



Comment on "Exposure to mercury and Aroclor 1268 congeners in least terns (*Sternula antillarum*) in coastal Georgia, USA" by G. L. Robinson, G. L. Mills, A. H. Lindell, S. H. Schweitzer and S. M. Hernandez, *Environmental Science: Processes & Impacts*, 2015, 17, 1424

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COMMENT

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Abstract

In a recent paper published in this journal (Robinson *et al.*, *Environmental Science: Processes & Impacts*, 2015, **17**, 1424) Robinson *et al.* reported concentrations of Aroclor 1268 congeners in least tern eggs in coastal Georgia, USA. This comment describes important omissions in Robinson *et al.*'s interpretation of those egg concentrations that alter the overall conclusions of the least tern study.

Introduction

We read with interest the recent publication by Robinson *et al.*¹ describing polychlorinated biphenyl (PCB) and mercury concentrations in least tern eggs and chicks collected from coastal wetlands in southeastern Georgia, USA. Robinson *et al.* focused on PCB congeners associated with the commercial PCB mixture, Aroclor 1268, and reported that these congeners were highest in least tern eggs and chicks found near the former LCP Chemicals Site in Brunswick, Georgia (LCP Site). Robinson *et al.* concluded that the levels in some least tern eggs were sufficient to elicit reproductive and developmental effects in chicks, including mortality, and they attributed the presence of PCBs solely to the LCP Site.

We respectfully disagree with Robinson *et al.*'s interpretation of the data, particularly related to the toxicity of Aroclor 1268 and sources of PCBs in the region. We are involved in environmental studies at the LCP Site, including aquatic and wildlife work conducted on behalf of the responsible parties to better understand environmental levels and ecological impacts of PCBs and other contaminants. As such, we are familiar with research relevant to Robinson *et al.*'s work and believe clarifications are warranted.

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Aroclor 1268 Toxicity

Aroclor 1268 is different from other commercial mixtures of PCBs. Aroclor 1268 contains much lower levels of dioxin-like PCB congeners than other more commonly used Aroclor formulations.² The Aroclor 1268 formulation consists primarily (86%) of octa-, nona-, and decachlorinated PCB congeners; these highly chlorinated congeners comprise less than 10% of the chlorinated PCB mixtures found in other Aroclor formulations.³ Since PCB toxicity is associated primarily with a planar, dioxin-like chemical structure, PCB congeners with eight or more chlorine substitutions exhibit lower toxicity because they cannot attain a planar conformation.

Our best understanding of Aroclor 1268 toxicity to avian wildlife is from U.S. Department of Agriculture (USDA) work conducted in the 1970s to determine the sensitivity of farm-raised chickens to different Aroclor formulations, in response to incidents of accidental chicken poisoning at poultry farms.^{4,5} Unlike other PCB formulations, Aroclor 1268 had no significant effect on egg production, hatching success, chick abnormalities, or chick survival at the high dose level administered in the study (20 mg/kg in diet). The low toxicity of Aroclor 1268 in chickens, as compared to other Aroclors, is consistent with the results of a recent mammalian toxicity study that found effect thresholds for Aroclor 1268 in mink (*Neovison vison*) one to two orders of magnitude higher (less toxic) than other Aroclors.⁶

In the USDA chicken study, the no adverse effects concentration of Aroclor 1268 in eggs was 22 mg/kg (dry or wet weight basis not reported).⁵ The highest Aroclor 1268 concentration in least tern eggs reported by Robinson *et al.* was 16.3 mg/kg dry weight.

Although not measured by Robinson *et al.*, Aroclor 1268 levels reported in prey fish from the salt marsh and tidal creek habitat surrounding the LCP Site are also well below the dietary no-effect level of 20 mg/kg reported in the USDA chicken study. For example, mean Aroclor 1268 concentrations

in mummichog (*Fundulus heteroclitus*) ranged from 1 to 6 mg/kg dry weight.⁷

The USDA chicken study provides an extra margin of safety because chickens are generally recognized as the most sensitive bird species with respect to PCB exposure.^{8,9,10} Terns are less sensitive to PCB exposure than chickens.¹⁰ Hence, if an Aroclor 1268 concentration of 22 mg/kg in eggs did not alter chicken reproduction or development, then least terns with eggs containing much lower Aroclor 1268 concentrations are not at risk of such effects.

Robinson et al.'s interpretation of the Aroclor 1268 concentrations measured in least tern eggs was based on comparisons to results of three field studies evaluating PCB effects on common terns and Forster's terns.^{11,12,13} Robinson et al. observed that 10 of 94 least tern eggs contained Aroclor 1268 at levels comparable to egg PCB concentrations (7 to 10 mg/kg) associated with reduced hatching success in common terns and Forster's terns. However, the PCB mixtures reported in those studies are not comparable to Aroclor 1268. Becker et al.¹¹ reported 97% of egg PCB content was tri- through heptachlorobiphenyls, and Harris et al.¹³ reported substantial concentrations of lower chlorinated, dioxin-like PCBs.

Furthermore, Robinson et al. reported egg PCB concentrations on a dry weight basis, whereas Becker et al.¹¹ and Hoffman et al.¹² reported egg PCB concentrations on a wet weight basis. We note some uncertainty in the Harris et al.¹³ data because the study failed to report the dry or wet weight basis of measurement units, but the authors state their purpose as to a comparison to data from Kubiak et al.¹⁴, which are reported on a wet weight basis. If the moisture content in least tern eggs averages 67%¹⁵, then the maximum Aroclor 1268 concentration reported by Robinson et al. (16.3 mg/kg dry weight) is equivalent to 5.4 mg/kg wet weight, which is less than the purported effect threshold range of 7 to 10 mg/kg wet weight in the eggs of common terns and Forster's terns.

Widespread Use of Aroclor 1268

Robinson et al. assert that Aroclor 1268 is only associated with the LCP Site, stating "[Aroclor 1268] was used and released exclusively at the LCP site and nowhere else in the south eastern USA" and "Aroclor 1268 is a unique, highly-chlorinated PCB mixture that is exclusively linked to LCP pollution in the south eastern U.S." Robinson et al. cite Gaines et al.¹⁶ as the basis for these statements. Gaines et al.¹⁶, however, claim only that LCP was the sole chemical company in the east to purchase Aroclor 1268. A review of the literature reveals that the use of Aroclor 1268 is far from unique to the LCP Site. For example, Navy submarines and surface ships constructed before the 1977 PCB ban commonly contained PCBs, including Aroclor 1268, in various components including paints, insulation, rubber, and other products.^{17,18} Hence, shipbuilding and maintenance facilities likely contributed to PCB contamination (Aroclor 1268 and other mixtures) in areas surrounding such operations in Brunswick and elsewhere along the southeastern US coast. Other historical uses and sources of Aroclor 1268 include pipeline valve grease, rubber products,

wax extenders, and insulation and other building materials including siding known as Galbestos.¹⁸⁻²² U.S. Environmental Protection Agency's^{23,24} Proposed Rule for Non-Liquid PCBs indicates that Galbestos was used and marketed worldwide to airlines, railroads, chemical plants, steel mills, mines, industrial/manufacturing facilities and military facilities.

Conclusion

In summary, we respectfully disagree with Robinson et al.'s interpretation of Aroclor 1268 data in least tern eggs. We find the results to be well below applicable toxicity thresholds. The reported Aroclor 1268 levels in least tern eggs are not sufficient to elicit a toxic response in adults or chicks. We also find Robinson et al.'s claim that the LCP Site is the sole source of Aroclor 1268 unsupported.

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