

## Chemical Pollution and One Health – from Reactivity to Proactivity October 2023

### Future monitoring of chemical exposure and effects in humans, wildlife and the environment – from a One Health perspective

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#### Background

Monitoring is an essential tool for understanding the state of the environment and identifying potential risks and threats to human and animal health. It is often designed to track chemical pollution over time, detect trends and changes, and provide early warnings of potential hazards based on recurring and systematic sample collections and analyses. Monitoring data are used to inform environmental policy and management decisions, as well as to track progress towards national and international environmental objectives.

There are many challenges for the future monitoring of exposure to and adverse effects of chemicals. Well-known examples include emerging chemicals and mixture toxicity. For monitoring to be effective, it is important to have the appropriate tissues and analytic methods available. Sensitive and specialized analytical methods may be required, but these may also be costly and time-consuming to develop and use. The way we decide to solve challenges such as these can affect our ability to effectively address health risks in the future.

Chemical exposure affects ecosystems, impacting individual and population health, leading to the loss of air and water quality, reduced ecosystem services, and disease risks. It is, therefore, important to embrace a comprehensive, integrated “One Health” approach to ensure the health and well-being of humans, animals, and the environment.

#### Approach

The aim of the workshop was to discuss and identify common challenges and to share perspectives. The objectives were to provide a forum for participants to discuss new ideas and explore approaches that can improve the monitoring of chemicals as well as identify possibilities for building bridges and integrating efforts for a holistic One Health approach.

Specifically, we explored the questions:

- What are the most pressing challenges within environmental and human monitoring today and in the future?
- How do we create monitoring and research frameworks for wildlife and human exposure that will ensure we can track and respond to emerging chemicals?
- What methods should we use to bridge the gap between our understanding of exposure and effects in humans compared to those in wildlife and the environment?
- How can research help in improving environmental and human monitoring from a One Health perspective, and how can researchers make use of the collections and data generated within monitoring?
- The workshop participants represented researchers and stakeholders who approach environmental, wildlife, or human aspects of chemical-related problems from various perspectives. The workshop started with a visionary exercise in which the concept of One Health was central. This was followed by small group discussions of the outlined questions, and individual votes were placed on the discussed ideas and actions. In the recommendations below, we synthesize the major topics of discussion with a focus on the prioritization provided by the participants.

#### Recommendations

##### Interdisciplinary collaboration for a One Health approach

The One Health approach necessitates the development of collaboration among various disciplines and actors, including producers/industries, chemists, communicators, engineers, veterinarians, social scientists, and data scientists. A major obstacle faced by the One Health approach is the lack of a common language with which to foster this collaboration. Even within the areas of human, environmental, and animal monitoring, large communication gaps currently exist. Partici-

pants brought this point forward during the workshop discussions and it also became evident during the visionary exercise, where the lack of comprehension of differences in approaches and methods within the disciplines resulted in communication difficulties. This makes it clear that a first vital step is to ensure that interdisciplinary conversations happen on all levels: project development, project execution, datasets, results, etc.

To start the conversation, we encourage the establishment of common platforms (for researchers, stakeholders, etc.) to identify problems and common scientific meetings for, e.g., ecotoxicologists, toxicologists, human/animal researchers. One future goal could be the establishment of One Health institutes where disciplines can be found under one roof and a combined human, environmental, and animal focus can be brought together to create strategies for dealing with new (and old) challenges as they arise.

### Shifts in perspectives and funding disparities

Monitoring approaches for humans, wildlife and environment vary across countries. In some, the government funds long-term projects, while in others, researchers decide the focus based on personal interest, knowledge, and available funding, which often results in short-term perspectives. In addition, prioritization varies across countries and over time due to differences in political will and interest.

During the workshop, funding systems and changing terms were identified as a major obstacle to long-term strategic chemical monitoring. Specifically, disparities in research funding for human and wildlife effect studies hamper improvement of chemical monitoring from a One Health perspective. As an example, chronic effects of environmental chemicals were historically first discovered in wildlife, such as in white-tailed sea eagles and marine mammals. Wildlife were long considered the sentinels of human exposure, but due to funding disparities, there is currently less emphasis on effects in wildlife than on effects in humans. A change in our perspective is therefore crucial, as humans are now the sentinels of environmental pollution. However, from a One Health perspective, it is central that we move away from a focus on one or the other and towards a cross-species extrapolation approach. To understand adverse effects across species, advanced methods aimed at understanding biological mechanisms, such as cell-based and computational approaches as well as transcriptomics and metabolomics for studying biomarkers, can be used, for example together with frameworks such as Adverse Outcomes Pathways. Further research is needed to facilitate prediction and extrapolation across species.

We encourage the publication of comprehensive reviews on chemical exposure and effects that apply this perspective, the goal being to bridge the gaps between animal, human, and environmental health and to make the advantages of the One Health approach visible to funding agencies.

### Transition to a multiple chemical approach

Within monitoring, there is a call to shift from a single/few chemical approach to a multiple chemical approach. The current monitoring paradigm focuses on measuring known environmental contaminants, while systematic tools for identifying future chemicals of concern are lacking.

We recommend an increased focus on a comprehensive battery of testing, including non-target chemical analysis, both in human and animal epidemiology and in *in vitro* as well as *in vivo* experimental approaches. However, there are still challenges associated with suspect screening and non-target analysis that need to be addressed through method development. There are also limitations associated with *in vitro* models. For example, they often cannot evaluate long-term exposure. Acute studies may not capture the effects of prolonged exposure, which is more relevant for the general population. Effect-based monitoring can overcome many issues of mixture toxicity and should in the future be used as a more integrated measure in combination with traditional monitoring. More focus should be placed on creating schemes for integrating the interpretation of chemical observations in relation to effect-based observations.

### Long-term monitoring and research

The general experience of the workshop participants was that the massive amounts of data collected in long-term monitoring programs are underutilized in the research and that this leads to gaps between the two fields. Contributing factors include limited awareness of open access monitoring data, that monitoring data formats are not curated towards research, and difficulties obtaining funding for projects that explore existing monitoring data.

We recommend that utilization of monitoring data be prioritized in research calls, and that time for conducting research be included in the funding of monitoring programs and/or that collaborators skilled in connecting different fields together be designated. This will help bring monitoring and research together, while also ensuring a focus on relevant monitoring questions. Furthermore, there was a consensus among workshop participants that better collaboration will allow new research findings to more rapidly translate into the existing monitoring programs and help identify important monitoring needs. Method development within research is another area where advances could be transferred and integrated into monitoring.

Biobanks play a crucial role in ensuring long-term monitoring and retrospective time series as well as meeting future research needs. We encourage further development of protocols for sampling and long-term preservation of monitoring samples to ensure their viability for addressing future challenges. Close collaboration between the monitoring community and researchers is needed to guarantee the relevance of collected media, tissues and data.

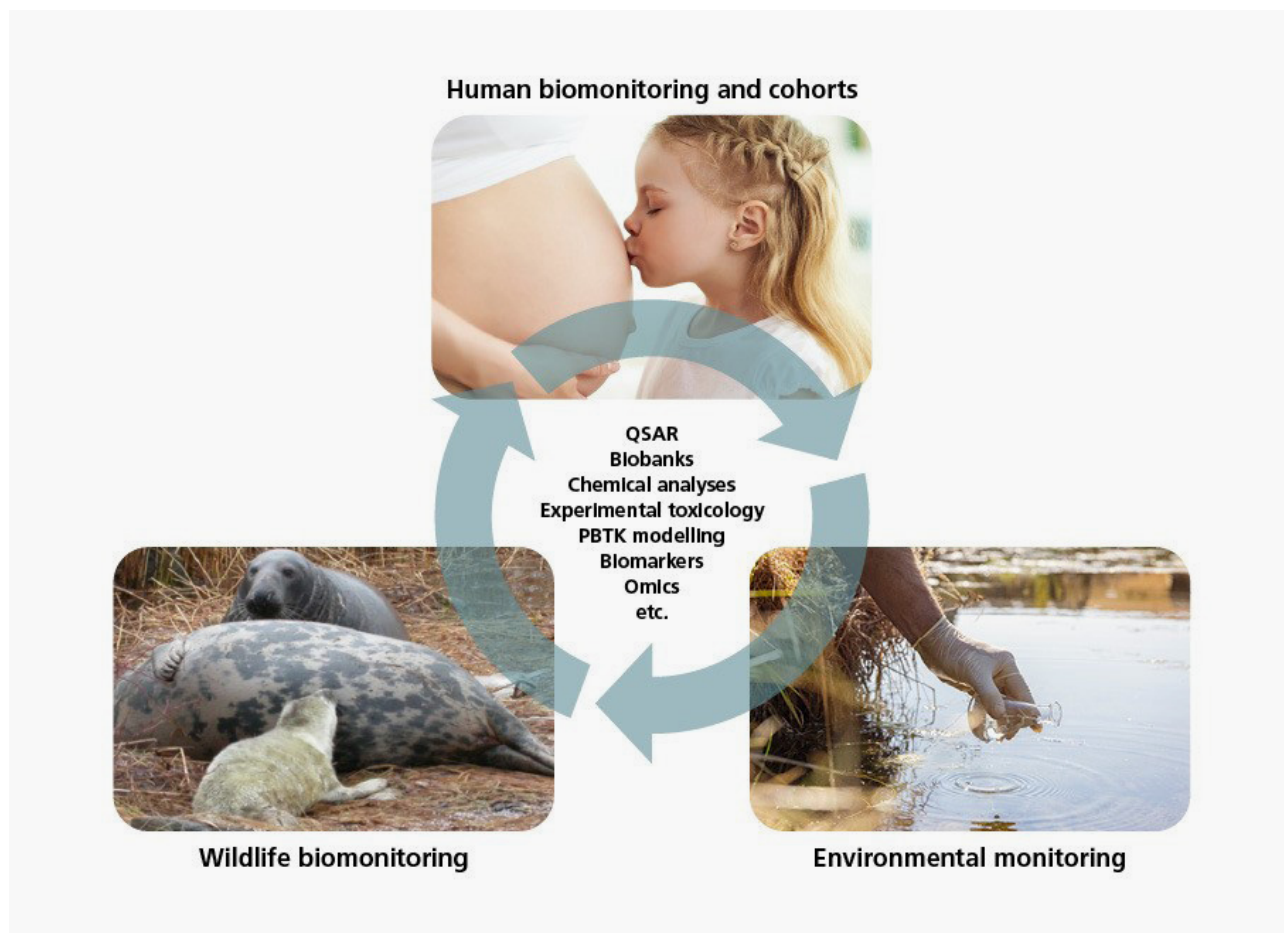


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Monitoring should continuously be reevaluated and adjusted to ensure that the monitoring process encompasses all relevant compounds without jeopardizing existing long-term trends. Achieving monitoring of emerging chemicals is a slow process, and we face challenges in determining what to monitor. We suggest that text-mining studies and AI might be helpful in advancing this work.

## Summary of recommendations

- Promote interdisciplinary collaboration, bridge communication gaps, and advocate for a paradigm shift towards a One Health focus, emphasizing the need for shared platforms, regular scientific meetings, and educational initiatives
- Encourage a shift in perspective, necessitating a cross-species extrapolation approach to better understand and address the impacts on wildlife and humans
- Advocate for increased funding for strategic chemical monitoring, recognizing it as a critical element in understanding and mitigating the impact of environmental chemicals

- Transition from a single-chemical focus to a comprehensive approach in monitoring, incorporating non-target analysis and effect-based measures for a more holistic monitoring strategy
- Prioritize the use of monitoring data in research through targeted funding and collaborative efforts
- Implement continuous evaluation and adjustment of monitoring processes to improve, for example, protocols for biobanks to support long-term monitoring and future research needs, thus fostering close collaboration between monitoring and research communities

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