Seals as Sentinels Research

PCBs and Chlorinated Pesticides in Harbor Seals (*Phoca vitulina concolor*) from the Northwest Atlantic Region

Abstract
Concentrations of polychlorinated biphenyls (PCBs), dichlorodiphenyltrichloroethane (DDT) and its metabolites, chlordane-related compounds (CHLs), mirex, hexachlorocyclohexane isomers (HCHs), dieldrin, and hexachlorobenzene (HCB) were determined in blubber of harbor seals (*Phoca vitulina concolor*) from the northwestern Atlantic coast. PCBs, DDTs, and CHLs were the major persistent organochlorines in harbor seal blubber, while mirex, HCHs, dieldrin, and HCB were minor contaminants. Highest concentrations were found in the adult males, followed by the pups, yearlings, adult females, and fetuses. DDT and PCB concentrations have declined from the high levels reported in the early 1970s, but no declines were observed in our samples over the ten-year period 1991-2001. DDT/PCB ratios were indicative of a more rapid decline of DDTs than PCBs, while ratios of p,p'-DDE/DDT were indicative of a metabolic "weathering" of DDT. The population appears to be susceptible to disease outbreaks, as evidenced by a recurrence of viral epizootics since the late 1970s. The PCB burdens in these seals are similar to levels reported in seals from polluted regions of Europe and Asia, and exceed the estimated threshold levels for adverse reproductive and immune system effects in the species. Shaw et al. (2005)*Marine Pollution Bulletin* 50:1069-1084.

Background
Over the past two decades, 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 persistent organochlorines (OCs) in harbor seals along the northwestern Atlantic coast and to examine the toxicological implications of their exposure.

Concentrations of PCBs and chlorinated pesticides were measured in blubber samples of 29 stranded harbor seals collected in 2001 and 2002, and in archived samples of a subset of yearling seals collected in 1991. These are the first region-wide contaminants data reported in harbor seals from the northwest Atlantic marine region.

Findings

The levels of persistent OCs found in northwestern Atlantic harbor seals are at the high mid-range of the contamination spectrum on a global scale. PCB concentrations are an order of magnitude higher than levels in US Pacific coast harbor seals.

PCB concentrations in blubber were highest in the younger seals (56800 – 60500 ng/g lipid weight). Dioxins and furans (PCDD/Fs) were detected at trace concentrations (<5 pg/g lw), likely reflecting a species specific

metabolic capacity for these compounds.

PCB burdens found in our adult male, pup, and yearling harbor seals exceed the estimated threshold level of 17µg PCB/g lw in blubber for adverse effects on immune function and fall within the estimated threshold level of 25-77 µg PCB/g lw for reproductive effects in marine mammals.

These observations, together with reports of at least two large-scale viral epizootics among these seals since the late 1970s, suggest that the population is currently at risk for adverse health effects.

Given their relatively high tissue burdens of PCBs and chlorinated pesticides, harbor seals inhabiting this region accumulate levels that place them at risk for adverse health effects including effects on reproduction and immune and endocrine function. Levels in the pups are of special concern given that young seals appear to be vulnerable to immune- and endocrine-disrupting effects of PCBs and DDT when levels are an order of magnitude lower.

In view of the vulnerability of these seals to recurring disease outbreaks, there is a clear need for further research to ascertain the average levels of a broad range of other halogenated compounds in the population in conjunction with an assessment of immune status, reproductive rates, and overall health.

Publications resulting from this research:

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., Brenner, D., Bourakovsky, A., Mahaffey, C.A., and Perkins, C.R. (2005). Polychlorinated biphenyls and chlorinated pesticides in harbor seals (*Phoca vitulina concolor*) from the northwestern Atlantic coast. *Marine Pollution Bulletin* 50:1069-1084.

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., Brenner, D., Bourakovsky, A., Mahaffey, C.A., and Perkins, C.R. (2004). Persistent organic pollutants (POPs) in harbor seals (*Phoca vitulina concolor*) from the northwestern Atlantic coast. *Organohalogen Compounds* 66:1581-1586.

Shaw, S.D. (2004). Persistent organic pollutants (POPs) and mercury in Gulf of Maine seals. In: Proceedings of the Gulf of Maine Forum 2002, Marine Environ. Research Institute, Blue Hill, ME

Shaw, S.D. (2002). An Investigation of Persistent Organic Pollutants (POPs) and Heavy Metals in Tissues of Harbor Seals (*Phoca vitulina concolor*) and Gray Seals (*Halichoerus grypus*) in the Gulf of Maine. *Final Report to the State of Maine Department of Environmental Protection*, Augusta, ME, 16 pp.

Press articles:

Northern Exposure, *OnEarth* Vol 23, No. 3, Fall 2001
Seals Show High Chemical Levels – *Portland Press Herald*, Sept. 25, 2004