FIELD REPORT 2014

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Publication date:
2014

Document Version
Peer reviewed version

Citation for published version (APA):
Møller, S., & Falk, K. (2014). *FIELD REPORT 2014: Monitoring of the Peregrine Falcon population in South Greenland*. Roskilde Universitetsbibliotek.

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Monitoring of the Peregrine Falcon population in South Greenland

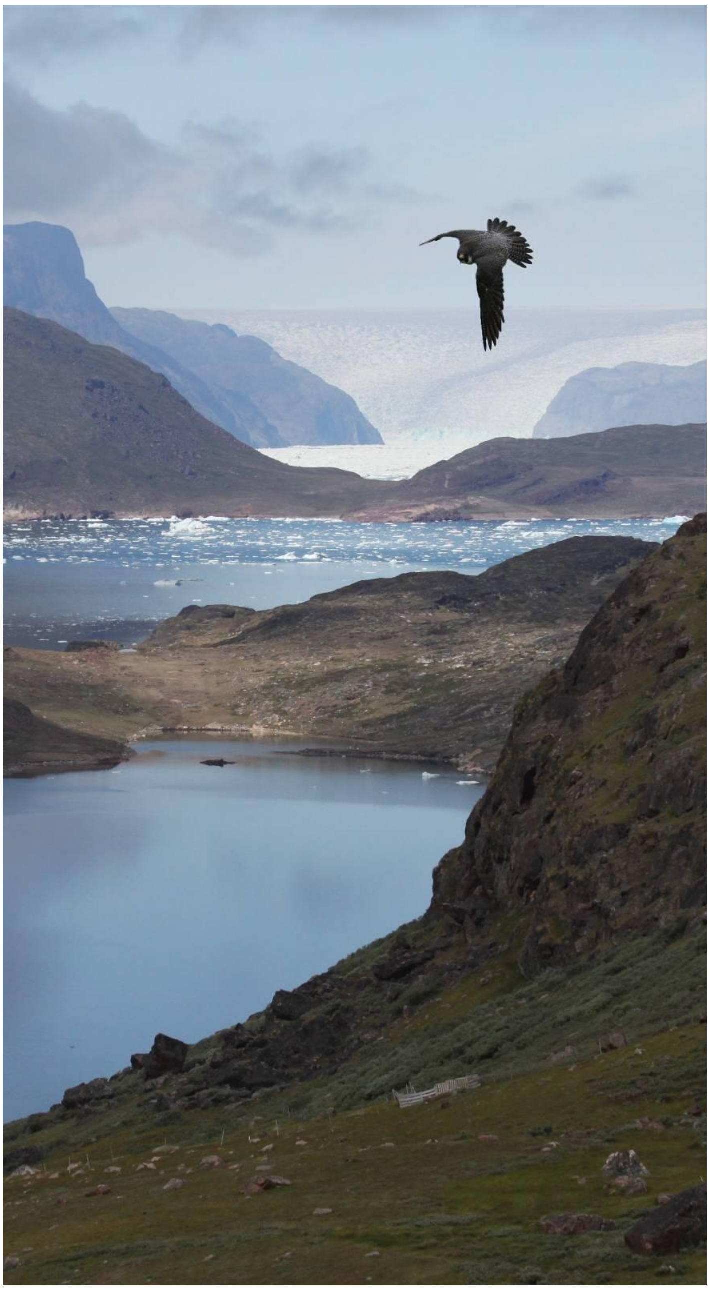
Knud Falk & Søren Møller

http://vandrefalk.dk/index_eng.shtml

Introduction

For several decades the Peregrine Falcon has served as an indicator species for the environmental effects of pesticides and other contaminants. Since 1981 we have conducted annual investigations of various aspects of Peregrine ecology and contaminant loads in the breeding population in South Greenland (*Falco peregrinus tundrius*), and results include:

- The identification of a slow, gradual decrease in classical pesticide loads and associated eggshell thinning effects.[1]
- Increased burdens of new contaminants such as brominated flame retardants.[2]
- The reproduction is healthy on average, while breeding phenology appears to be gradually shifting towards earlier hatching dates, possibly as a consequence of changing climatic conditions.
- The Peregrines in South Greenland maintain a high productivity – 2.9 young/ successful pair, or 1.8 young/occupied territory (1981-2014). The high reproduction is to compensate for a high adult (female) turnover of around 25% (1985-2003).
- Ring recoveries reveal that the Peregrines migrate to Latin America – which is probably the source areas of the classical pesticides – whereas the more specific source areas of the new potentially harmful substances are more uncertain.



Research objectives

The overall project objective is to *monitor and assess current and future impacts of environmental changes – chemical as well as climatic – and their effects on the Peregrine Falcon population in Greenland*. Hence, we aim to continue one of the longest raptor monitoring efforts in the Arctic.

[1] Vorkamp *et al.* (2009, 2014); Falk *et al.* (2005)
[2] Vorkamp *et al.* (2005)

Methods and approaches

The project is designed as a "lean" field programme to be conducted annually by two persons in 21-30 days. Small dinghies or Zodiacs are used to navigate the fjords between camp sites, from where the field team hikes to the selected monitoring Peregrine sites (see map, right).

All field work is based on *basic* monitoring parameters sampled at selected sites every year in the core survey area and include:

- Reproduction: number of young reaching banding age per occupied and successful site.
- Breeding phenology: Date of first hatching in each nest – measured by standard aging catalogue and wing length[3] or egg weight/measurements.
- Samples
  - Addled eggs collected for contaminant analyses
  - Eggshell fragments from hatched eggs – for monitoring the slowly improving eggshell thickness[4]
  - Moulted feathers for mercury and other heavy metals.[5]

The new migration study applies miniature (1.9 g) archival light level data loggers[6] ("geolocators" – GLs) providing daily locations almost year round. Adult females are (re)captured at the breeding site by standard methods we have applied for many years when studying adult turnover.

In addition, from 2013 we also collect data on prey density by recording passerines on line transects along the hikes to/from Peregrine nesting sites (and other trips). We identify all species and age (adult or fledgling) and count all birds within 50 m horizontal distance from the observer path. This is a rough method providing an index for comparing changes over the coming years.

Field work 2014

Field work in 2014 was conducted 24 June - 24 July by Knud Falk and Søren Møller assisted by Lena Hansson and Marianne Lind. This year the project was supported by Bodil Pedersen Fonden, William A. Burnham Memorial Fund and Aase og Jørgen Münters Fond.

In 2014 the spring weather was rather "average" and the summer relatively dry and sunny – i.e. presumably favourable breeding conditions for the falcons compared to the poor weather conditions in 2013. The Peregrines' prey base was also better than last year, but nevertheless the Peregrines bred relatively late, and breeding success remained very low. (see details below).

A total of 17 site visits to the 12 monitoring sites were conducted. Passerines were recorded at seven different line transects covering a total of 27.3 km.

The standard Peregrine Falcon sample sites selected for long-term monitoring in South Greenland.

Field work is based on a boat-based two-man team navigating the fjords and hiking to each of the cliffs included in the monitoring programme.

Egg mass and measurements helps determine hatching dates.

Addled eggs are collected for contaminant analyses along with any shell fragments from hatched eggs for monitoring eggshell thickness.

[3] Clum *et al*. (1996), White *et al.* (2002)
[4] Falk *et al.* (2005)
[5] Dietz *et al*. (2006)
[6] http://birdtracker.co.uk/

Results

Occupancy
All 12 monitoring sites were occupied by at least one defensive adult Peregrine, but only 6 pairs were recorded as attempting to breed (eggs and/or young recorded) – table 1 and 2.

Breeding success
The proportion of sites where a Peregrine pair attempted breeding was very low – over the entire monitoring programme it was only surpassed by teh event poorer performance in 2013 (table 2 and figure 1 and 2). Due to the late breeding season this year most young were too small to be ringed at the last site visits to the nests and therefore breeding success (no of young per pair) is very unreliably estimated this particular year.

Breeding phenology
Mean hatching date for first egg in the 4 clutches determined was 12 July – 8 days later than the overall average (4 July) for 1981-2014, or even 2 days later than in 2013. In figure 3 the late hatching dates in 2013 and 2014 stand out as all being above, and contributing to lifting, the overall trend line. However, again note that the sample size is small.

Samples
One addled egg was collected and eggshell fragments collected at the four known successful sites (table 1). In addition, feathers were collected at four sites.

All samples were transferred to Denmark with CITES permits. The whole egg has been opened and the contents stored at the sample depository maintained at Aarhus University, Danish Centre for Environment and Energy, for analysis of 'classical' and 'emerging' problem contaminants in 2014-15.

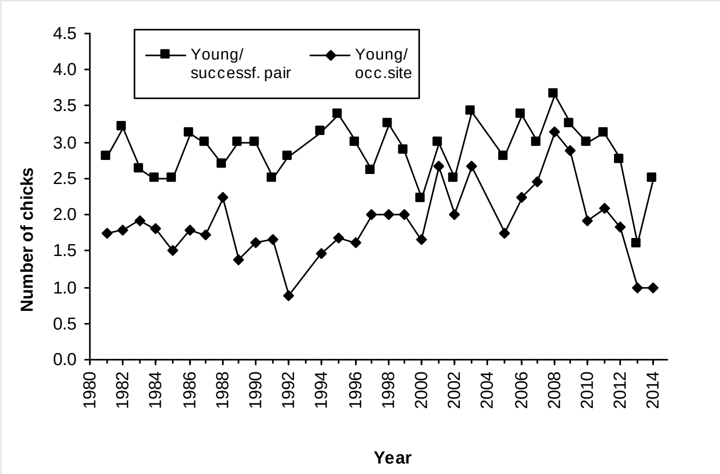


Figure 1: Annual production during the entire monitoring programme – measured as no of young per successful pair as well as no of young per occupied site – for all sites checked each year.

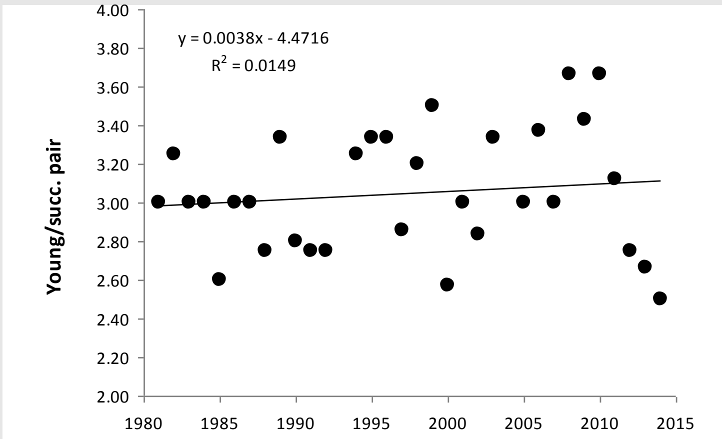


Figure 2: Annual production (no of young per successful pair) data from the *selected monitoring sites only*; sample size in some years (incl. 2013 and 2014) is very small (n=4).

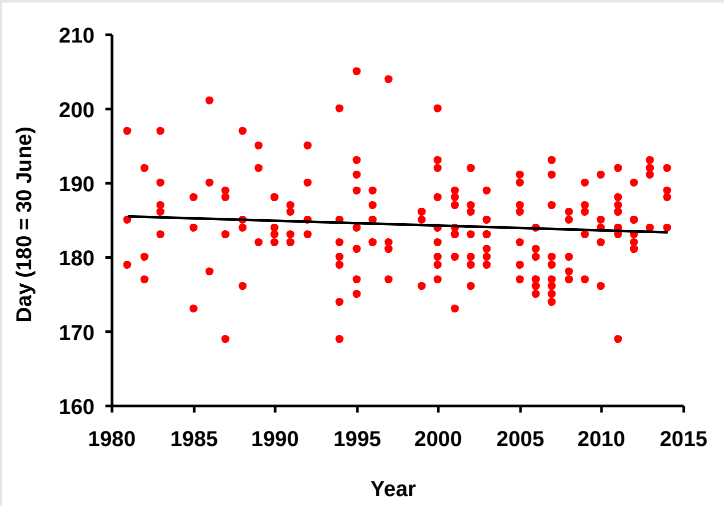


Figure 3: Hatching date for first egg in each clutch – and the long term trend (line) in breeding phenology over the 34 year study; note how the 2013 and 2014 data points are all above (helping lift) the trend line (note: preliminary data only).

Monitoring of eggshell thickness

The thickness of eggshell fragments from the hatched eggs have been measured and added to the long-term trend analysis (based on Falk *et al.* 2006), showing the continued improvement in shell thickness (figure 4) although it is yet not back to normal. A more comprehensive reanalysis of all eggshell data is planned for 2014-15.

Migration studies by geolocators

In 2012 and 2013, geolocators (GL) were deployed at a total of eight different adult breeding females. So far, GLs from two birds have been recovered for analysis of movements in the autumn/winter/spring of 2012-13. Data from the two GL's is plotted in Figure 5, where blue dots represent the female breeding at site no. 23 and red dots represent the female breeding at site no. 32. Around equinox conversion of raw GL data to latitude information is not possible and, hence, data from this period has been omitted form the figure. However, longitude information around equinox remains reliable and can be used to extract some information on migration timing and route along the E-W direction.

Both females were stationary at their wintering locations. The female from site no. 23 wintered on Hispaniola (Dominican Republic) after having started southward migration on October 1 and passing over Cuba around October 15. Spring migration started April 1 where this female moved to NW Florida and remained stationary there at least until the GL stopped working on April 18. The female from site no. 32 started southward migration around September 20 and arrived in Nicaragua/Costa Rica around October 20. It remained stationary until the first days of April where northbound migration started. The longitude data suggests it followed a route along the east coast of the Gulf of Mexico, at least until the GL stopped collecting data on May 8. Note that location uncertainty on latitude is several times larger than uncertainty on longitude. Both females now carry new GLs, and we hope to recapture them in 2015 and check whether they show site fidelity to their wintering grounds as has been noted for Peregrines in other studies.

In 2014 we deployed GL's on five females. In all, six (possibly seven) female peregrines from the study area in South Greenland now wear GLs (see table 2).

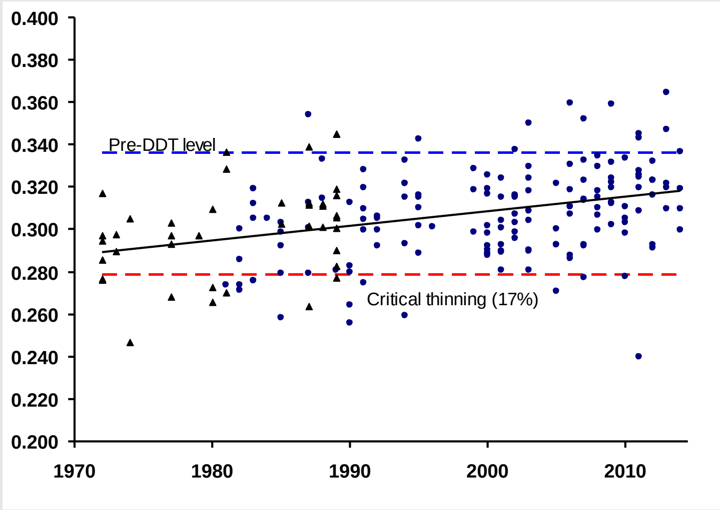


Figure 4: Eggshell thickness (incl. shell membranes) of fragments from hatched eggs in South Greenland 1981-2014 (circles) and central West Greenland 1972-1988 (triangles) as well as the joint trend line. The blue horizontal line indicates the average shell thickness in Greenlandic Peregrines before 1947 (= "normal" thickness) while the red line shows the 17% thinning threshold below which Peregrine populations have been shown to decline.[7]

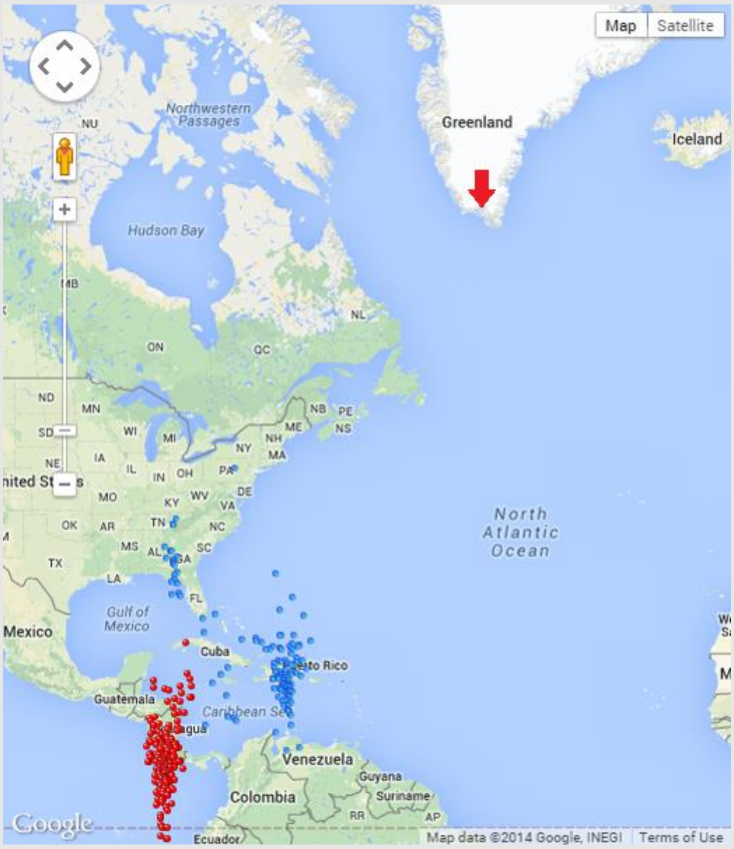


Figure 5: Geolocator data from two female peregrines from the study area (red arrow) in South Greenland. Blue dots: Peregrine breeding at site no. 23. Red dots: Peregrine breeding at site no. 32. Data around equinox omitted. See text for further explanation.

(Google maps screenshot)

[7] Falk & Møller (1990), Peakall & Kiff (1988)

Prey abundance

A total of 238 passerines were recorded during the 27.3 km of survey on 7 different line transects conducted 28 June - 12 July (see table right). This translates into 8.7 birds per km transect. The most abundant species was the Wheatear, which had large broods of fledglings everywhere we went. In 2014 the transects covered differed a bit from those in 2013, when more high-country routes were included, which partly accounts for the absence of Snow Buntings in the 2014 transect data.

In 2014 the density of passerines was nearly a factor 5 higher than in 2013 (8.7 *vs* 1.8), confirming that 2013 was probably a very unusual year, as we subjectively reported last year.

If only the three transects covered both years are compared the pattern remains similar, with about 3.5 times more (9.3 *vs* 2.7) passerines recorded per kilometre transect in 2014 (see tables).

		2013 (37 km)		2014 (27.3 km)	
Species	**Age**	**Total**	**per km**	**Total**	**per km**
All transects					
Redpoll		21	0.57	40	1.46
Lapland Bunting	*ad*	11	0.30	45	1.65
	juv	1	0.03	4	0.15
Snow Bunting	*ad*	7	0.19	0	0.00
	juv	1	0.03	0	0.00
Wheatear	*ad*	15	0.41	57	2.09
	juv	11	0.30	92	3.37
Total		**67**	**1.81**	**238**	**8.71**
Repeated transects both years(12.3 km)					
Redpoll		6	0.49	27	2.20
Lapland Bunting	*ad*	12	0.98	25	2.03
	juv	0	0.00	0	0.00
Snow Bunting	*ad*	2	0.16	0	0.00
	juv	0	0.00	0	0.00
Wheatear	*ad*	9	0.73	31	2.52
	juv	4	0.33	31	2.52
Total		**33**	**2.68**	**114**	**9.27**

Passerines are the main prey of Peregrines in the study area where feathers of young, newly fledged Wheatears, Lapland Buntings and Redpolls are found on all successful Peregrine nesting ledges.

Passerines were much more abundant in 2014 compared to 2013; fledged Wheatear broods of up to 5 chicks were the most widespread and conspicuous on all transects surveyed.

Table 1. Site checks; sites in bold italics indicate where GLs were (re)deployed in 2014.

Site no.	Date	No of eggs	No of young	Hatching (1. chick)	Notes	Samples
1	27 Jun, 9 + 11 Jul	3	2	4 Jul	Female captured – but had lost her GL from 2012; new GL attached	1 addled egg, fragments and feather samples
2	10 + 14 Jul		2	9 Jul	GL deployed	Eggshell fragments and feather samples
6	30 Jun	0	0	-	2 adults, no breeding.	
7	2 Jul	0	0	-	Female seen carry 2013 GL	
8	3 Jul	3			Huge cliff: no capture	
23	28 Jun	0			New female (2013 GL lost)	
29	6 + 21 Jul	2	2	12 Jul	GL attached	Eggshell fragments and feather samples
32	30 Jun	2			2012 GL collected, new atta-ched	
42	4 Jul	0	0		Lone male (2013 GL lost?)	
61	12 Jul		4	8 Jul	GL attached	Eggshell fragments and feather samples
63	5 + 16 Jul	0	0		2 adults, no breeding	
66	10 Jul	0	0		2 adults, no breeding	

Table 2. Summary of occupancy and productivity of the Peregrine Falcon population in South Greenland 1981-2014

Year	**Occupancy** Number of sites					**Reproduction**		
	Checked	Occupied	Successful (known # of young)	Successful, but un-known # of young	Occ. site, status unknown (incl. eggs w unknown success)	Total no of young known	Young/ occ.site	Young/ suc-cessf. pair
1981	15	13	5	2	3	14	1.8	2.8
1982	16	11	5	1	1	16	1.8	3.2
1983	19	13	8		2	21	1.9	2.6
1984	18	11	8		0	20	1.8	2.5
1985	16	10	6		0	15	1.5	2.5
1986	22	15	8		1	25	1.8	3.1
1987	17	14	8		0	24	1.7	3.0
1988	16	13	10		1	27	2.3	2.7
1989	14	14	6		1	18	1.4	3.0
1990	16	13	7		0	21	1.6	3.0
1991	19	14	6	1	4	15	1.7	2.5
1992	19	17	5	1	0	14	0.9	2.8
1994	20	15	7		0	22	1.5	3.1
1995	20	16	8		0	27	1.7	3.4
1996	18	13	7		0	21	1.6	3.0
1997	15	13	10		0	26	2.0	2.6
1998	15	13	8		0	26	2.0	3.3
1999	16	13	9		0	26	2.0	2.9
2000	18	15	9		3	20	1.7	2.2
2001	14	13	8		4	24	2.7	3.0
2002	14	11	8	1	0	20	2.0	2.5
2003	12	11	7	2	0	24	2.7	3.4
2005	12	11	5		3	14	1.8	2.8
2006	13	13	8	1	0	27	2.3	3.4
2007	13	13	9		2	27	2.5	3.0
2008	11	11	6		4	22	3.1	3.7
2009	12	10	8		1	26	2.9	3.3
2010	11	11	7		0	21	1.9	3.0
2011	13	13	8	1	0	25	2.1	3.1
2012	12	12	8		0	22	1.8	2.8
2013	12	10	5	2	0	8	1.0	1.6
2014	12	12	4		2	10	1.0	2.5
Total	**490**	**407**	**231**	**12**	**32**	**668**	**1.8**	**2.9**

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Annex I: Ringing 2014

Ring no.		Site	Date	Type[1]	Sex[2]	Age	Unit[3]
Left leg	Right leg						
3022681*	3R-0406*	60032	30-06-2014	M	F	4	K+
3022682	3R-0407	61029	06-07-2014	M	F	2	K+
3022683*	3R-0408*	61001	11-07-2014	M	F	5	K+
3022684	3R-0409	61061	12-07-2014	M	F	2	K+
3022685	3R-0410	61002	14-07-2014	M	F	2	K+
3022700		60007		O	F	4	K+
* Recapture of bird ringed 2012.							

1: O = observation of ringed adult; K=control; M = ringing
2: M = Male; F = Female
3: K = calendar year