

# Eggshell thinning in Greenland

## Greenlandic Peregrines will have normal eggshell thickness by 2034



Knud Falk, [www.vandrefalk.dk](http://www.vandrefalk.dk)  
Søren Møller, Roskilde University Library  
Frank F. Rigét, Aarhus University  
Peter B. Sørensen, Aarhus University  
Katrin Vorkamp, Aarhus University

### Introduction

Since it was first shown that DDT caused eggshell thinning and breeding failure in wild Peregrine Falcon populations, the effects on the eggshell thickness and breeding success in high-trophic level birds have been widely documented. Studies of Peregrines<sup>1</sup> and Ospreys<sup>2</sup> in Europe have shown that it took 30 years from DDT was phased out until eggshell thickness was back to normal pre-DDT levels.

The study combines samples from South Greenland (1981-2014), and West Greenland (1972-1988). Results for 1972-2003 were published earlier<sup>3</sup> but here the time series is extended to 2014 and all data re-analysed.



### Methods

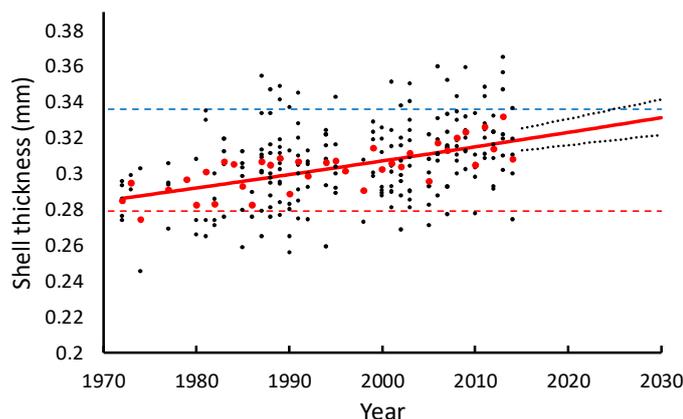
**Samples:** Eggshell fragments from the hatched eggs were collected. In addition, whole added eggs sampled for contaminant analyses were included. Full clutches from 1881-1930 stored at Zoological Museum, Copenhagen, provide the reference for "normal" pre-DDT thickness.<sup>4</sup>

**Measurements:** Shell thickness was measured according to Falk et al. (2006)<sup>3</sup> and mean shell thickness was estimated for 184 clutches based on at least 20 fragments measured, and for 56 whole added eggs from 44 clutches. Paired t-test showed no significant difference ( $t=0.38$ ,  $p=0.71$ ) between mean shell thickness based on fragments and whole eggs so data were combined for analyses. The temporal trend is analysed by log-linear regression analysis on mean annual shell thickness.

### Results

**Figure:** Shell thickness shown as clutch means (black symbols), annual means (red symbols) and projected red trend line with 95% confidence limits (black dashed lines); pre-DDT normal thickness (0.336 mm, blue dashed line);<sup>3</sup> red dashed line indicate empiric 17% "danger threshold" (0.279 mm) associated with population declines across the world.<sup>5</sup>

The increasing trend (0.25% per year) in the average eggshell thickness is highly significant ( $p < 0.001$ ). This corresponds to a change in eggshell thinning from 13.9% in 1972 to 3.4% thinning in 2014 when compared to pre-DDT eggs.



### References

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### Conclusions

- Based on the current rate of increase, **normal shell thickness is predicted to be reached around 2034**. However, the wide 95% confidence limit on the predicted values should be noted.
- **A few clutches are still below the critical limit.**
- The much slower recovery of the shell thickness in the Greenland population compared to Europe is likely indicative of the slower phasing out of DDT in the Americas where the Greenland Peregrines winter.<sup>6</sup>
- The general **DDT metabolite level** in the areas the peregrines are "sampling" **can be continuously monitored by low-cost collection of eggshell material** in Greenland.