

## Historien om miljøgifterne: falken som varnar människan

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A scenic landscape featuring a calm lake in the foreground, surrounded by a dense forest of evergreen trees. In the background, rolling hills and mountains are visible under a sky filled with soft, grey clouds. A single bird is captured in flight in the center of the sky. The overall mood is serene and natural.

# Historien om miljögifterna: falken som varnar människan

Peter Lindberg, Søren Møller & Knud Falk



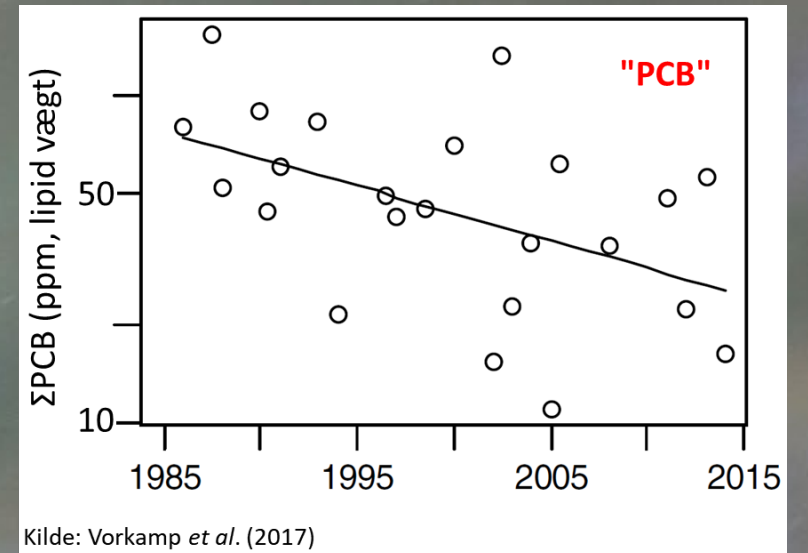
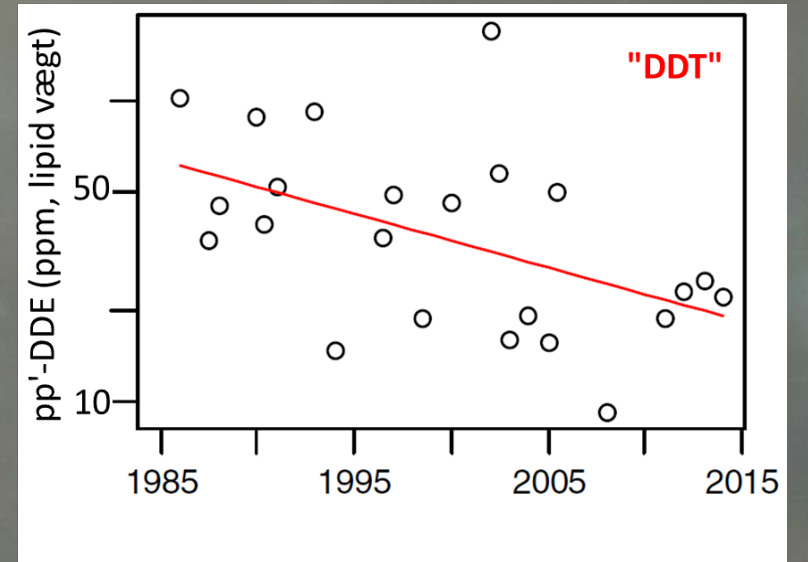
## Gammal nyhet: miljögifter drabbade rovfåglar – Pilgrimsfalk och Havsörn nästan försvann

- Rovfåglarne **larmklockan** som varnade om biverkningar av vissa kemiska ämnen
- DDT, PCB och andra ämnen **förbjöds** i många länder under 1970-talet
- ... och de mest farliga ämnen **"reglerades"** sedan globalt genom på FNs "Stockholmkonvention"





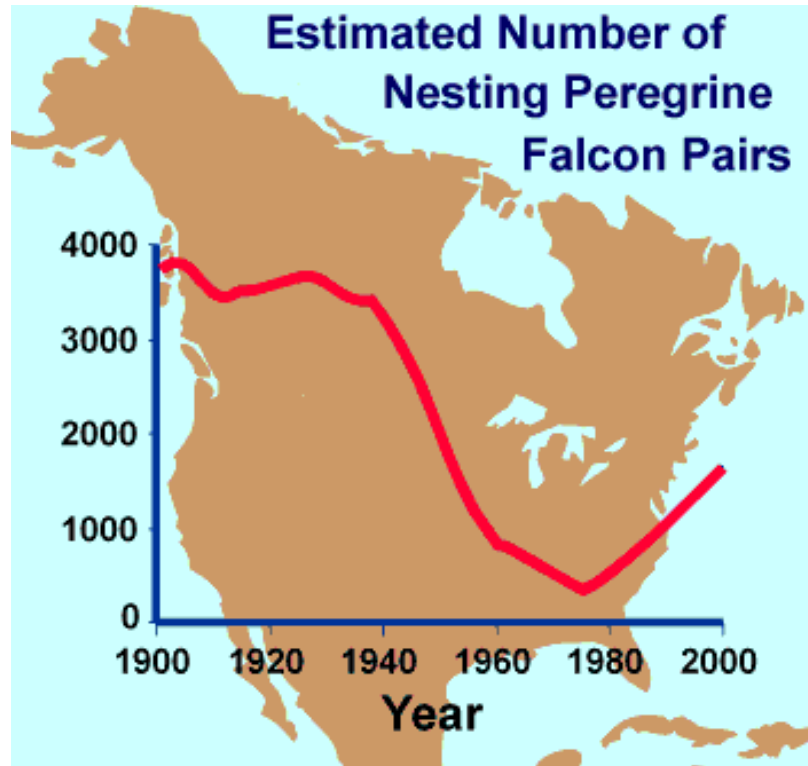
Sedan dess har "klassiska" miljögifter minskat i rovfåglar



Kilde: Vorkamp *et al.* (2017)

# Environmental Chemistry

## Eggshell thickness



NATURE, VOL. 215, JULY 8, 1967

209

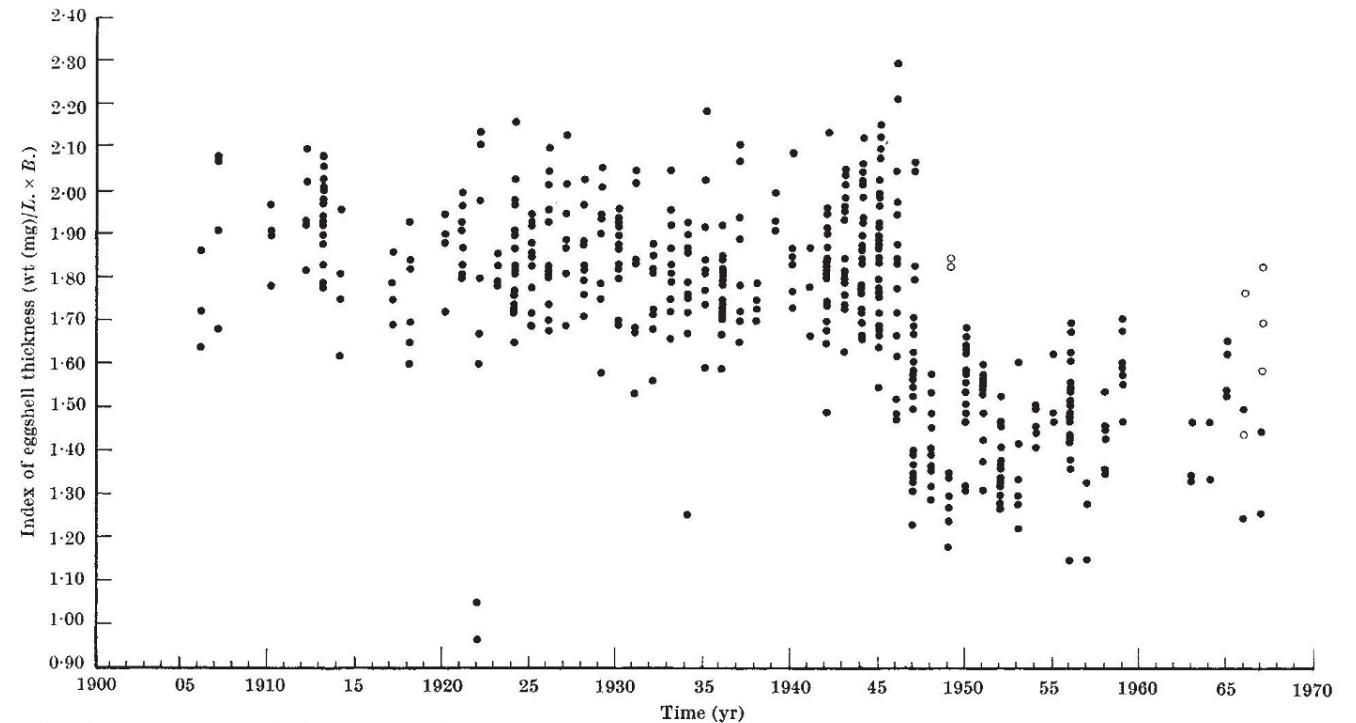


Fig. 1. Change in the ratio of weight to size (index of thickness) in eggshells of the peregrine falcon in Britain. Circles represent eggshells from the central and eastern Scottish Highlands, and dots represent eggshells from other districts (see Table 1).





# Tjockleken på äggskal påverkas särskilt av DDT

Mätning av äggskal visar hur långsamt det går att rena miljön





# Ägg för dig som vill må bra.

Omega-3 är en livsnödvändig fettsyra som behövs i uppbyggnaden av  
celler och som skyddar mot hjärt & kärlsjukdomar.

mnena för att skydda

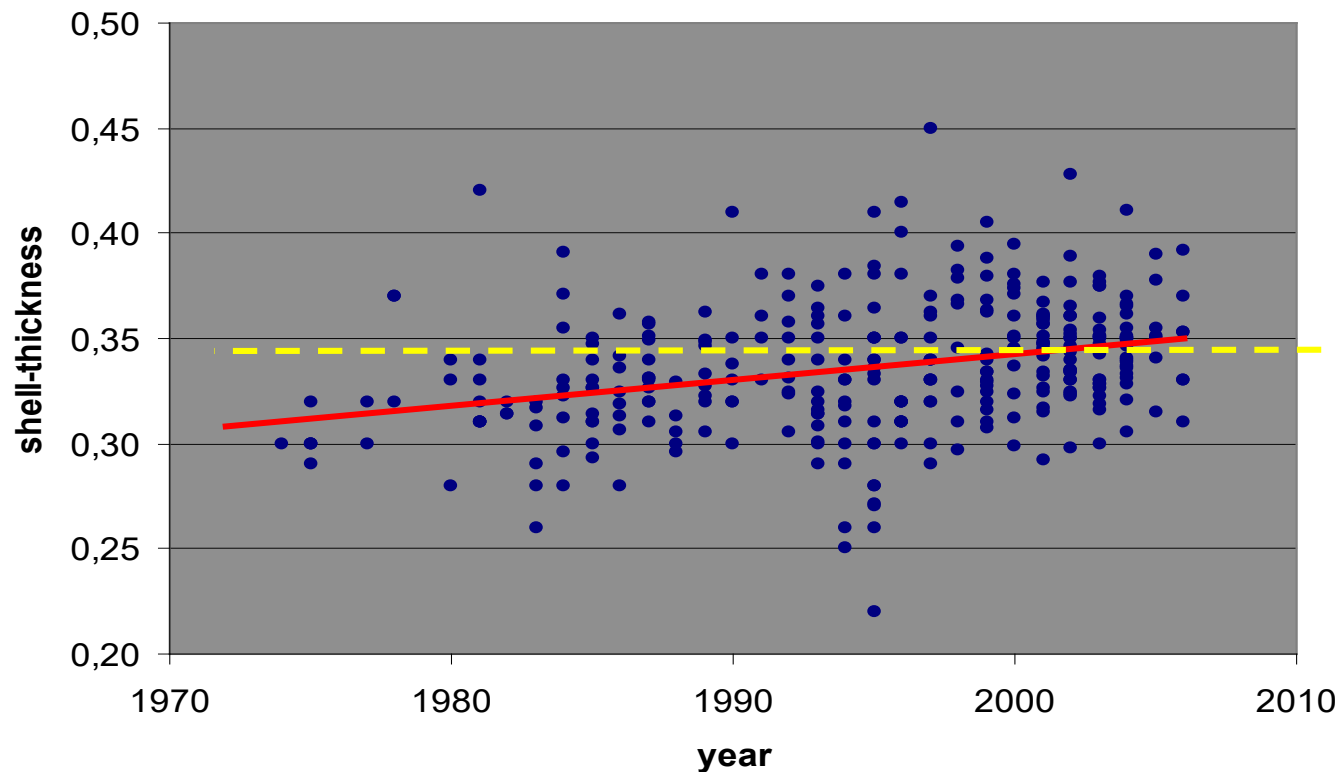
av s.k. fri

fettsy

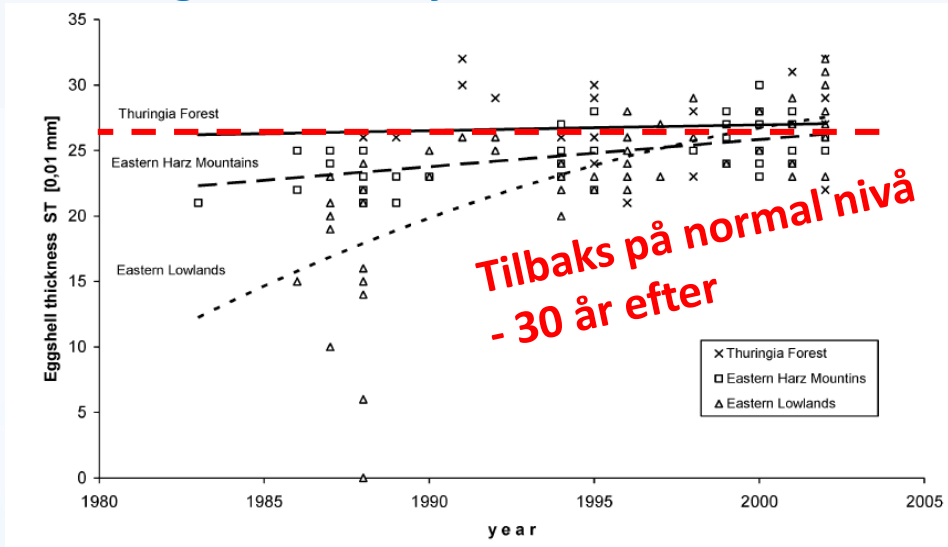
no

Svenska Pilgrimsfalksägg  
"normal" tjocklek kring  
år 2000 – ca. 30 år efter  
DDT förbjöds

shell-thickness (mm) 1972-2006

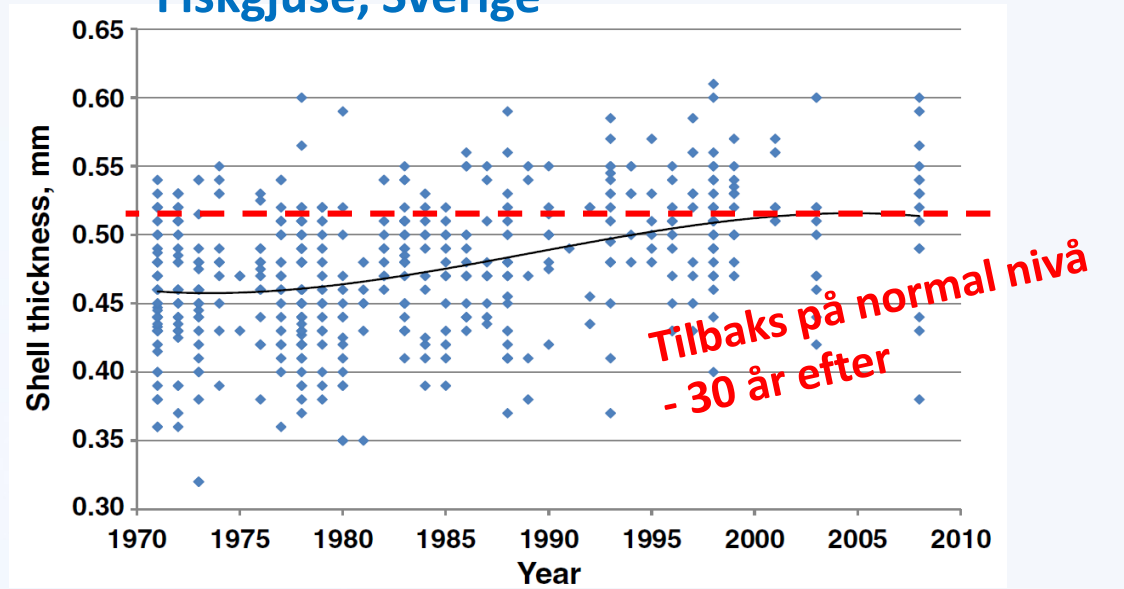


## Pilgrimsfalk, Tyskland



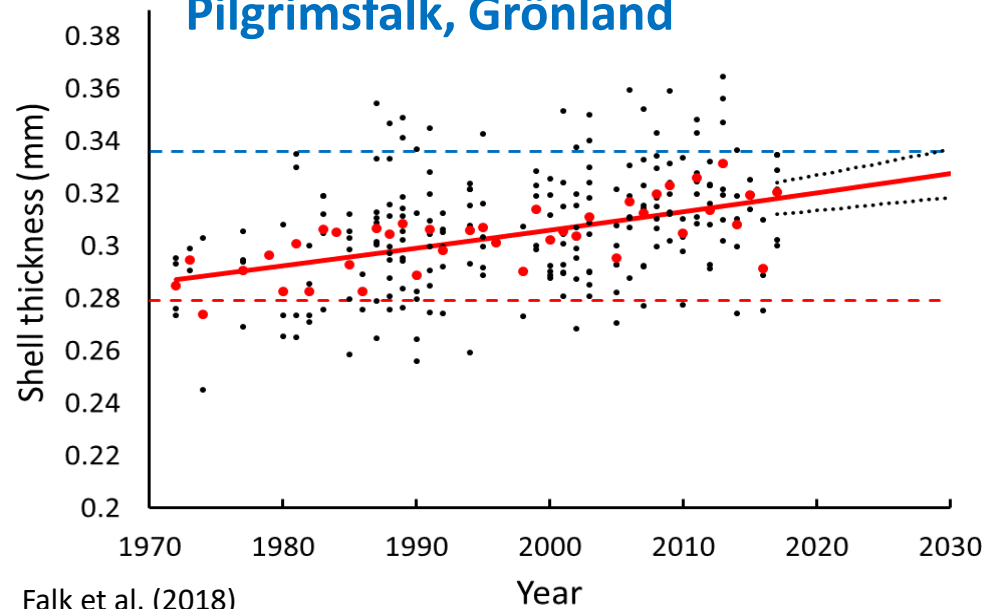
Wegner et al. (2005)

## Fiskgjuse, Sverige



Odsjö & Sondell (2014)

## Pilgrimsfalk, Grönland



Falk et al. (2018)

Förväntas normal kring 2035

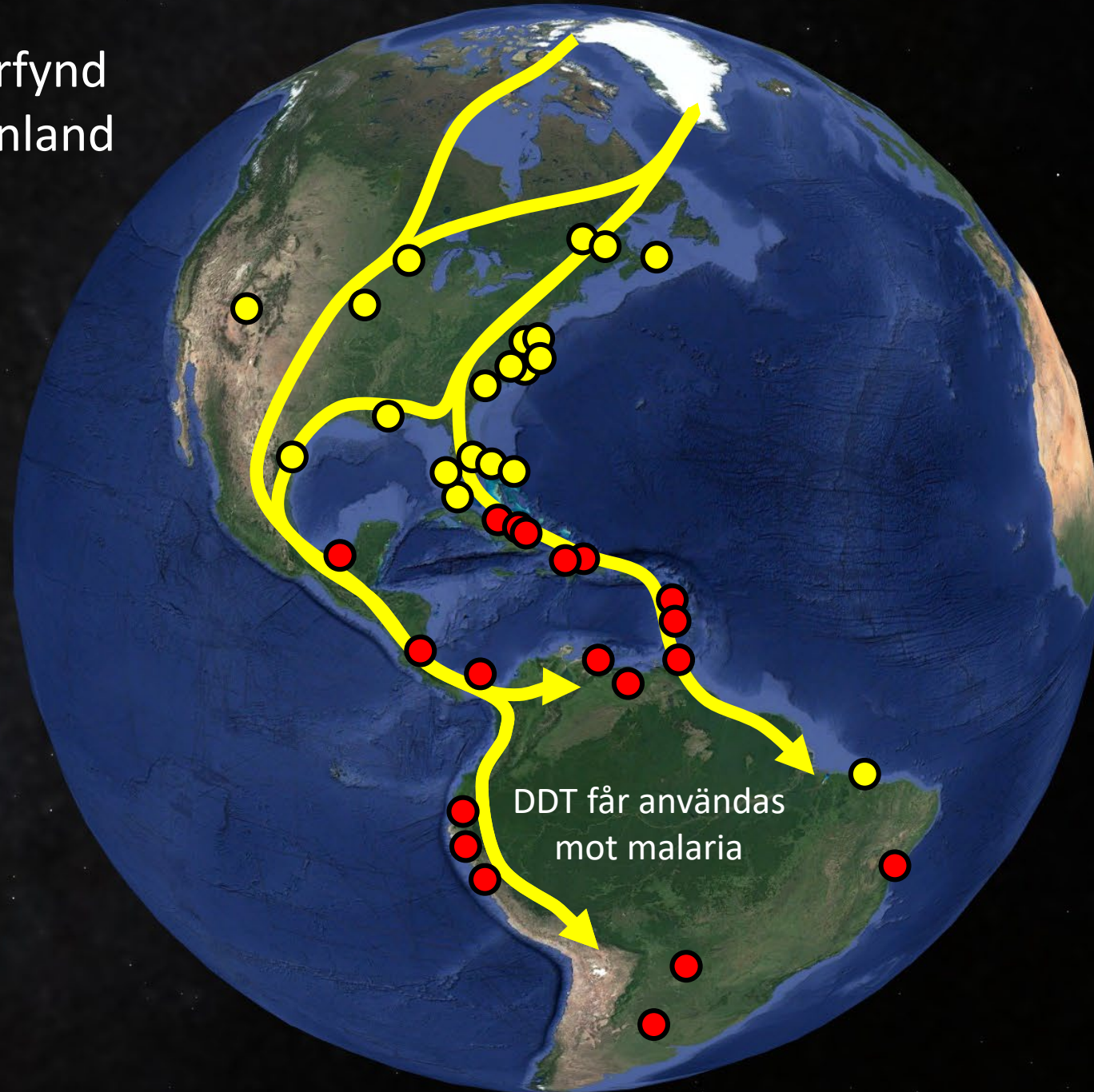
Varför?





# Migration och återfynd Pilgrimsfalkar, Grönland

- Sträck
- Vinter







**Fortsätta följa miljögifter genom rovfåglar  
- häckningsframgång och prov (ägg, skal, fjädrar etc.)**



# Analyser av rötägg varnar om nya risker





# Analyser av flamskyddsmedel i Pilgrimsfalk

## – Sverige, USA, Grönland mm.

Environ. Sci. Technol. 2010, 44, 4083–4088

### Temporal Trends of Perfluorinated Surfactants in Swedish Peregrine Falcon Eggs (*Falco peregrinus*), 1974–2007

KATRIN E. HOLMSTRÖM,<sup>\*,†</sup> ANNA-KARIN JOHANSSON,<sup>†</sup> ANDERS BIGNERT,<sup>†</sup> PETER LINDBERG,<sup>‡</sup> AND URS BERGER<sup>†</sup>

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Received January 11, 2010. Revised manuscript received April 10, 2010. Accepted April 13, 2010.

Perfluorinated alkyl substances (PFAS) are today known to be globally distributed environmental contaminants. In the present study, concentrations of PFAS were analyzed in Swedish peregrine falcon eggs (*Falco peregrinus*), collected between 1974 and 2007. Analyses included in the study were perfluorinated carboxylates (PFCA; carbon chain lengths C6–C15), perfluorinated sulfonates (PFSA; C4, C6, C8, and C10), and perfluorooctane sulfonate, PFOS (83 ng/g wet weight (w/w) mean concentration in samples from 2006), followed by perfluorotridecanoate, PFTriA (7.2 ng/g w/w). This is the first study for PFAS in terrestrial biota. The results indicate that concentrations of PFOS and perfluorohexane sulfonate (PFHxS) increased exponentially over the studied time. In contrast, concentrations of PFOS and perfluorohexane sulfonate (PFHxS) decreased initially but leveled off after the mid 1980s. This is different from previously observed temporal trends in marine organisms. The present study is the first to establish temporal differences between marine and terrestrial biota. The toxicological implications of PFAS exposure for

### Materials and Methods

### Sampling and Study Design

Population breeding in the southwest of Sweden (see

applications such as fire retardants and as insecticides (1). PFAS are also present (2). Due to their persistence, PFOS was included in the persistent organic pollutants (POPs) list. The peregrine falcon (*Falco peregrinus*) is a raptor found in a variety of habitats in the Northern Hemisphere. In the mid 1970s, the population was endangered due to high eggshell thickness and the use of several pesticides, particularly in many European countries. Peregrine falcon populations have since been left in Sweden. The result is estimated to be a result of a successful conservation program (5). The peregrine falcon population in Sweden is recovering. It is a species for emerging pollutants (PFAS) are known to be present in several bird species (6). PFAS are known to be present in several bird species (6). PFAS are known to be present in several bird species (6).

The aim of this study was to investigate temporal trends of PFAS in peregrine falcon eggs. The study was conducted in Sweden, and a captive breeding population. All BFRs analyzed were found, including BDE-183 and -209, and mean ΣPBDE, BB-153, and HBCD for northern/southern populations of 2200/2700, 82/77, and 150/250 ng/g lw, respectively) than in captive falcons (39, 8 ng/g lw, and not detected, respectively). This is the first time, to our knowledge, that BDE-183 and -209 have been quantified in high trophic level wildlife.

### Introduction

Polybrominated diphenyl ethers are widely used as flame retardants in textiles and plastics. The world market demand for the technical BDE products in 2001 was 7500 tons penta-, 3800 tons octa-, and 56100 tons decaBDE (1). Market demand for HBCD was 16100 tons (1). Based on recent risk assessments, penta- and octaBDE will be banned within the EU in 2004 (2). There are no restrictions on the use of decaBDE

### Higher Brominated Diphenyl Ethers and Hexabromocyclododecane Found in Eggs of Peregrine Falcons (*Falco peregrinus*) Breeding in Sweden

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LISBETH HÄGGBERG, AND  
CYNTHIA A. DE WIT<sup>†</sup>

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Several brominated flame retardants (BFRs) were analyzed in peregrine falcon eggs collected in 1987–1999, including the constituents of the technical polybrominated diphenyl ether (PBDE) products Penta (BDE-47, -99, -100, -153, -154), Octa (BDE-183), and Deca (BDE-209), hexabrominated biphenyl (BB-153), and hexabromocyclododecane (HBCD). The eggs represented females from three different breeding populations, northern Sweden, southwestern Sweden, and a captive breeding population. All BFRs analyzed were found, including BDE-183 and -209, and mean ΣPBDE, BB-153, and HBCD for northern/southern populations of 2200/2700, 82/77, and 150/250 ng/g lw, respectively) than in captive falcons (39, 8 ng/g lw, and not detected, respectively). This is the first time, to our knowledge, that BDE-183 and -209 have been quantified in high trophic level wildlife.

### Methods

Peregrine falcon eggs were collected within the Swedish Society for Nature Conservation inventory program, with

Environ. Sci. Technol. 2004, 38, 93

SETAC PRESS

### POLYBROMINATED DIPHENYL ETHERS IN PEREGRINE FALCON EGGS FROM THE GREENLAND REGION, USA, PEREGRINE FALCON EGGS FROM GREENLAND

KATHERINE E. POTTER,<sup>†</sup> BRYAN D. MARIANNE THOMSEN,<sup>†</sup> KNUD FALK,<sup>‡</sup> HEATHER LESLIE,<sup>‡</sup> SØREN MØLLER,<sup>‡</sup> AND PETER B. SØRENSEN<sup>‡</sup>

<sup>†</sup>Department of Chemistry, <sup>‡</sup>Center for Conservation and Environmental Science, University of Alaska, Fairbanks, P.O. Box 135660, Fairbanks, Alaska 99775-0660, USA

(Received 2004)

**Abstract**—A total of 23 peregrine falcon (*Falco peregrinus*) eggs were collected from 11 locations in the Chesapeake Bay region, USA. The mean concentration of total PBDEs was 354 ng/g. This egg also exhibited the highest concentration of total PBDEs (26.0, 24.8, and 13.1%, respectively, of total PBDEs). The sum of the octa- to nonabrominated congeners, exceeding the contribution of BDE 209, was 2.2-bis(*p*-chlorophenyl)ethylene (4,4'-DDE) also and were an order of magnitude greater than the corresponding levels were not correlated to human

**Keywords**—Persistent organic pollutant, Dichlorodiphenylchloroethylene, Reproductive toxicity

### INTRODUCTION

Because of their lipophilic properties, persistent organic pollutants (POPs), such as polychlorinated biphenyls and organochlorine pesticides, accumulate in exposed organisms. Use of some of these POPs has been restricted by international treaty. Manufacture of other chemicals with similar properties, however, either continues or has only recently ceased (e.g., polybrominated diphenyl ethers [PBDEs]). The available PBDE data suggest that concentrations in birds of prey from Europe, Asia, and North

trophic position. Most data products with lower trophic position. Most data products with lower trophic position. Most data products with lower trophic position.

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Several brominated flame retardants (BFRs) were analyzed in peregrine falcon eggs collected in 1987–1999, including the constituents of the technical polybrominated diphenyl ether (PBDE) products Penta (BDE-47, -99, -100, -153, -154), Octa (BDE-183), and Deca (BDE-209), hexabrominated biphenyl (BB-153), and hexabromocyclododecane (HBCD).

Environ. Sci. Technol. 2005, 39, 8199–8206

### Temporal Development of Brominated Flame Retardants in Peregrine Falcon (*Falco peregrinus*) Eggs from South Greenland (1986–2003)

KATRIN VORKAMP,<sup>\*,†</sup> MARIANNE THOMSEN,<sup>†</sup> KNUD FALK,<sup>‡</sup> HEATHER LESLIE,<sup>‡</sup> SØREN MØLLER,<sup>‡</sup> AND PETER B. SØRENSEN<sup>‡</sup>

<sup>\*</sup>National Environmental Research Institute, Departments of Environmental Chemistry & Microbiology and Policy Analysis, Frederiksborgvej 399, DK-4000 Roskilde, Denmark; <sup>†</sup>Teglstrupvej 6A, 1. tv., DK-2100 Copenhagen Ø, Denmark; <sup>‡</sup>Netherlands Institute for Fisheries Research, P.O. Box 68, NL-1970 AB Ymuiden, The Netherlands, and Roskilde University Library, P.O. Box 258, DK-4000 Roskilde, Denmark

A time trend between 1986 and 2003 was found for brominated flame retardants in peregrine falcon eggs from South Greenland, with significantly increasing concentrations of the polybrominated diphenyl ethers (PBDEs) 99, 100, 153, 154, and 209. For BDE-99 and -100, the concentration increased approximately 10% per year. The concentrations of PBDEs were among the highest detected in wildlife so far and ranged from 300 to 12 900 ng/g lipid weight (lw) for ΣPBDE. While tetrabromobisphenol A (TBBPA) was below the limit of detection in all eggs, hexabromocyclododecane (HBCD), dimethyl-TBBPA, and brominated biphenyl BB-153 were detected in a majority of eggs, with median concentrations of 2.4, 230, and 550 ng/g lw, respectively. Analyses of eggs of the same bird showed no significant intra-clutch variation for PBDEs, BB-153, and HBCD but larger variations for dimethyl-TBBPA. Inter-clutch variations with increasing time trends exist for the BDEs 99, 100, 153, 154, and 209, while a decreasing contamination with increasing time trends from in-service and discarded polymer products, however, will continue for years. Substantial releases of deca-BDE from industrial sources directly to the environment also have been reported in the U.S. Environmental Protection Agency Toxics Release Inventory [7]. Additional concerns have been voiced with respect to potential debromination of BDE 209.

The brominated substances used as flame retardants in electric and electronic equipment, textiles, and paint are polybrominated diphenyl ethers (PBDEs), hexabromocyclododecane (HBCD), and tetrabromobisphenol A (TBBPA). The production of polybrominated biphenyls (PBBs) was discontinued in the U.S. in 2001, TBBPA had the highest world market demand with 119 700 metric tons, followed by deca-BDE (56 100 tons) and in Europe in the 1970s and in 2000, respectively (4). The world market demand for HBCD and penta- and octa-BDE was 16 700, 7500, and 3790 tons, respectively (5). TBBPA is the only compound partly used as a reactive flame retardant, which presumably reduces loss to the environment. The use of penta-BDE was voluntarily withdrawn from the Japanese market and has been banned in Europe, but production and use continues in North America (4). The European Union has also banned the production and marketing of octa-BDE (5). The regulatory measures taken in Europe are considered as the main reason for declining PBDE concentrations in Europe, for example, those observed in Swedish human milk samples during the last 5 years (7). There are no restrictions on the use of deca-BDE, HBCD, or TBBPA.

In Greenland, previous studies on BFRs included fish and blue mussels (*Mytilus edulis*), black guillemot (*Cephus grylle*), ringed seal, shorthorn sculpin (*Myoxocephalus scorpius*), and Arctic char (*Salvelinus alpinus*) (8–10). Most data have been obtained for the penta-BDE compounds, while data on octa- and deca-BDE as well as HBCD and TBBPA are still sparse. The studies confirm the presence of PBDEs in the remote area of the Arctic, show similarities to the bioaccumulation and geographical patterns of PCBs, and indicate a contribution from local sources. The objective of this study was to monitor the long-term development of BFRs in a top predator, the peregrine falcon, from Greenland. Organochlorine compounds, such as polychlorinated biphenyls (PCBs) and organochlorine pesticides, were analyzed in the same samples but are presented elsewhere (11). In addition, possible relations to the eggshell thickness of the peregrine falcon eggs have been studied (12).

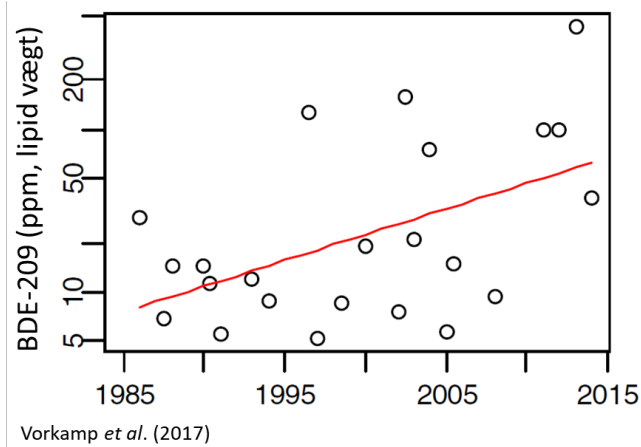
The peregrine falcon population in South Greenland is conservatively estimated at 500–1000 pairs (13). On the basis of reported in the U.S. Environmental Protection Agency Toxics Release Inventory [7]. Additional concerns have been voiced with respect to potential debromination of BDE 209.



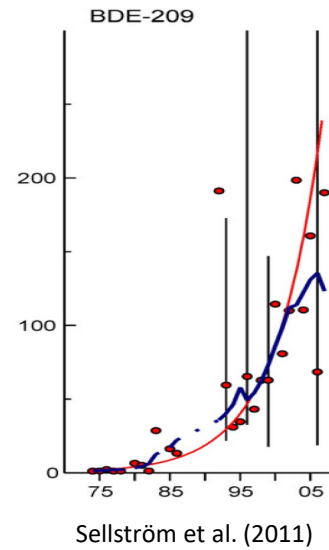
# ... kraftigt ökande mängder i ägg bidragit till att få ännu ett ämne på "förbuds-listan"

## "Flamskyddsmedel" BDE-209

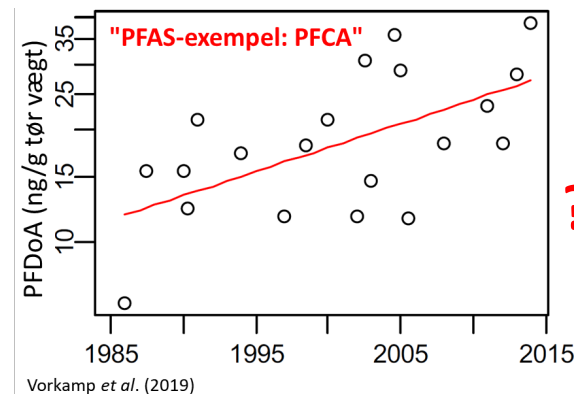
Pilgrimsfalk, Grönland



Pilgrimsfalk, Sverige



Stor chans att också få en rad PFAS ämnen på "listan" – delvist tack vara analyser av Pilgrimsfalk



**Falken varnar fortfarande människan**

**Tack**

