Use of raptor chemical monitoring data to assess effectiveness of EU chemical management measures; the impact of pooling liver samples on power to detect change in contaminant conc…

Poster · May 2021

DOI: 10.13140/RG.2.2.17032.34565

CITATIONS
0

READS
131

26 authors, including:

Paola Movalli
Naturalis Biodiversity Center
81 PUBLICATIONS **600** CITATIONS
SEE PROFILE

Nikiforos Alygizakis
Environmental Institute, Ltd.
57 PUBLICATIONS **873** CITATIONS
SEE PROFILE

Alexander Badry
Federal Environmental Agency
13 PUBLICATIONS **49** CITATIONS
SEE PROFILE

Alessandra Cincinelli
University of Florence
178 PUBLICATIONS **4,678** CITATIONS
SEE PROFILE

Use of raptor chemical monitoring data to assess effectiveness of EU chemical management measures; the impact of pooling liver samples on power to detect change in contaminant concentrations at country scale

Paola Movalli♯, Nikiforos Alygizakis, Alexander Badry, Ralph Buij, Alessandra Cincinelli, Eleonora De Beni, René WRJ Dekker, Wiebke Drost, Guy Duke, Georgios Gkotsis, Natalia Glowacka, Hugh Jansman, Jan Koschorreck, Tania Martellini, Maria-Christina Nika, Varvara Nikolopoulou, Elaine D Potter, Saul Santini, Chiara Sarti, Richard F Shore, Jaroslav Slobodnik, Nikolaos S Thomaidis, Gabriele Treu, Nico W van den Brink, Steven van der Mije, Lee A Walker

♯ corresponding author: paola.movalli@naturalis.nl

1. Raptors as sentinels of environmental contaminants

Raptors (both diurnal and nocturnal birds of prey) are suitable sentinel species for contaminants in the environment. They are especially suitable for monitoring contaminant substances that are persistent and bioaccumulate in the environment.

Contaminant monitoring in raptors is particularly useful to assess the effectiveness of chemical management measures, and of regulations more generally, in protecting environmental (and human) health.

Buzzards (*Buteo buteo*) are an ideal sentinel for the terrestrial environment © Francesco Riva 2021

2. Study objectives

Using polychlorinated biphenyls (PCBs) and polybrominated diphenyl ethers (PBDEs) as exemplars, this study explores:

- The impact that within-year pooling of samples has on the provision of representative country-scale data for the detection of temporal changes in sum residue concentrations;
- The trade-offs between extent of sample pooling, number of pooled samples that are analysed, and the magnitude of change in environmental concentrations that would be detectable.

Power here means the magnitude of change that can be detected with a certain statistical probability over a specified time period.

3. Method - Analysis of PCBs and PDBEs

64 buzzard livers from The Netherlands, for the period 1996-2020, were analysed. Samples were homogenized with sodium sulphate, spiked with a surrogate standard mixture and Soxhlet extracted using a solvent mixture 3:1 (v/v) n-hexane. Extracts were rotary evaporated, and 1mL was used for the gravimetric determination of the lipid content. Extracts were cleaned-up in multilayer silica gel column. Samples, reduced to a small volume, were spiked with an internal standard mixture and analysed by GC-MS operating in NCI mode for PCBs and PBDEs determination.

4. Method - Simulation of pooling samples

The basis for the power analysis was to consider the following design set up:

- Data had been collected over 6 consecutive years
- For each year up to 12 values are randomly selected from the simulated dataset which was parameterised from descriptive statistics derived from the measured values.

4a. Method – Simulation of pooling samples (contd.)

An annual trend of 1%, 2%, 3%, 4%, and 5% annual change was applied to the data set to simulate an annual change in the magnitude of residues; the latter (5%) would result in a 30% reduction in residues by the end of the simulated monitoring period.

This design was tested against averaging the 12 samples into bulked samples of: 12 samples of 1; 6 samples of 2; 4 samples of 3; 3 samples of 4; 2 samples of 6; or 1 sample of 12.

A generalised linear model (using a gamma distribution to account for skew in the data) was then fitted to the simulated data set with a single term representing a linear trend over the 6 years included as a covariate.

This whole process was repeated 1000 times for each scenario and each bulking configuration. All p values were saved and the proportion of significant values for each scenario was calculated to represent the power of the statistical test.

5. Results – Sum PCB and Sum PBDE residues

- The was no significant temporal trend for residues of Sum PCBs or Sum PBDEs during the monitoring period (Fig. 1).
- Sum PCB residues ranged 0.1 – 54.7 µg/g lipid wt. (Geometric mean 3.4 µg/g)
- Sum PBDE residues ranged 0.006 – 4.15 µg/g lipid wt. (Geometric mean 0.1 µg/g)

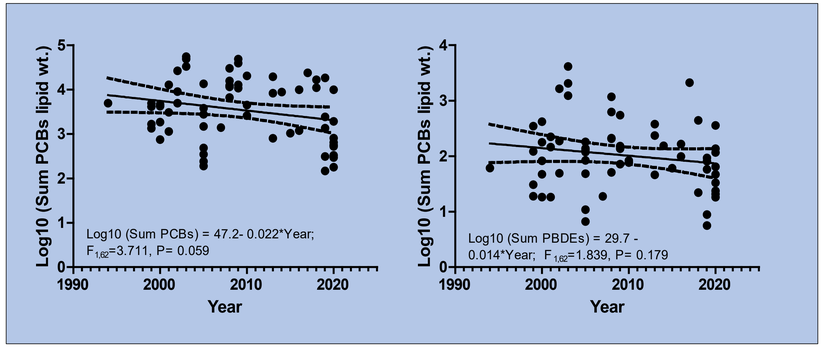

Fig. 1. Log10-transformed concentrations of sum PCB and sum PBDE in buzzards (*B. buteo*) from the Netherlands. Neither linear regression was statistically significant.

Acknowledgements

This research was carried out under the auspices of the **LIFE APEX** project which is funded by the LIFE programme of the European Union.

6. Results – Power to detect change

For both Sum PCBs and Sum PBDEs (Fig. 2), an increasing number of pooled samples used per year increased the power to detect change, but the differences between pooling regimes were relatively small.

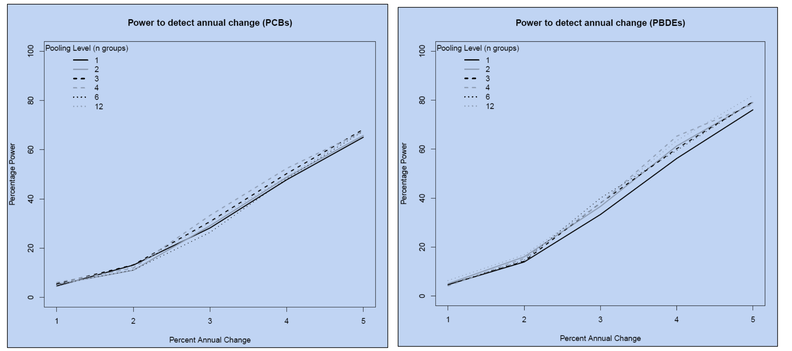

Fig. 2. Estimates of power for detecting different a temporal trend over 6 years for Sum PCB and Sum PBDE residues.

7. Discussion and Conclusions

- The power analysis carried out in this study demonstrates that sufficient power (>70%) can be achieved with relatively few pooled samples to detect small annual changes in average residue magnitude.
- This study demonstrates that, where possible, maintaining a higher number of samples per year increases the power to detect change.
- However, pooling samples reduces the number of samples to be analysed, and therefore can be a cost-effective approach for the detection of temporal trends or differences among populations at large spatial scales. By reducing the number of samples to be analysed per time period or per spatial area, pooling may allow monitoring resources to be extended to assessment of contaminant residue levels over longer time periods or larger spatial areas

Author affiliations, extended introduction, and methods are presented in the supplementary materials.