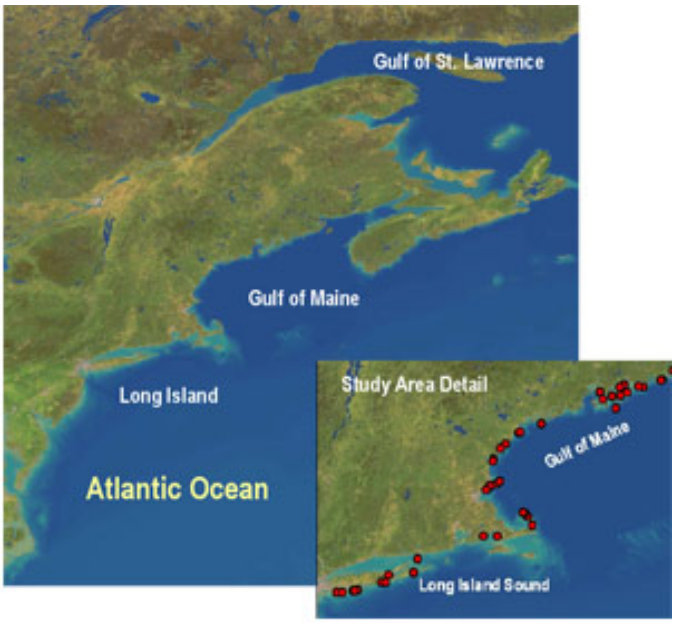
Seals as Sentinels Research

Dioxin-like Compounds in Harbor Seals from the Northwest Atlantic: Reassessing Toxic Threshold Levels

Abstract

Harbor seals (Phoca vitulina concolor) inhabiting the northwestern Atlantic are closely associated with polluted near-shore environments and are highly contaminated by persistent organic pollutants (POPs). The population is experiencing recurring epizootics, and it can be speculated their high body burdens of immunotoxic chemicals may be playing a contributory role in these events. Here we report, for the first time, the levels, patterns, and trends of PCBs, dioxins and furans (PCDD/Fs) in harbor seals from this region. PCB concentrations in blubber were relatively high, especially in the younger seals (56800 – 60500 ng/g lw). PCDD/Fs were detected at trace concentrations (<5 pg/g lw), likely reflecting a species specific degradative capacity for these compounds. No temporal trend was found in concentrations between 1991 and 2005, suggesting a continuous input of PCBs in the northwestern Atlantic. Highest concentrations were found in seals in the southern region (New York to Massachussetts) compared with those in eastern Maine, indicating that the main sources are near the highly industrialized population centers in the northeastern US. WHO-TEQs of 12 dioxin-like PCBs and PCDD/Fs calculated using the most recent TEFs were two to four times lower than those calculated using 1998 TEFs, implying that the estimated threshold value for adverse effects in the species should be reassessed. Shaw et al. (2007) *Organohalogen Compounds* 69:1752-1756.



Background

Since 1980, the northwest Atlantic harbor seal population has been affected by a series of disease outbreaks and mass mortalities. The possible role of environmental chemicals in these outbreaks has not been investigated. Data from the 1970s indicated that blubber concentrations of PCBs and DDTs in these seals exceeded or were approaching the 100 ppm concentration range (lipid basis), similar to the levels associated with population declines among European seals. The goal of the present study was to determine current burdens of dioxin-like compounds (PCBs, PCDD/Fs) in harbor seals along the northwestern Atlantic coast and to estimate the toxicological implications of their exposure using the most updated dioxin toxic equivalency factors (TEFs).

Findings

Mean concentrations of PCBs found in northwestern Atlantic harbor seals are high on a global scale. PCB concentrations in the younger seals (~50-60 µg/g lw) and adult males (~37 µg/g lw) are two to four-fold higher than the estimated threshold level of 17 µg PCB/g lw for adverse effects in the species.

The total WHO-TEQ values of dioxin-like PCBs and PCDD/Fs in blubber of the pups (mean 191 pg/g, lw) are approaching the estimated threshold level of 209 pg/g, lw for immune suppression and endocrine disruption in harbor seals based on results of a captive feeding experiment. However, it should be noted that TEQ values calculated for dioxin-like PCBs and PCDD/Fs in the feeding experiment used the 1998 TEFs. Re-calculation of these values using the most recent TEFs would yield total TEQ concentrations at least 50% lower (~100 pg/g, lw).

Alternatively, calculation of the WHO-TEQs in our samples using the 1998 TEFs yields values that are two to four times higher (584, 490, 145, and 60 pg/g lw in pups, yearlings, adult males and females, respectively) than those we report here, meaning that the levels in the pups and yearlings in this study would exceed by two to three-fold the estimated threshold value published in the literature for adverse effects in pinnipeds including immunotoxic effects.

These observations underscore the need to recalculate the estimated threshold value for adverse effects using the new TEFs. Moreover, in view of the recurring epizootics affecting the northwestern Atlantic harbor seal population, further research is needed to elucidate the real risks of dioxin-like compounds and numerous other immune-and endocrine-disrupting POPs to which these seals are exposed.

Publications resulting from this study:

Shaw, S.D., Brenner, D., Berger, M.L., Dwyer, M., Fang, F., Hong, C-S., Storm, R., O'Keefe, P. (2007). Patterns and trends of PCBs and PCDD/Fs in northwestern Atlantic harbor seals: Revisiting threshold levels using the new TEFs. Organohalogen Compounds 69:1752-1756.

Shaw, S.D., Berger, M.L., Brenner, D., Chu, M.D., Matherly, C.K., Chu, A.C., Clark, G.C. (2006). Application of the CALUX bioassay for the determination of PCDD/Fs and dioxin-like PCBs in tissues of harbor seals. *Organohalogen Compounds* 68: 587-591.

Shaw, S.D. (2006). Seals as Sentinels: Assessing Toxic Contaminants in Northwestern Atlantic Coast Seals. Final Project Report to the National Oceanographic and Atmospheric Administration. Marine Environmental Research Institute, Blue Hill, ME, 123 pp. Contract No. EA133F05CN1358.