Nestling predatory bird feathers as a non-destructive biomonitor for persistent organic pollutants in northern ecosystems

Eulaers I[1], Covaci A[1], Herzke D[2], Eens M[1], Halley DJ[3], Sonne C[4], Moum T[5], Schnug L[6], Hanssen SA[3], Ims RA[3], Johnsen T[3], Bustnes JO[3] & Jaspers VLB[1]

[1] University of Antwerp, Belgium; [2] Norwegian Institute for Air Research, Norway; [3] Norwegian Institute for Nature Research, Norway; [4] Århus University, Denmark; [5] Bodø university college, Norway [6] Norwegian Institute for Agricultural and Environmental Research, Norway

✉ Igor.Eulaers@ua.ac.be

Abstract

We were able to detect a wide variety of persistent organic pollutants (POPs) in nestling feathers of predatory birds. Furthermore, concentrations and accumulation patterns in feathers reflected the internal state of pollution, as determined by blood plasma analysis. Additionally, ^{13}C and ^{15}N stable isotope analysis of feathers provided information on diet and trophic position of the studied species and seems to explain accumulation and spatial distribution patterns. In conclusion, using nestling body feathers seems to be a valid non-destructive biomonitoring strategy for assessing the pollution with POPs of arctic predatory bird species and the ecosystems they reside in.

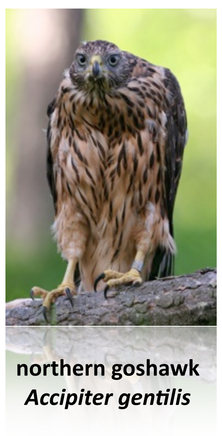
Introduction

Global long-range transport mechanisms are responsible for pollution of vulnerable Arctic ecosystems with persistent organic pollutants[1]. Monitoring all individual compartments of the environment is not practical, or relevant. Therefore biomonitoring species are useful for assessing environmental pollution and its effects on biota and humans[2]. Since POPs biomagnify through the food chain, avian top predators are very interesting species to monitor[3].

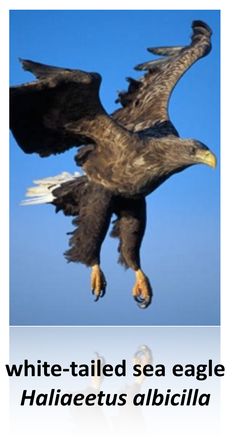
Recently, feathers have been proven to be useful non-destructive biomonitors for POPs[4,5]. Furthermore, feathers can be obtained from living birds, causing minimal harm, or molted feathers can be collected at the nest. In addition, feathers are easily stored and transported[2].

Objectives & Sampling

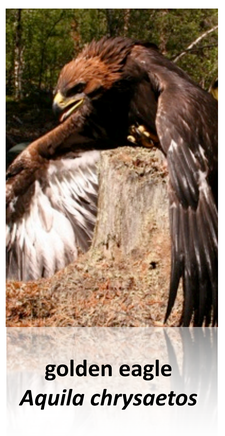
In summer 2008 we collected body feathers and blood from nestling northern goshawks (*Accipiter gentilis*), white-tailed sea eagles (*Haliaeetus albicilla*) and golden eagles (*Aquila chrysaetos*). We investigated if levels and accumulation patterns of POPs in feathers reflect the internal state of contamination through analysis of blood plasma analysis. To evaluate the impact of diet and trophic position on the accumulation of POPs, we analyzed $\delta^{13}C$ and $\delta^{15}N$ isotope rates in feathers. Analysis of these isotopes is indicative for the carbon source (^{13}C) and trophic position (^{15}N)[6]. This analysis also contributed to the investigation of spatial distribution patterns. Finally, we made a holistic evaluation of nestling feathers as a non-destructive monitoring matrix for POPs in Norwegian arctic ecosystems.



northern goshawk
Accipiter gentilis



white-tailed sea eagle
Haliaeetus albicilla



golden eagle
Aquila chrysaetos

Analysis

Feathers: After washing and cutting of feathers, they were incubated overnight with HCl (4 M) and hexane/dichloromethane (4:1, v/v) at 45 °C. Organic layers were liquid/liquid extracted and cleaned up on acidified silica. Analytes were detected and quantified using GC-MS[7].

Blood plasma: After denaturation with $(NH_4)_2SO_4$ and ethanol, organic layers were liquid/liquid extracted and cleaned op using Florisil column chromatography. Analytes were detected and quantified using GC-MS[7].

Results & Discussion

POP concentrations in feathers and blood plasma

We could detect a wide variety of pollutants in feathers and blood plasma of all species (Table 1). More pollutants could be detected in feathers. As expected[4,5,7], PCB and DDE levels were at least ten times higher than levels of PBDEs and other OCPs. This is observed for both feathers as blood plasma.

Table1: Concentrations of main POP classes measured in feathers and blood plasma from nestling predatory birds from northern Norway.

	feathers			blood plasma			
	northern goshawk	white-tailed sea eagle	golden eagle		northern goshawk	white-tailed sea eagle	golden eagle
ng g^{-1}	n = 18	n = 5	n = 15	ng mL^{-1}	n = 18	n = 5	n = 7
Σ PCBs	40 ± 20	35 ± 31	32 ± 13	Σ PCBs	12 ± 5.2	27 ± 21	12 ± 7.2
HCB	0.90 ± 0.43	0.60 ± 0.18	0.54 ± 0.20	HCB	0.62 ± 0.26	0.76 ± 0.26	0.46 ± 0.36
DDE	44 ± 20	8.3 ± 6.8	33 ± 16	DDE	9.2 ± 3.0	5.8 ± 4.2	11 ± 19
Σ CHLs	na.	na.	na.	Σ CHLs	0.40 ± 0.15	1.3 ± 1.0	0.20 ± 0.19
β-HCH	0.30 ± 0.15	0.20 ± 0.05	0.29 ± 0.15	*β*-HCH	na.	na.	na.
Σ PBDEs	3.5 ± 1.0	2.2 ± 1.4	1.2 ± 0.51	Σ PBDEs	1.0 ± 0.58	1.5 ± 1.4	0.40 ± 0.34

^{13}C and ^{15}N stable isotope signatures in feathers

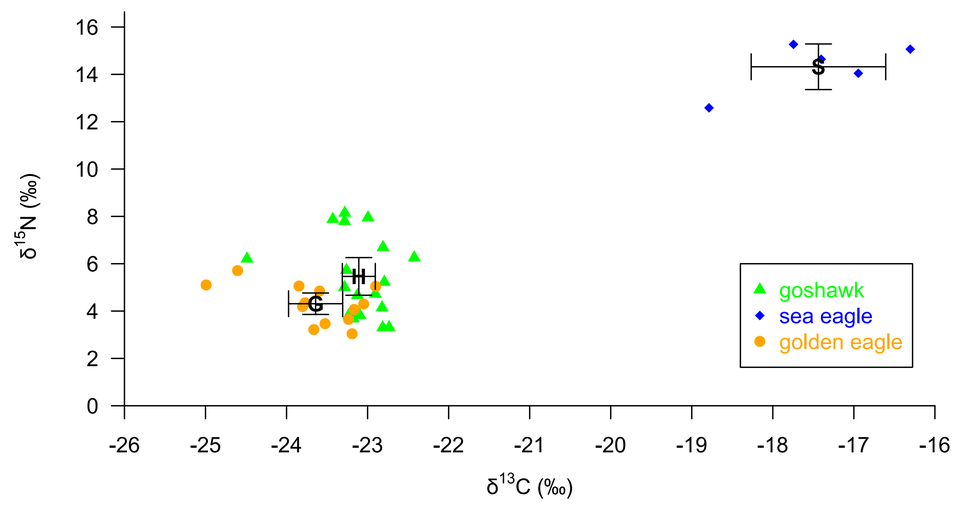


Figure 2: ^{13}C and ^{15}N signaturs in nestling feathers indicating diet and trophic level of predatory bird species from northern Norway.

^{13}C and ^{15}N isotope signatures in nestling feathers (Figure 2) indicated that sea eagles feed two to three trophic levels higher than the terrestrial goshawks and golden eagles. Furthermore, sea eagle diet was completely marine based while the diet of golden eagles had little marine input. Goshawks had a slightly more marine based diet however their diet was also primarily based on the terrestrial food chain.

Accumulation profiles in feathers and blood plasma

Accumulation profiles showed similar patterns between feathers and blood plasma. Furthermore, patterns were in agreement with those reported earlier and showed similar ecological trends, e.g. lower chlorinated compounds were more abundant in the marine sea eagle species while higher chlorinated compounds were more abundant in the terrestrial goshawks and golden eagles (Figure 1)[5].

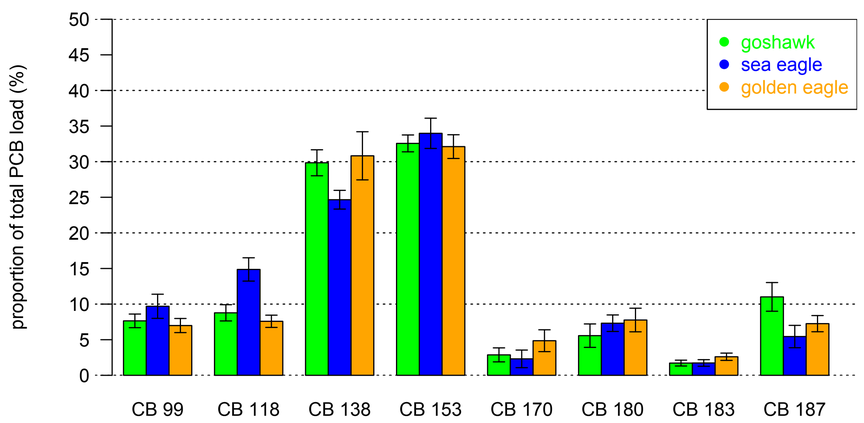
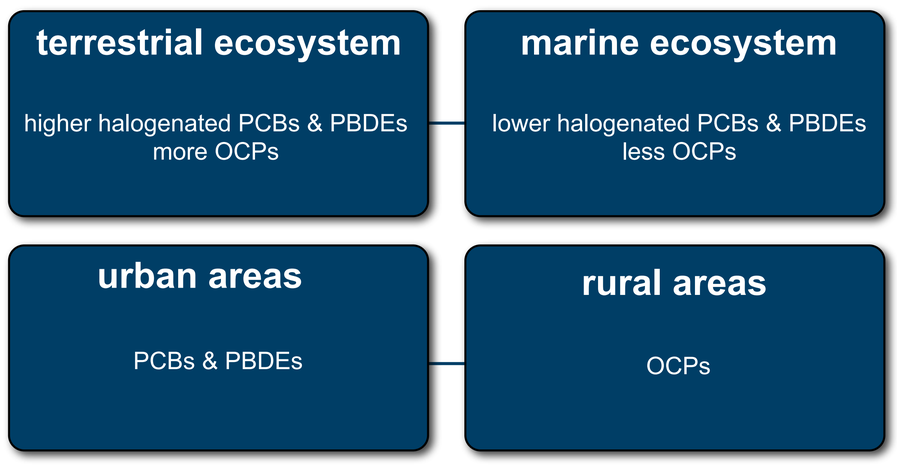


Figure 1: Accumulation profile (mean ± 2SE) of CB congeners in feathers from nestling predatory bird species from northern Norway.

Spatial distribution of POPs in northern Norway



Above stated observations were based upon POP accumulation patterns, depicted in accumulation profiles, and were supported by diet and trophic level data outcome from ^{13}C and ^{15}N stable isotope analysis.

1. AMAP, 2004. AMAP Assessment 2002, Oslo, Norway. xi + 100 pp. **2.** Jaspers VLB et al. 2006. *Environ. Pollut.* 139: 340-352. **3.** Furness RW. 1993. London, Chapman & Hall. **4.** Jaspers et al. 2006. *Biol. Lett.* 2: 283-285. **5.** Jaspers et al. 2007. *Environ. Int.* 33: 328-337. **6.** Jardine TD et al. 2006. *Environ. Sci. Technol.* 40(24): 7501-7511. **7.** Dauwe T et al. 2005. *Environ. Toxicol. Chem.* 24(2): 442-449.