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Mercury in freshwater fish from Fennoscandia (1965-2015) - temporal trends and potential environmental drivers

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A database consisting of 54 560 measurements of mercury (Hg) in freshwater fish from Fennoscandia (Norway, Sweden, Finland and Russian Kola Peninsula) was analysed to test for relationships between Hg in fish and environmental drivers, including atmospheric Hg loading. The database presents a valuable baseline for evaluation of efforts to reduce Hg in the environment, including the Convention on Long-Range Transboundary Air Pollution (CLTRAP) and the Minamata Convention. The Minamata Convention entered into force in August 2017 and demand monitoring of Hg in the environment (e.g. fish) to document the success (i.e. effectiveness) of the convention. Following this, identification of legacy Hg sources (i.e. local direct industry emission) and separating these sources from long-range atmospheric sources of Hg, according to the scheme in this work, is necessary. The present work is an example on how fish (and other biological matrices) Hg databases can be used to assess effects of reduced/changed air pollution on fish Hg levels and trends, and measures taken under international environmental agreements.

Freshwater fish are receptors for atmospherically deposited Hg, and an important Hg exposure source for humans and wildlife. The database includes representative freshwater fish species for Fennoscandian ecosystems from the boreal to the subarctic region (Arctic charr, brown trout, perch, pike, roach). Total Hg of fish muscle sampled between 1965 and 2015 was combined from a total of 3505 lakes, located from 55° to 70°N. Only lakes with a minimum of five fish specimen sampled per year were included in the final evaluation of the database, and lake Hg medians for each fish species and year were estimated. We evaluated several methods for adjustment of fish Hg concentration, necessary due to the strong co-variation between fish Hg concentrations and fish size. Different adjustment techniques caused the lake median concentration to vary considerably, 1-2 times compared to observed concentration levels, and we discuss how these issues should be considered in future database evaluations.

We separated lakes impacted by long-range transported atmospheric Hg pollution from lakes also impacted by local pollution sources. On average, the fish species from lakes that were exposed to atmospherically deposited Hg had lower concentrations compared to lakes in the database where a local pollution source was or had historically been present. We found a significant increasing north-to-south Hg concentrations gradient for both perch and pike. Additionally, temporal trends in fish (pike and perch) Hg concentration since 1965 were neutral, despite large reductions in emissions and deposition of Hg in Scandinavia. We also tested hypotheses on the main drivers of temporal trends of Hg in fish in these lakes by collecting data on catchment characteristics, water chemistry, gridded downscaled weather data (temperature and precipitation), and reconstructed DOC trends based on monitoring data and process-understanding of DOC drivers. We will show robust tests of hypotheses on these effects on the temporal trends and spatial patterns of Hg in fish, and illustrate how these types of data are important for the evaluation of international agreements such as the Minamata Convention.