Lessons learned from testing $PNEC_{oral}$ as reference value in a component based prediction of mixture effects of contaminants

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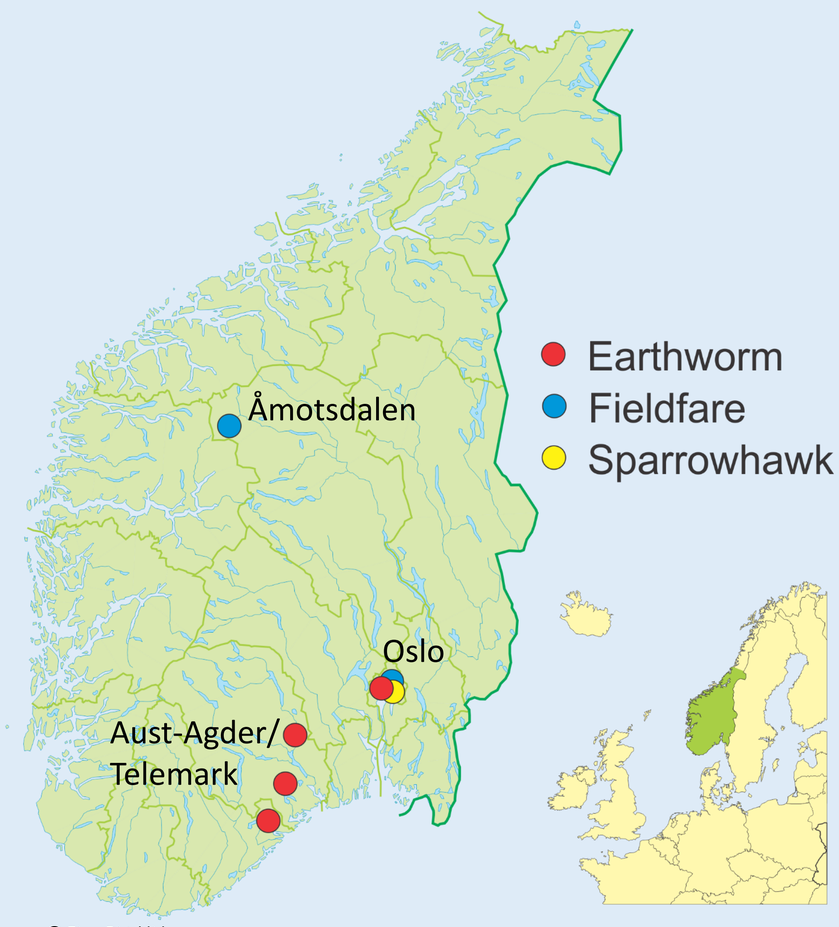
Background

- Knowledge of potential impact of contaminants in urban terrestrial ecosystems is in general lacking in Norway. Norwegian Environment Agency initiated monitoring studies in 2013-2015 of terrestrial urban sites (capital Oslo) and rural sites as reference. Representative species of a food-chain such as earthworm, fieldfare and sparrowhawk eggs were collected and analysed. The investigated compound classes were PCBs, PBDEs, PFAS and metals.
- Within the European regulation, the risk for wildlife and predators due to oral intake from lower trophic levels of bioaccumulative contaminants, is estimated with the use of $PNEC_{oral.}$ $PNEC_{oral}$ values represent dietary predicted no effect concentrations, below which food concentrations are not expected to pose a risk to birds or mammals (ECHA 2008). Results from long-term laboratory studies are strongly preferred, such as NOECs for mortality, reproduction or growth. If a chronic NOEC for both birds and mammals is available, the lower of the resulting PNECs may be used as the secondary poisoning assessment to represent all predatory organisms (ECHA, 2008).
- The method of summing up $MEC/PNEC_{oral}$ ratios was applied as a first tier approach (Backhaus & Faust, 2012) in order to evaluate the potential risk of contaminant mixtures for fieldfare with earthworm as substantial part of diet, and for sparrowhawk as predator of fieldfare chicks. MEC was the median or 90th percentile concentration (ng/g ww) of contaminants in earthworm and fieldfare bird eggs. $PNEC_{oral}$ values were preferentially adopted from risk assessment reports (RAR) produced by European Union and/or Environment Agency.



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Earthworm (*Lumbricidae*)
Oslo: 8 pooled samples
Reference site: 9 pooled samples (Aust Agder and Telemark)

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Fieldfare (*Turdus pilaris*)
Oslo: 10 egg samples (2015)
Reference site: 10 egg samples (Åmotsdalen, Oppdal 2014)

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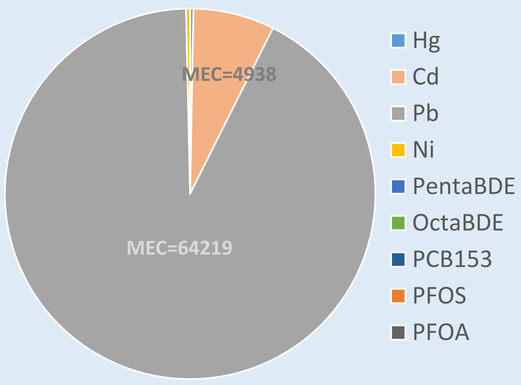
Sparrowhawk (*Accipiter nisus*)
Oslo: 10 egg samples
Reference site: 10 egg samples (Aust Agder and Telemark, same general area as for earthworm reference)

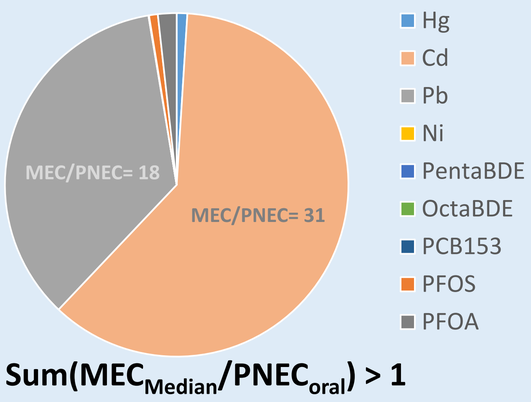
Compounds	*$PNEC_{oral}$ (mg/kg food)	Reference	Endpoint
Hg	0.4	Muñoz et al 2009 doi:10.1016/j.trac.2009.03.007	NOEC 4 mg/kg food for Coturnis c. Japonica, AF=10
Cd	0.16	EU RAR Cd Report 2007	Based on 4 studies with birds and 5 studies with mammals, AF=10
Pb	3.6	Lead WFD EQS dossier 2011	AF=15 SSD
Ni	8.5	EU RAR Ni 2008	Wild duck, tremor effects observed in chicks at day 28, AF=10
PentaBDE	1	EU RAR Diphenyl ether, Pentabromo deriv., 2000	30 day oral rat study-liver effects, AF =10
OctaBDE	6.7	EU RAR Diphenyl ether, Octabromo deriv. 2003	Rabbit phetotoxicity, AF=10
DecaBDE	833	EA-EnvRA 2009 DecaBDE	Rat, two years carcino-genicity study, AF=30
PCB153	0.67	TemaNord 2011: 506	NOEC=20
PFOS	0.013	Newsted et al 2005	Quail reproduction study AF=30
PFOA	0.9E-03	Valsecchia et al 2016 doi:10.1016/j.jhazmat.2016.04.055	Developmental abnormalities in mice, AF=90

***Most $PNEC_{oral}$ values adopted from report TA-3005/2012 by Norwegian Environment Agency**

Earthworm Oslo MEC_{Median} (ng/g ww)

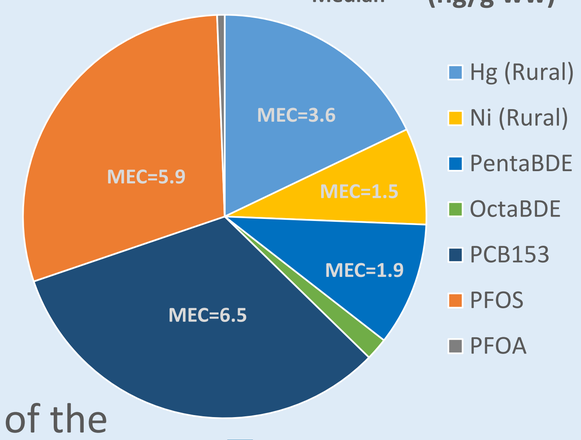


General risk for predators, Oslo $MEC_{Median}/PNEC_{oral}$

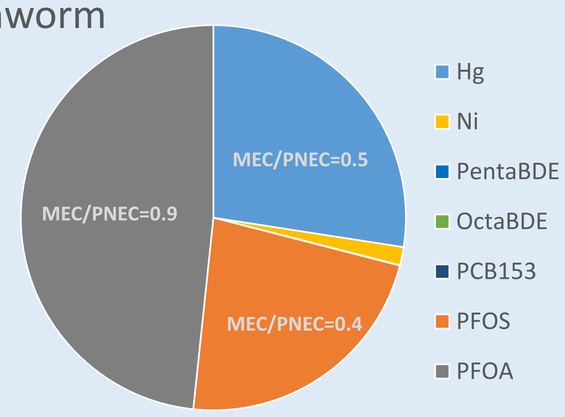


Sum($MEC_{Median}/PNEC_{oral}$) > 1

Fieldfare Oslo MEC_{Median} (ng/g ww)

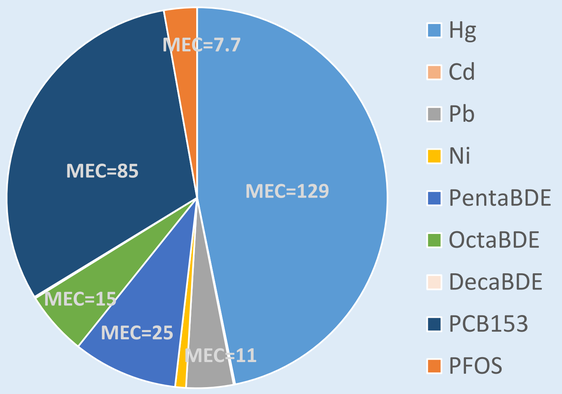


Predicted risk of the detected contaminants in fieldfare eggs based on MEC in earthworm

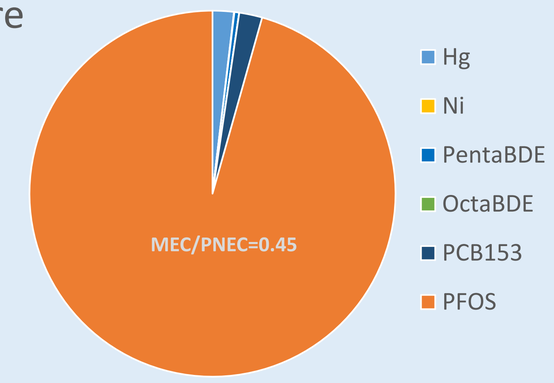


Sum($MEC_{Median}/PNEC_{oral}$) > 1

Sparrowhawk Oslo MEC_{Median} (ng/g ww)



Predicted risk of the detected contaminants in sparrowhawk eggs based on MEC in fieldfare



Sum($MEC_{Median}/PNEC_{oral}$) < 1

Conclusion & perspectives

- Concentrations of contaminants in earthworm, fieldfare and sparrowhawk were higher in the urban Oslo sites compared to rural sites. Cd, Pb and Hg revealed highest risk quotients for predators of earthworm and Sum($MEC_{Median}/PNEC_{oral}$) was above 1 for both urban (Oslo) and rural site.
- Cd and Pb was not analysed or detected in fieldfare eggs from Oslo and rural site, respectively. Risk calculations from prey MEC were therefore performed only for the compounds found in fieldfare and sparrowhawk: An unacceptable risk (Sum($MEC_{Median}/PNEC_{oral}$) > 1) was predicted with earthworm as prey for the contaminants found in fieldfare from Oslo, but Sum <1 at the rural site. PFOA contributed highest to the risk with a low PNEC value. Only the Oslo site based on 90th percentile concentration of fieldfare revealed unacceptable risk for sparrowhawk, and was dominated by PFOS. Note that Cd, Pb and DecaBDE found in sparrowhawk, in relatively low concentrations, were absent in fieldfare. PFOA was not detected (< LOD) in sparrowhawk.
- Component based concentration approach is useful as a first tier prediction of mixture risk of contaminants, but should be interpreted with caution. $PNEC_{oral}$ is not developed for specific species, but rather to protect the most sensitive predators in the ecosystem. There is also a need for a more comprehensive evaluation of the derived $PNEC_{oral}$ values, especially for PFOS, PFOA and PCB153
- Future studies are recommended to assess if Cd and Pb pose a risk and are detected in predators of earthworm- lack of data for fieldfare from Oslo due to small sample size.

References: Backhaus, T; Faust, M. (2012). Environ Sci Technol 46, 2564-2573; ECHA (2008) Guidance on information requirements and chemical safety assessment. Chapter R.10: Characterisation of dose (concentration)–response for environment. Helsinki, European Chemicals Agency. **Acknowledgements:** Norwegian Environment Agency.