A novel role for natural science collections in European contaminant monitoring

Poster · May 2021

DOI: 10.13140/RG.2.2.18710.06724

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Acknowledgements

This poster is based upon work from COST Action European Raptor Biomonitoring Facility (ERBFacility) and the LIFE APEX project. ERBFacility is supported by COST (European Cooperation in Science and Technology) and funded by the Horizon 2020 Framework Programme of the European Union and LIFE programme of the European Union, respectively.

In loving memory of Richard F. Shore

cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Funded by the Horizon 2020 Framework Programme of the European Union

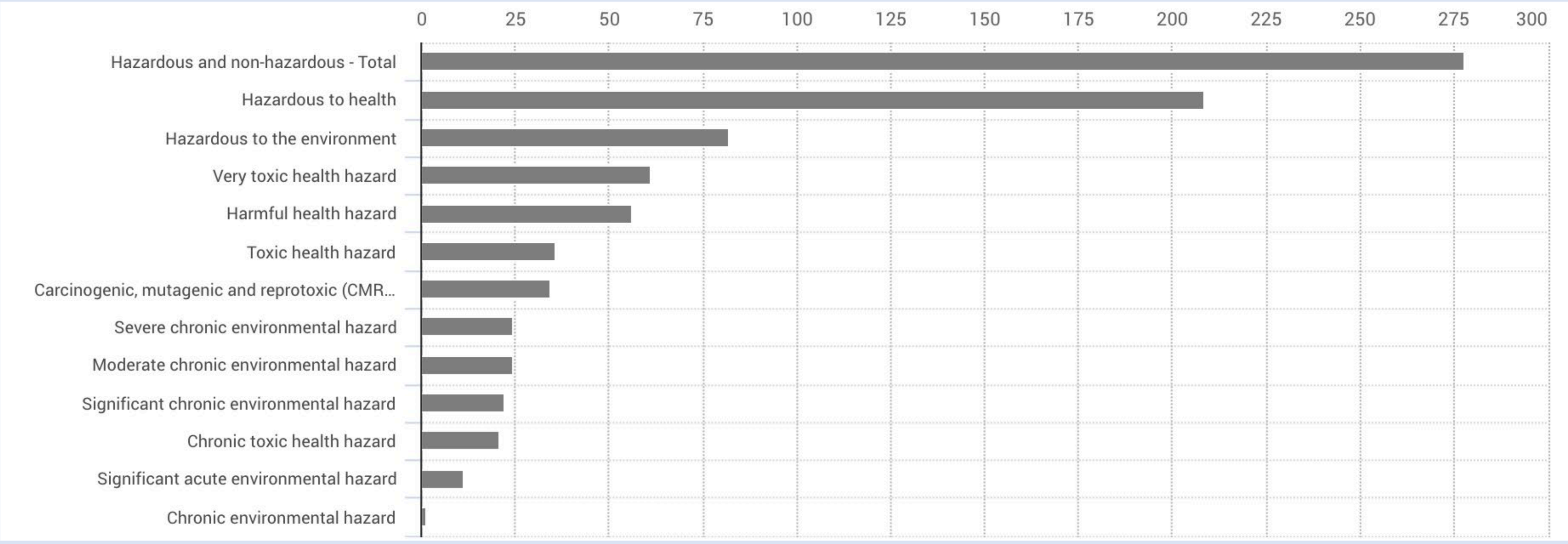
1. Monitoring contaminants in biota – enhancing societal relevance of collections

Natural science collections (NSCs) – including natural history museums (NHMs), environmental specimen banks (ESBs), and other research collections – engage in a wide range of applied research. While monitoring of contaminants in biota is a key purpose of ESBs and many research collections, it is relatively novel for most NHMs. Contaminant monitoring has potential for high environmental, social and economic impact, which can in turn enhance the value of collections [**1**, **2**].

2. Hazardous chemicals in the environment – the extent of the challenge

Tens of thousands of chemical substances are released into Europe's environment. In 2019, the EU produced 81.8 m tonnes of chemicals hazardous to the environment and 208 m t hazardous to human health (**Fig. 1**). The increasing presence of these substances in the environment carries high costs for wildlife and human health [**3**].

Fig 1: EU Production of hazardous chemicals 2019, million tonnes (source: Eurostat [i])



3. EU ambition and regulations

EU regulations – such as REACH [ii] and the Biocides Directive [iii] – seek to address this challenge. The European Green Deal [iv], the EU's new growth strategy, sets a '*zero pollution ambition for a toxic free environment.*' Yet regulators struggle to assess and manage chemical risks, given the vast number of substances involved and the lack of data on exposure and hazards. Recognising this, the recent EC Communication on a Chemicals Strategy [v] states that "*Monitoring the presence of chemicals in humans and ecosystems is key to improve the understanding of their impact… In partnership with Member States, the Commission will continue to foster research and (bio-)monitoring to understand and prevent chemicals-related risks and drive innovation in chemical risk assessment and regulatory science.*"

Naturalis Biodiversity Center, Netherlands, one of the world's five largest natural science collections

4. Raptors as sentinel species for hazardous chemicals in the environment

Raptors (Accipitriformes, Falconiformes and Strigiformes) are especially suitable for monitoring persistent, bioaccumulative substances in the environment because: (a) they are generally long-lived, apex predators; (b) they are exposed to contaminants over time and over relatively large spatial areas; (c) they can be sampled without a need to sacrifice or harm birds (e.g. feathers, blood, preen oil, addled/deserted eggs); (d) internal tissues are frequently available from birds found dead or injured, and (e) their populations can be relatively easily monitored and quantified [**1**, **4**, **5**, **6**, **7**]. Monitoring contaminants using raptors can usefully complement biomonitoring in humans within a One Health approach [**8**, **9**, **10**, **11**, **12**].

Raptor collections
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Peregrine falcon *Falco peregrinus*
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5. European Raptor Biomonitoring Facility – applying biomonitoring data

European Raptor Biomonitoring Facility (ERBFacility) [vi] (2017-2022) aims to put in place a distributed 'Facility' that brings together field ornithologists, collections and analytical laboratories, for the gathering, storage and analysis of raptor samples, to deliver data at pan-European scale on contaminants in raptor tissues. This can provide **early warning** of the persistence and bioaccumulation of emerging contaminants, aiding **prioritisation of substances for PBT assessment**, e.g. under REACH. This can help reduce administrative costs of prioritisation, and enable more timely introduction of chemical risk management measures (RMM), which can in turn prevent costly impacts on human and wildlife health. Biomonitoring data can also inform **assessment of effectiveness of RMM**, such as those enacted under REACH, enabling adjustment of RMM to improve effectiveness and reduce negative impacts of chemicals in the environment.

6. ERBFacility & collections

Recent ERBFacility work with collections has included:

(a) **A review of raptor collections in Europe [13] –** collections receive well over 5000 raptor carcasses per annum, and probably store >10,000 carcasses in their freezers - a substantial resource for contaminant monitoring.

(b) **A protocol for gathering, processing and storing raptor samples –** ERBFacility is preparing a protocol for NHMs for gathering, processing and storing of raptor carcasses and tissues for contaminant monitoring [**14**].

(c) **Shipping of raptor samples –** ERBFacility has developed guidance on shipping of raptor samples to meet these legal requirements [**15**].

(d) **A European Raptor Specimen Database –** ERBFacility is collaborating with the Distributed System of Scientific Collections (DiSSCo) [vii] (a major European Research Infrastructure coordinated by Naturalis Biodiversity Center) to develop this database. The aim is to provide near real-time data on available frozen raptor carcasses and tissues in collections around Europe [**16**].

(e) **Proof of Concept study –** ERBFacility, in collaboration with LIFE APEX [viii] (2018-2022), has surveyed available frozen carcasses/tissues of 4 raptor species (common buzzard *Buteo buteo*, tawny owl *Strix aluco*, barn owl *Tyto alba*, Eurasian kestrel *Falco tinnunculus*) in collections across Europe, revealing >3700 specimens across c.60 collections. A Proof of Concept study is now analysing c.600 tawny owl livers from these collections to determine spatial pattern of selected pollutants (second generation anticoagulant rodenticides, mercury, lead) across Europe.

LIFE APEX is meanwhile conducting **demonstration studies** on c.100 buzzard livers (as well as tissues from other top predators and fish) from across Europe to: (a) screen presence/ absence of 65000+ substances, apply target analysis for 2400+ known chemicals of emerging concern and a range of legacy pollutants (e.g. POPs, Hg) and (b) assess effectiveness of RMM for PCBs, PDBEs, second generation anti-coagulant rodenticides and mercury. These studies further demonstrate the important role that collections play in the delivery of biomonitoring data for regulatory applications.

7. Looking ahead

While monitoring contaminants in raptors presents a new challenge for many NSCs, ERBFacility is helping collections meet this challenge. A framework document on the **European Raptor Specimen Bank**, pulling together work pertinent to the Collections Arena, is under preparation. A video [ix] on *Contaminant Monitoring in Europe for Better Chemicals Management – the Role of Collections* has been produced.

ERBFacility's work with the 'collections arena' is integrated with work to coordinate pan-European collection of raptor specimens (among conservation and other groups active in the 'field arena') and to coordinate pan-European analysis of raptor samples (among laboratories active in the 'analysis arena').

Going forward, integrating work across these three arenas, ERBFacility is well placed to generate pan-European contaminant data from raptors. This has *inter alia* the potential to contribute to key initiatives under Horizon Europe such as the European Partnership for Chemicals Risk Assessment (PARC) [x].