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## Organochlorine Chemical Residues in Northern Cardinal (*Cardinalis cardinalis*) Eggs from Greater Washington, DC USA

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 A [Correction](#) to this article was published on 03 July 2018

 This article has been [updated](#)



## Abstract

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Northern Cardinal eggs from six neighborhoods near Washington DC were analyzed for organochlorine pesticides and PCBs. All compounds were detected more frequently and at higher concentrations in more heavily urbanized neighborhoods. DDT (mostly as *p,p'*-DDE) was detected in all neighborhoods. *p,p'*-DDT was typically 0.5–16 ng/g (ww) in most suburban neighborhoods but was not detected (< 0.1 ng/g) in more rural areas; however, *p,p'*-DDT was 127–1130 ng/g in eggs from two suburban Maryland nests and comprised 65.7% of total *p,p'*-DDT isomers in the most contaminated sample, indicating recent exposure to un-weathered DDT. Total chlordane (sum of 5 compounds) was 2–70 ng/g; concentrations were greatest in older suburban neighborhoods. Total PCB (sum of detected congeners) was < 5–21 ng/g. Congener patterns were similar in all neighborhoods and resembled those typical of weathered mixtures. Results indicate that

wildlife remains exposed to low concentrations of legacy contaminants in suburban neighborhoods and that cardinal eggs can be used to monitor localized contamination.

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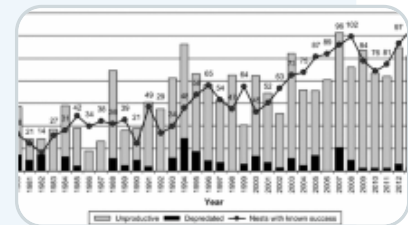
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**03 July 2018** The original version of this article contained a mistake. Author name in the text citation and reference in section should be Maldonado et al (2016), it was incorrectly spelled as Maldinado et al (2015).

## References

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Agency for Toxic Substances and Disease Registry (ATSDR) (1994) Toxicological profile for chlordane.

U.S. Department of Health and Human Services,  
Public Health Service, Atlanta, GA

[Google Scholar](#)

Aguilar A (1984) Relationships of DDE/DDT in marine mammals to the chronology of DDT input into the ecosystem. Can J Fish Aquat Sci 21:840–844

[Article](#) [Google Scholar](#)

Bekarian N, Payne-Sturges D, Edmondson S, Chism B, Woodruff TJ (2006) Use of point-of-sale data to track usage patterns of residential pesticides: methodology development. Environ Health 5:15–26

[Article](#) [CAS](#) [Google Scholar](#)

Beyer WN, Meador JP (eds) (2011) Environmental contaminants in biota, 2nd edn. CRC Press, Boca Raton, FL

[Google Scholar](#)

Bienkowski B (2014) DDT still killing birds in Michigan. Environ Health News July 28.

<https://www.scientificamerican.com/article/ddt-still-killing-birds-in-michigan/>. Accessed 11 Jun 2017

Bishop CA, Koster MD, Chek AA, Hussell DJT, Jock K (1995) Chlorinated hydrocarbons and mercury in sediments, red-winged blackbirds (*Agelaius phoeniceus*) and tree swallows (*Tachycineta bicolor*) from wetlands in the Great Lakes–St. Lawrence River basin. Environ Toxicol Chem 14:491–501



[Article](#) [CAS](#) [Google Scholar](#)

Blus LJ (2011) DDT, DDD, and DDT in birds. In: Beyer WN, Meador JP (eds) Environmental contaminants in biota, 2nd edn. CRC Press, Boca Raton, pp 425–444

[Chapter](#) [Google Scholar](#)

Blus LJ, Wiemeyer SN, Bunck CM (1997) Clarification of effects of DDE on shell thickness, size, mass, and shape of avian eggs. Environ Pollut 95:67–74

[Article](#) [CAS](#) [Google Scholar](#)

Bouwman H, Viloen IM, Quinn LP, Polder A (2013) Halogenated pollutants in terrestrial and aquatic bird eggs: converging patterns of pollutant profiles,

and impacts and risks from high levels. Environ Res  
126:240–253

[Article](#) [CAS](#) [Google Scholar](#)

Chen D, Hale RC, Watts BD, La Guardia MJ, Harvey E, Mojica EK (2010) Species-specific accumulation of polybrominated diphenyl ether flame retardants in birds of prey from the Chesapeake Bay region, USA. Environ Pollut 158:1883–1889

[Article](#) [CAS](#) [Google Scholar](#)

Darnerud PO (2003) Toxic effects of brominated flame retardants in man and in wildlife. Environ Internat 29:841–853

[Article](#) [CAS](#) [Google Scholar](#)

Echols KR, Tillitt DE, Nichols JW, Secord AL, McCarty JP (2004) Accumulation of PCB congeners in nestling Tree Swallows (*Tachycineta bicolor*) on the Hudson River, New York. Environ Sci Technol 38:6240–6246

[Article](#) [CAS](#) [Google Scholar](#)

Echols KE, Peterman PH, Hinck JE, Orazio CE (2013) Polybrominated diphenyl ether metabolism in field collected fish from the Gila River, Arizona, USA—levels, possible sources, and patterns. Chemosphere 90:20–27

[Article](#) [CAS](#) [Google Scholar](#)

Eens M, Jaspers VLB, Van den Steen E, Bateson M, Carette C, Clergeau P, Cotantini D, Dolenec Z, Elliott JE, Flux J, Gwinner H, Halbrogk RS, Heeb P,

Mazgajski TD, Moksnes A, Polo V, Soler JJ, Sinclair R, Veiga JP, Williams TD, Covaci A, Pinxten R (2013) Can starling eggs be useful as a biomonitoring tool to study organohalogenated contaminants on a worldwide scale? *Environ Internat* 51:141–149

[CAS](#) [Google Scholar](#)

Elliott JE, Bishop CA (2011) Cyclodiene and other organochlorine pesticides in birds. In: Beyer WN, Meador JP (eds) *Environmental contaminants in biota*, 2nd edn. CRC Press, Boca Raton, pp 447–475

[Chapter](#) [Google Scholar](#)

Elliott JE, Brogan J, Lee SL, Drouillard KG, Elliott KH (2015) PBDEs and other POPs in urban birds of prey partly explained by trophic level and carbon source. *Sci Tot Environ* 524–525:157–165

[Article](#) [CAS](#) [Google Scholar](#)

Farmahin R, Wu D, Crump D, Herve JC, Jones SP, Hahn ME, Karchner SI, Giesy JP, Bursian SJ, Zwiernik J, Kennedy MJ SW (2012) Sequence and in vitro function of chicken, ring-necked pheasant, and Japanese quail AHR1 predict in vivo sensitivity to dioxins. *Environ Sci Technol* 46:2967–2975

[Article](#) [CAS](#) [Google Scholar](#)

Gao F, Luo X-J, Yang Z-F, Wang X-M, Mai B-X (2009) Brominated flame retardants, polychlorinated biphenyls, and organochlorine pesticides in bird eggs from the Yellow River Delta, North China. *Environ Sci Technol* 43:6956–6962

[Article](#) [CAS](#) [Google Scholar](#)

Halkin SL, Linville SU (1999) Northern cardinal (*Cardinal cardinalis*). In: Poole A, Gill F (eds) The birds of North America, no. 440. Academy of Natural Sciences, Philadelphia, and American Ornithologists Union, Washington, DC

[Google Scholar](#)

Harris ML, Elliott JE (2011) Effects of polychlorinated biphenyls, dibenzo-*p*-dioxins and dibenzofurans, and polybrominated diphenyl ethers in wild birds. In: Beyer WN, Meador JP (eds) Environmental contaminants in biota, 2nd edn. CRC Press, Boca Raton, pp 477–528

[Chapter](#) [Google Scholar](#)

Harris ML, Wilson LK, Elliott JE, Bishop CA, Tomlin AD, Menning KV (2000) Transfer of DDT and

metabolites from fruit orchard soils to American Robins (*Turdus migratorius*) twenty years after agricultural use of DDT in Canada. Arch Environ Contam Toxicol 39:205–220

[Article](#) [CAS](#) [Google Scholar](#)

Hebert CE, Weseloh DV, Kot L, Glooschenko V (1994) Organochlorine contaminants in a terrestrial foodweb on the Niagara Peninsula, Ontario, Canada 1987–89. Arch Environ Contam Toxicol 26:356–366

[Article](#) [CAS](#) [Google Scholar](#)

Hinck JE, Norstrom RJ, Orazio CE, Schmitt CJ, Tillitt DE (2009) Persistence of organochlorine chemical residues in fish from the Tombigbee River (Alabama, USA): continuing risk to wildlife from a

former DDT manufacturing facility. Environ Pollut  
157:1207–1219

[Article](#) [CAS](#) [Google Scholar](#)

Hwang JH, Park JY, Park HJ, Bak SM, Hirano M,  
Iwata H, Park YS, Kim EY (2016) Ecological factors  
drive natural selection pressure of avian aryl  
hydrocarbon receptor 1 genotypes. Sci Rep 6:27526

[Article](#) [CAS](#) [Google Scholar](#)

Kolpin DW, Furlong ET, Meyer MT, Thurman EM,  
Zaug SD, Barber LB, Buxton HT (2002)  
Pharmaceuticals, hormones, and other organic  
wastewater contaminants in U.S. streams, 1999–  
2000: a national reconnaissance. Environ Sci  
Technol 36:1202–1211



[Article](#) [CAS](#) [Google Scholar](#)

Mackintosh SA, Dodder NG, Shaul NJ, Aluwihare LI, Maruya KA, Chivers SJ, Danil K, Weller DW, Hoh E (2016) Newly identified DDT-related compounds accumulating in Southern California bottlenose dolphins. *Environ Sci Technol* 50:12129–12137

[Article](#) [CAS](#) [Google Scholar](#)

Maldonado AR, Mora MA, Sericano JI (2016) Seasonal differences in contaminant accumulation in neotropical migrant and resident songbirds. *Arch Environ Contam Toxicol* 72:39–49

[Article](#) [CAS](#) [Google Scholar](#)

Mora MA, Durgin B, Hudson LB, Jones E (2016) Temporal and latitudinal trends of p,p'-DDE in

eggs and carcasses of North American birds from 1980 to 2015. Environ Toxicol Chem 35:1340–1348

[Article](#) [CAS](#) [Google Scholar](#)

Nowell LH, Moran PW, Gilliom RJ, Calhoun DL, Ingersoll CG, Kemble NE, Kuivila KM, Phillips PJ (2013) Contaminants in stream sediments from seven United States metropolitan areas: part I: distribution in relation to urbanization. Arch Environ Contam Toxicol 64:32–51

[Article](#) [CAS](#) [Google Scholar](#)

Peterman PH, Feltz KP, Orazio CE, Echols KR (2006) Basic alumina flash chromatographic separation of bulk ortho-PCBs from non-ortho-PCBs, PBDEs, PCDFs, PCDDs, PCDTs, OCPs and PCTs. Organohalogen Compd 68:2458–2461

Peterman PH, Feltz KP, Echols KR, Orazio CE (2009)  
A miniaturized S-X3 flash GPC cleanup column. In:  
Pittsburgh Analytical Conference (PittCon) 2009,  
Chicago, IL

Priha E, Hellman S, Sorvari J (2005) PCB  
contamination from polysulphide sealants in  
residential areas-exposure and risk assessment.  
Chemosphere 59:537–543

Rattner BA, Wiemeyer SN, Blus LJ (2016)  
Retrospective: adjusting contaminant  
concentrations in bird eggs to account for moisture

and lipid loss during their incubation. Bull Environ Contam Toxicol 97:2–3

[Article](#) [CAS](#) [Google Scholar](#)

Reynolds KD, Rainwater TR, Scollon EJ, Sathe SS, Adair BM, Dixon KR, Cobb GP, McMurry ST (2001) Accumulation of DDT and mercury in Prothonotary Warblers (*Protonotaria citrea*) foraging in a heterogeneously contaminated environment. Environ Toxicol Chem 20:2901–2909

[Article](#) [Google Scholar](#)

Roux K, Marra PP (2007) The presence and impact of environmental lead in passerine birds along an urban to rural land-use gradient. Arch Environ Contam Toxicol 53:261–268

[Article](#) [CAS](#) [Google Scholar](#)

Scheifler R, Coeurdassier M, Morilhat C, Bernard N, Faivre B, Flicoteaux P, Giraudoux P, Noel M, Piotte P, Rieffel D, de Vaufleury A, Badot P-M (2006) Lead concentrations in feathers and blood of common blackbirds (*Turdus merula*) and in earthworms inhabiting unpolluted and moderately polluted urban areas. *Sci Tot Environ* 371:197–205

[Article](#) [CAS](#) [Google Scholar](#)

Schmitt CJ, Echols KR, Peterman PH, Orazio CE, Grim C, Tan S, Diggs NE, Marra PP (2018) Organochlorine chemicals in northern cardinal eggs from suburban. U.S. Geological Survey data release, Washington, DC.

<https://doi.org/10.5066/F76W999M>

[Book](#) [Google Scholar](#)

Secord AL, McCarty JP, Echols KR, Meadows JC, Gale RW, Tillitt DE (1999) Polychlorinated biphenyls and 2,3,7,8-tetrachlorodibenzo-*p*-dioxin equivalents in tree swallows from the upper Hudson River, New York State. Environ Toxicol Chem 18:2519–2525

[CAS](#) [Google Scholar](#)

Stapleton HM, Dodder NG, Offenbergh JH, Schantz MM, Wise SA (2005) Polybrominated diphenyl ethers in house dust and clothes dryer lint. Environ Sci Technol 39:925–931

[Article](#) [CAS](#) [Google Scholar](#)

U.S. Environmental Protection Agency (USEPA) (2017) Superfund site: Beltsville Agricultural

Research Center (USDA), Beltsville, MD.

<https://www.cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0300415>. Accessed 26 Sept 2017

U.S. Environmental Protection Agency (USEPA)  
(2018a) DDT-a brief history an statues.

<https://www.epa.gov/ingredients-used-pesticide-products/ddt-brief-history-and-status>. Accessed  
03 Jul 2018

U.S. Environmental Protection Agency (USEPA)  
(2018b) Polychlorinated biphenyls.

<https://www.epa.gov/pcbs/learn-about-polychlorinated-biphenyls-pcbs>. Accessed 03 Jul  
2018

van den Berg M, Birnbaum L, Bosveld AT,  
Brunström B, Cook P, Feeley M, Giesy JP, Hanberg

A, Hasegawa R, Kennedy SW, Kubiak T, Larsen JC, van Leeuwen FX, Liem AK, Nolt C, Peterson RE, Poellinger L, Safe S, Schrenk D, Tillitt D, Tysklind M, Younes M, Waern F, Zacharewski T (1998) Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. *Environ Health Perspect* 106:775–792

[Article](#) [Google Scholar](#)

Van den Steen E, Dauwe T, Covaci A, Jaspers VLB, Pinxten R, Eens M (2006) Within- and among-clutch variation of organohalogenated contaminants in eggs of great tits (*Parus major*). *Environ Pollut* 144:355–359

[Article](#) [CAS](#) [Google Scholar](#)



Vermeer K, Reynolds LM (1970) Organochlorine residues in aquatic birds in the Canadian prairie provinces. *Can Field Natur* 84:117–130

[Google Scholar](#)

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