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Seasonal variability of metal and metalloid concentrations in blue mussels from the North and Baltic Seas

Authors: Burkhard Knopf[1], Martin Paulus[2], Jan Koschorreck[3], Annette Fliedner[1], Heinz Rüdel[1]

[1]Fraunhofer Institute for Molecular Biology and Applied Ecology IME, Germany
[2]Trier University / Biogeography, Germany
[3]German Environmental Agency UBA, Germany

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Since the 1980s, blue mussels are sampled annually for the German Environmental Specimen Bank (ESB; www.umweltprobenbank.de/en). The samples are collected in two-monthly intervals at the North Sea sampling sites Eckwarderhörne and Königshafen and in six-month intervals at the Baltic Sea site Darßer Ort. The frozen mussel samples are cryo-milled to annual pooled samples for each sampling site. We investigated seasonal trends of metals/metalloids in the six-/ bimonthly sub-samples of the years 2013, 2015 and 2017. The objectives of this approach of this project should answer the following questions:

1) Are there any significant seasonal trends of the analytes investigated?
2) How does the seasonal variability compare to the concentration ranges covered by the temporal trends over the last decade(s)?
3) Is it possible to select one sampling period per year which would be representative for the annual mean value gathered from yearly pooled samples for future time trend analysis?

In blue mussels at the North Sea site Königshafen we found consistent seasonal trends for cobalt, nickel, cadmium, copper and lead, as well as for selenium and arsenic for the years 2013 and 2015. However, in this trend was confirmed only for selenium in samples from 2017. The picture for mussels collected at the North Sea (Eckwarderhörne) was different: samples of 2013, 2015 and 2017 showed a consistent seasonality of exposure to metals/metalloids. In contrast, arsenic did not follow this trend.

One remarkable result of our study is that the variability of element concentrations in the seasonal samples of one single year can be in the same order of magnitude as the concentration ranges over many years, i.e. the temporal trend, which is based on annual pool samples. A possible reason for the seasonal pattern can be the annual life cycle of the mussels. However, the concentrations of metals/metalloids in the mussel tissue are not only influenced by intrinsic biological factors but also by the concentrations of the elements in the surrounding water of the mussel. According to the concentration data found during the seasons it is not possible to determine one representative sampling point during the year which gives a comparable information as the annual pooled samples. It is therefore recommended to pool annual samples.