

# Antarctic Seabird Feathers as Hidden Archives of Marine Pollution

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Antarctic and subantarctic marine ecosystems are often considered to be pristine environments, yet wildlife in the polar regions can still be exposed to pollution. Mercury (Hg) is a globally important pollutant that can negatively impact the health of both humans and wildlife. Hg enters the environment from natural sources (e.g., volcanism, rock weathering, hydrothermal vents), but anthropogenic releases have greatly increased the amount of Hg circulating in the environment since the Industrial Revolution. Hg is emitted in its gaseous elemental form (Hg<sub>0</sub>), which travels vast distances from emission sources via atmospheric transport to remote regions of the globe, such as Antarctica. Hg is assumed to mainly be deposited within the same hemisphere from which it was emitted.

◀ Fossil fuel combustion and artisanal and small-scale gold mining are important sources of anthropogenic Hg emissions to the atmosphere.

## Seabird indicators

Directly monitoring Hg levels in Antarctica is logistically challenging and the background concentrations are already at detection limits. One solution is to instead measure the Hg concentrations in seabird feathers. Seabirds are long-lived, feed at high trophic levels and have large geographic ranges, thus integrating pollutant levels over 100s-1000s kilometres.

## Mercury in the oceans

Hg enters the marine environment after atmospheric deposition, and methylation of inorganic Hg by microorganisms (e.g., sulfate- and iron-reducing bacteria) results in the production of methyl-Hg (MeHg), which is the highly toxic form of Hg.

◀ Marine predators feeding at high trophic levels accumulate high Hg concentrations in their tissues via their prey.

MeHg bioaccumulates within the tissues of marine organisms over time and biomagnifies through marine food webs, with concentrations increasing with successive trophic levels.

## Outcomes

Using seabirds as biomonitors of Hg, my work has shown that Hg contamination is higher when birds feed in subtropical compared to subantarctic and Antarctic waters in the Southern Ocean.<sup>1,2</sup> I have also shown that Hg contamination of an Endangered albatross has increased threefold since the 1980s at South Georgia.<sup>2</sup> Finally, our studies of skuas and albatrosses on the Antarctic Peninsula and subantarctic islands have demonstrated that Hg contamination can negatively impact the immune status, physiology and breeding success of seabirds.<sup>1,3,4</sup> Next, I will use feathers from museum specimens to understand long-term trends (>150 years) in Hg contamination.

[1] Mills et al. 2022 Environ Pollut 297, 118841; [2] Mills et al. 2021 Proc R Soc B 287, 20202683; [3] Ibañez et al. 2022 Mar Pollut Bull 181, 113919; [4] Ibañez et al. 2024 Chemosphere 346, 140630.