# Seals as Sentinels Research

## Dioxin-like Compounds and Immune Function In Free-Ranging Harbor Seals (*Phoca vitulina concolor*) from the Northwest Atlantic

Polyhalogenated aromatic hydrocarbons (PHAHs), particularly the dioxin-like polychlorinated biphenyls (PCBs), dioxins and furans (PCDD/Fs) are potent immunotoxins that biomagnify in aquatic food chains and are associated with disease susceptibility and immune-disrupting effects in marine mammals. Harbor seals (*Phoca vitulina concolor*) inhabiting the northwest Atlantic are closely associated with polluted near-shore environments and are highly contaminated by dioxin-like PHAHs. The population is experiencing recurring disease outbreaks and mass mortalities, and it can be speculated their high body burdens of immunotoxic chemicals may be playing a contributory role in these events. This study evaluated the relationship between body burdens of dioxin-like compounds and *in vitro* immune responses in peripheral blood of 29 free-ranging harbor seals from the northwest Atlantic coast.

### Findings

Dioxin-like activity (toxic equivalents, TEQ) was measured in seal plasma using the CALUX bioassay. The CALUX-TEQ values detected in the seals reflect relatively high burdens of dioxin-like compounds. The levels of dioxin-like compounds in these seals (mean TEQ 235 ± 155 and 137 ± 94 pg/g lw for adults and juveniles, respectively) are comparable to or higher than those recently reported in ringed seals (*Phoca hispida baltica*) and gray seals (*Halichoerus grypus*) from the polluted Baltic Sea using a CALUX bioassay on liver extracts.

Regression analysis revealed a significant positive linear relationship between CALUX-TEQ values in the adult harbor seals (n=11) and lymphoproliferative responses to the T cell mitogen PHA and the B cell mitogen LPS. There were no correlations between the CALUX-TEQs and age, gender or condition of the animals. Thus, the CALUX-TEQ explained 57% and 49% of the variation in proliferative responses of harbor seal lymphocytes to the mitogens PHA and LPS, respectively. To our knowledge, this is the first study to document a positive relationship between CALUX-TEQ values and mitogen-induced responses of peripheral lymphocytes in free-ranging phocid seals.

As a tool for measuring the toxic potency of dioxin-like compounds, the CALUX bioassay has several advantages, including its applicability to diverse tissues and its fast, relatively inexpensive, straightforward procedures. In the present study, logistical constraints prevented invasive sampling and thus correlations between the CALUX response and blubber burdens of dioxin-like compounds could not be examined. However, validation studies have revealed a good correlation between the activity in these assays and TCDD/HAH concentrations in environmental and biologic samples as determined by GC/MS.

Although possible links between contaminant burdens and health status are not clear, the CALUX-TEQ values in adult harbor seals from the US Atlantic coast exceed the estimated threshold value of 160 pg TEQ/g lw in blubber for adverse effects on immune function in the species.

Dioxin-like PHAHs causing either inhibition of immunoregulatory cells or increased synthesis of cytokines may explain the observed positive correlation between lymphocyte mitogenesis and CALUX-TEQ burdens. While this relationship is not evidence per se of a direct cause-effect association, the results indicate that the exposure of these seals to environmentally relevant levels of dioxin-like compounds in the wild may alter their normal immune responses.

**Publications resulting from this study:**

Shaw, S.D. (2007). Chapter 7. How are seals, as top predators, impacted by toxic contaminants in Casco Bay and the Gulf of Maine? In: *Toxic Pollution in Casco Bay: Sources and Impacts.* Casco Bay Estuary Partnership (http://www.cascobay.usm.maine.edu).

Shaw, S.D. (2005). 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, 69 pp. Contract No. EA133F04CN0062.

Shaw, S.D. (2004). Seals as sentinels for the Gulf of Maine ecosystem. In: Proceedings of the Gulf of Maine Forum 2002, Marine Environ. Research Institute, Blue Hill, ME.

Shaw, S.D., Brenner, D., Mahaffey, C.A., De Guise, S., Perkins, C.R., Clark, G.C., Denison, M.S., and Waring, G.T. (2003). Persistent organic pollutants (POPs) and immune function in US Atlantic coast harbor seals (*Phoca vitulina concolor*).*Organohalogen Compounds* 62:220-223.