny, C.J. and D.L. Meeker, Envir. Poll. (Series A) 28, 291-304 (1981).
4. Henny, C.J., C.R. Griffin, D.W. Stahlecker, A.R. Harmata, and E. Cromartie, Can. Field Nat. 95, 249-252 (1981).
5. Frenzel, R.W., Oreg. State Univ.,unpubl. Ph.D. thesis Corvallis, OR (1984).

6. Garrett, M., R.G. Anthony, J.W. Watson, and K. McGarigal, Final Report, U.S. Army COE Contract No. DACW57-84-C-0071, Oreg. Coop. Wildl. Res. Unit, Oreg. State Univ., Corvallis, OR (1988).
7. Frenzel, R.W. and R.J. Anthony, J. Wildl. Manage. 53(3), 792-802 (1989).
8. Morizot, D.C., R.G. Anthony, T.G. Grubb, S.W. Hoffman, M.E. Schmidt, and R.E. Ferell, Biochem. Gen. 23(3/4), 337-345 (1985).
9. Price, H.A., R.L. Welch, R.H. Scheel, and L.A. Warren, Bull. Environ. Contam. Toxicol. 37, 1-9 (1986).
10. Mich. Dept. Publ. Hlth., Anal. Method No. 7, Cntr. Environ. Hlth. Sci., Epid. Stud. Lab., Lansing, MI (1987).
11. Sprunt, A., IV, W.B. Robertson, Jr., S. Postupalsky, R.J. Hensel, C.E. Knoder, and F.J. Ligas, Trans. N. Am. Wildl. Nat. Resour. Conf. 38, 96-106 (1973).
12. Kubiak, T.J., Testimony Before U.S. House of Representatives Subcommittee on Investigations and Oversight of the Committee on Public Works and Transportation, April 14, 72-81 (1988).
13. Kubiak, T.J., H.J. Harris, L.M. Smith, T.R. Schwartz, D.L. Stalling, J.A. Trick, L. Sileo, D.E. Docherty, and T.C. Erdman, Arch. Environ. Contam. Toxicol. 78, 706-727 (1989).
14. Platonow, N.S. and B.S. Reinhart, Can J Compar Med 37, 341-346 (1985).
15. Brunstrom, B. and L. Anderson, Arch. Toxicol., 62, 263-266 (1988).