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Mercury, arsenic, cadmium, chromium lead, and selenium in feathers of pigeon guillemots (*Cepphus columba*) from Prince William Sound and the Aleutian Islands of Alaska

Joanna Burger [a,b,c,*], Michael Gochfeld [b,c,d], Kelsey Sullivan [e,f], David Irons [e]

[a] *Division of Life Sciences, Rutgers University, 604 Allison Road, Piscataway, New Jersey 08854-8082 USA*
[b] *Consortium for Risk Evaluation with Stakeholder Participation (CRESP), Piscataway, New Jersey 08854, USA*
[c] *Environmental and Occupational Health Sciences Institute (EOHSI), Piscataway, New Jersey 08854, USA*
[d] *Environmental and Occupational Medicine, UMDNJ-Robert Wood Johnson Medical School, Piscataway, New Jersey 08854, USA*
[e] *U.S. Fish & Wildlife Service, 1011 East Tudor Road, Anchorage, Alaska 99503, USA*
[f] *P.O. Box 801, Bethel, Maine, 04217, USA*

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Abstract

Arsenic, cadmium, chromium, lead, manganese, mercury and selenium were analyzed in the feathers of pigeon guillemots (*Cepphus columba*) from breeding colonies in Prince William Sound and in the Aleutian Islands (Amchitka, Kiska) to test the null hypothesis that there were no differences in metal levels as a function of location, gender, or whether the birds were from oiled or unoiled areas in Prince William Sound. Birds from locations with oil from the Exxon Valdez Oil Spill in the environment had higher levels of cadmium and lead than those from unoiled places in Prince William Sound, but otherwise there were no differences in metal levels in feathers. The feathers of pigeon guillemots from Prince William Sound had significantly higher levels of cadmium and manganese, but significantly lower levels of mercury than those from Amchitka or Kiska in the Aleutians. Amchitka had the lowest levels of chromium, and Kiska had the highest levels of selenium. There were few gender-related differences, although females had higher levels of mercury and selenium in their feathers than did males. The levels of most metals are below the known effects levels, except for mercury and selenium, which are high enough to potentially pose a risk to pigeon guillemots and to their predators.

Keywords: As; Cd; Cr; Pb; Mn; Hg; Se; Valdez; Seabirds; Feather levels; Pigeon guillemot; Aleutians; Prince William Sound

1. Introduction

Chemical use is increasing in our environment, and may pose a threat to some species and populations. Chemical levels are often elevated in marine and coastal ecosystems because of river outflow, runoff, and direct pollution, and from atmospheric transport and deposition (Mailman, 1980; Furness and Rainbow, 1990). Mercury and other elements are transported around the globe, including relatively isolated lakes and marshes, and remote polar and subpolar regions (Fitzgerald, 1989; Houghton et al., 1992; Nygard et al., 2001; Metcheva et al., 2006). Species living in aquatic environments are particularly vulnerable because of the potential for rapid movement of contaminants in water, compared to movement in

* Corresponding author. Division of Life Sciences, Rutgers University, 604 Allison Road, Piscataway, New Jersey 08854-8082 USA. Fax: +1 732 445 5318.
E-mail address: burger@biology.rutgers.edu (J. Burger).

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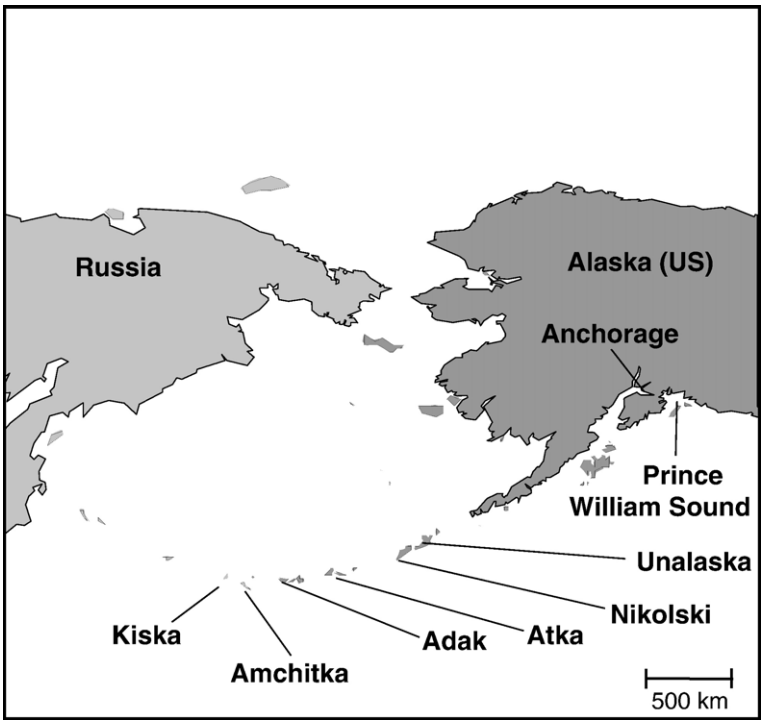

Fig. 1. Map showing the locations of collections of feathers of adult and young pigeon guillemots from Amchitka and Kiska Islands in the Aleutians, and colonies in Prince William Sound, Alaska.

terrestrial environments, and because chemicals can be stored in sediments in intertidal environments, providing a pool for years to come.

Seabirds are useful as bioindicators of pollution because they are exposed to a wide range of chemicals, are often at the top of their food chain, and are susceptible to bioaccumulation (Walsh, 1990; VanStraalen and Ernst, 1991; Furness, 1993; Furness and Camphuysen, 1997; Burger and Gochfeld, 2002). Further, Gilbertson et al. (1987) suggested that contaminant levels in seabirds have lower coefficients of variation than fish or marine mammals, making them important bioindicators of marine pollution.

For birds, feathers are useful indicators of metal contamination because: 1) Birds sequester metals in their feathers, 2) The proportion of body burden that is in feathers is relatively constant for each metal, 3) A relatively high proportion of the body burden of certain metals is stored in the feathers (Burger, 1993), 4) There is a high correlation between levels of contaminants in the diet of seabirds and levels in their feathers (especially for mercury, Monteiro and Furness, 1995). Breast feathers are the best indicator of whole-body burdens, particularly for mercury (Furness et al., 1986). Heavy metals in the feathers represent circulating concentrations in the blood during the few weeks of feather formation, which in turn represents both local exposure and mobilization from internal tissues (Lewis and Furness, 1991; Monteiro, 1996). Once the feather matures, the vascular connection atrophies, leaving the feather as a record of blood levels at the time of its formation, and the concentration of metals in the feathers remains constant (Braune and Gaskin, 1987).

In this paper we examine the levels of arsenic, cadmium, chromium, lead, manganese, mercury, and selenium in the feathers of pigeon guillemot (*Cepphus columba*) collected from Amchitka and Kiska Islands in the Aleutian Archipelago, and from colonies in Prince William Sound, Alaska. Our overall objective was to test the null hypothesis that there were no differences in the levels of heavy metals in the feathers of pigeon guillemots among the locations, and as a function of gender. Further, some of the birds in PWS nested in areas oiled by the Exxon Valdez Oil Spill (EVOS) and some nested in unoiled areas. We wanted to examine whether there were differences as a function of the EVOS.

The Bering Sea/Northern Pacific marine ecosystem and the coast of Alaska are important commercially, especially to the fishing industry. The Bering Sea ecosystem, for example, provides a large percentage of the fish and shellfish for commercial sale in the United States and elsewhere (AFSC, 2006). Dutch Harbor in the