8.c.4. Chemicals in marine plastics and potential risks for a seabird like the Northern Fulmar (*Fulmarus glacialis*).

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KEYWORDS
Plastic; Ingestion; *Fulmarus-glacialis*; North-Sea; mass-mortality; seabird-wreck; POP; effect; hormonal disturbance

BACKGROUND
Some seabird species consume major quantities of different types of marine plastic debris. In addition to direct physical effects, there is a growing concern on the potential effects from chemicals built in or adsorbed to the plastics that are ingested. Under natural conditions it will be extremely difficult to firmly demonstrate effects. Observations in relation to a mass mortality of Northern Fulmars (*Fulmarus glacialis*) in the North Sea in 2004 do suggest that such effects may occur, and that effects can be sudden and severe.

METHODOLOGY
In the North Sea area, a monitoring system of the amount of plastics ingested by Fulmars is in place (van Franeker et al. 5IMDC abstract 0054). In March 2004, beach surveyors of the project in the southern North Sea encountered exceptionally large numbers of dead Fulmars on the beaches, and many were collected and processed according to the standard protocol in the project (van Franeker 2004a), which includes a range of variables on age, sex, condition, origin, death cause etc. These records allow a closer analysis of backgrounds of the mass mortality incident.

OUTCOMES
Even if the Fulmar mortality in March 2004 was perceived as a sudden event, survey data and details from dissections showed that the wreck had its origin in autumn 2003 and continued until the start of the breeding season 2004 (Van Franeker 2004b).

Patterns of molt of primaries and tail feathers of the March victims showed that most of them had suffered food shortage in the previous autumn that had caused them to slow down or even fully arrest the renewal of their feathers. Apparently this situation had continued over the full winter until March and even into June 2004, thus preventing that molt was resumed. June showed unusual mortality of birds in extremely poor plumage. In many birds, feathers had degraded to a level that must have affected waterproofing, flying capacities and insulation (Fig.1). Less conspicuous, but possibly even more important, was the fact that a considerable proportion of the dead birds had very poor to no down plumage, and thus suffered from poor insulation, increasing energy demands and thus exacerbating the apparent shortage of food.

The most serious aspect however, was that a large majority of birds that died were adult females, which is highly unusual as most mass mortalities of seabirds concern young and inexperienced birds, and are not normally strongly sex-biased (Table 1). Such age and sex bias continued into the June mortality and even showed mortality among several egg carrying females at large distances from colonies. The normal strategy in long-lived seabirds like the Northern Fulmar is that reproduction is not started or aborted if well-being or survival of the adult is threatened by e.g. poor food conditions.

Many aspects of feather growth and reproductive decisions are hormonally regulated. The serious aberrations in down plumage, the highly abnormal sex and age ratio in mortality, and the illogical reproductive individual decisions all create heavy suspicion towards a disturbed endocrine hormonal system.

Disruption of the endocrine hormonal system may occur as a consequence of the various types of chemicals built into plastics, or adsorbed onto them in sea water. As a top level consumer of the marine system, Fulmars already accumulate considerable amounts of toxic substances via the normal bioaccumulation in the food chain (Knudsen et al. 2007). However, in addition to that, Fulmars are among the most serious plastic consumers among seabirds (5IMDC abstract 0054) and grind down plastics in their gizzard (5IMDC abstracts 0056) which is likely to maximize uptake of plastic related chemicals known to be linked to plastics (Teuten et al. 2009).

The question is why this mortality occurred now. In principle, the effects of pollutants become apparent when birds utilize their fat reserves and the contaminants start circulating in blood in higher concentrations. However, that is a situation that happens frequently in a normal annual cycle. What made the 2004 wreck different, is that apparently low body condition persisted over a very long period from autumn throughout winter. It is well possible that only under prolonged periods of reduced body condition, that endocrine hormone disruptors can take their full effect, and then bring the animal in a spiral of ever increasing energy demands that cannot be met.

This means that chemical loads related to plastic ingestion can be latent for a long time, but then under unfavorable conditions may pass a threshold level triggering serious population consequences. Excessive mortality of adult females will have an exceptionally heavy impact on a seabird population.

Over the years the proportion of industrial plastic granules ingested by Fulmars has been reduced, but unfortunately increased amounts of user plastics took their place. Virgin industrial pellets contain relatively little added chemicals in comparison to user plastics. Also, the particle size of ingested consumer plastics has decreased, which increases the surface to volume ratio. The changes in type of plastics and in particle size may both have enhanced chemical transfer of chemicals from plastics to Fulmars in comparison to earlier years. However, as long as food availability is in order, the effects of such pollutants remains latent, but represents a threat of irreversible events once started.

The interpretation of events during the 2004 mass mortality is of course speculative. No funds were available to test details of pollutants and hormones in these birds. But also with more

detailed research, it will always be possible to question actual causes and effects in complicated ecosystem events like those seen in 2004. Evaluations of consequences of plastic pollution on natural populations and ecosystems will inevitably remain difficult and a case of common sense.

PRIORITY ACTIONS

In the marine plastic pollution issue, postponing policy decisions until full scientific proof of effects on species or ecosystems is given, is not an option. Effects may not be gradual but could show sudden high impacts in relation to unpredictable triggers or thresholds.

FIGURES AND TABLES

Table 1. The unusual sex and age composition of Fulmars in the 2004 wreck, illustrated by comparison of different periods in the full Fulmar EcoQO dataset for the Netherlands.

Sex-age composition of Fulmars in the Netherlans

	n	FEMALE ADULT	female imm-juv	MALE ADULT	male imm-juv
1980s	*363*	22%	29%	25%	23%
1990s	*232*	29%	29%	23%	19%
2000-03	*187*	30%	30%	20%	19%
2004	*134*	67%	11%	13%	8%
total NL	*916*	32%	27%	22%	19%

Figure 1. Postponed or arrested molt caused excessive wear of plumage of many Fulmars in the 2004 wreck in the Southern North Sea to an extent that must have affected their insulation, waterproofing and flying capacity.

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Environmental impacts of chemicals in marine plastics *presentation 0058*

Chemicals in marine plastics and potential risks for a seabird like the Northern Fulmar

(Fulmarus glacialis)

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North Sea Fulmar EcoQO *(monitoring session: presentation 54)*

2003-2007 North Sea *(n=1095)*

incidence	95	%
average nr	35	particles / bird
avg mass	0.31	gram / bird

Northern Fulmar – *Fulmarus glacialis*

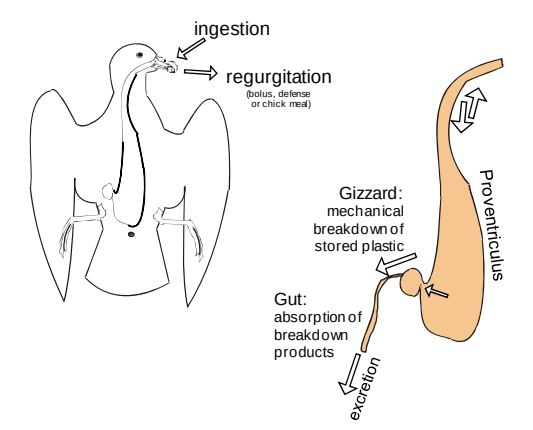
Rate of passage and breakdown of plastics through the digestive system

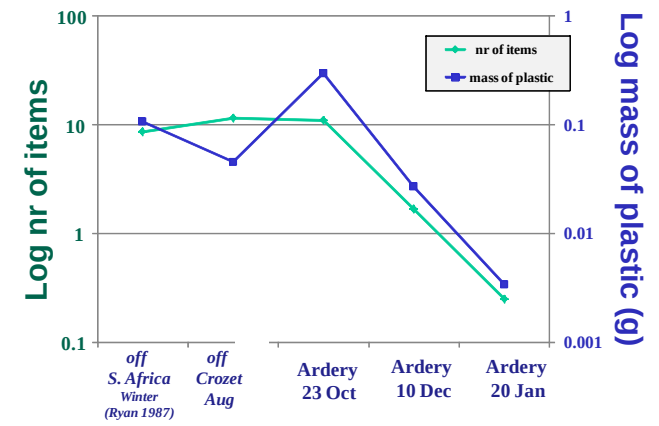
75 % *per month*....

2.5 % *per day*

Absolute minimum, because measured from disappearance rate of hard plastic items over longer periods: the initial breakdown, especially of soft materials will be very much faster ..... 25% per day...???

>> North Sea Fulmars *(average contents ca 0.31 gram plastic)* 'digest' in order of 7.5 mg to 75 mg of grinded plastics every day.





Marine plastic litter contains many built-in and adsorbed contaminants

- **Ingestion and ‘digestion’ of plastic debris is likely to contribute substantially to body burdens of contaminants** *(in addition to “ normal” food chain accumulation)*

➢ Fulmars do have high levels of contaminants

Halogenated organic contaminants in Fulmars from Bear Island *(Knudsen et al 2007; Env.Pol.146)*	**Average ± sd in liver ng/g lipid**	**range**
∑ HCBs (Hexachlorobenzenes)	602±117	423-802
∑ HCHs (Hexachlorocyclohexanes)	15.7±4.9	12.9-23.0
∑ Chlordanes	3363±1065	1425-5047
∑ DDTs	1289±524	867-2881
∑ PCBs	7273±1306	5264-10013
∑ PCDD (Dioxins)	4.0±6.7	0.7-27.5
∑ PCDF (Furans)	7.8±14.	1.2-57.4
Etc ….. Aldin, Eldrin, Dieldrin, Mirex, Brominated compounds, Toxaphenes, Perfluorinated Alkyl Substances (PFAS)		
Toxic Equivalents (TEQs) well above thresholds for reproductive effects in seabirds		
POP levels in Faroe Fulmars similar to those in Pilot whales with associated health risks (Fängström et al 2005)		

But can we observe and prove harm to natural populations ?

The 2004 wreck of fulmars in the southern and eastern North Sea

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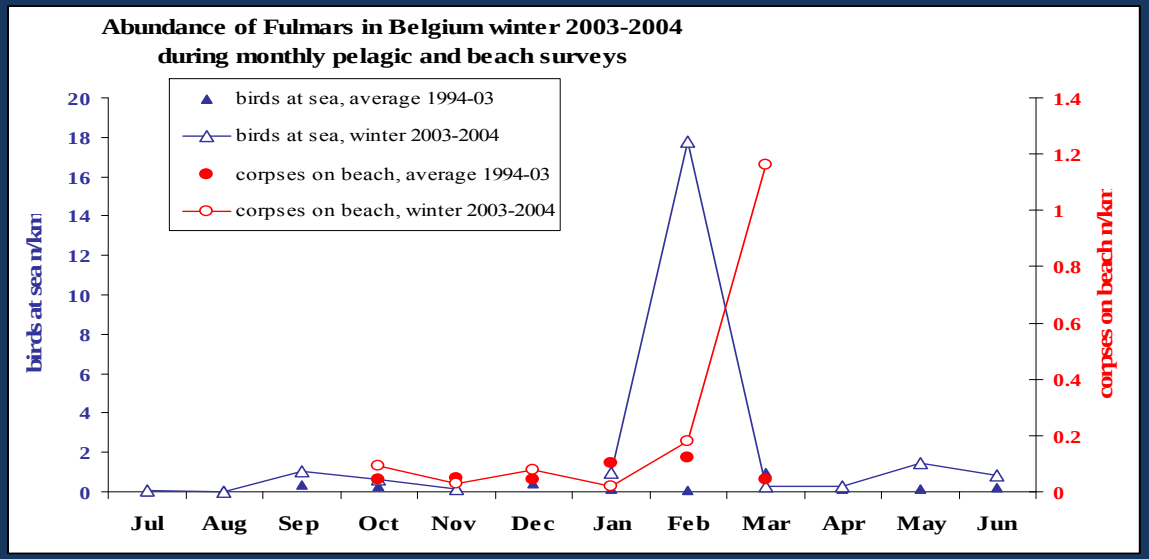
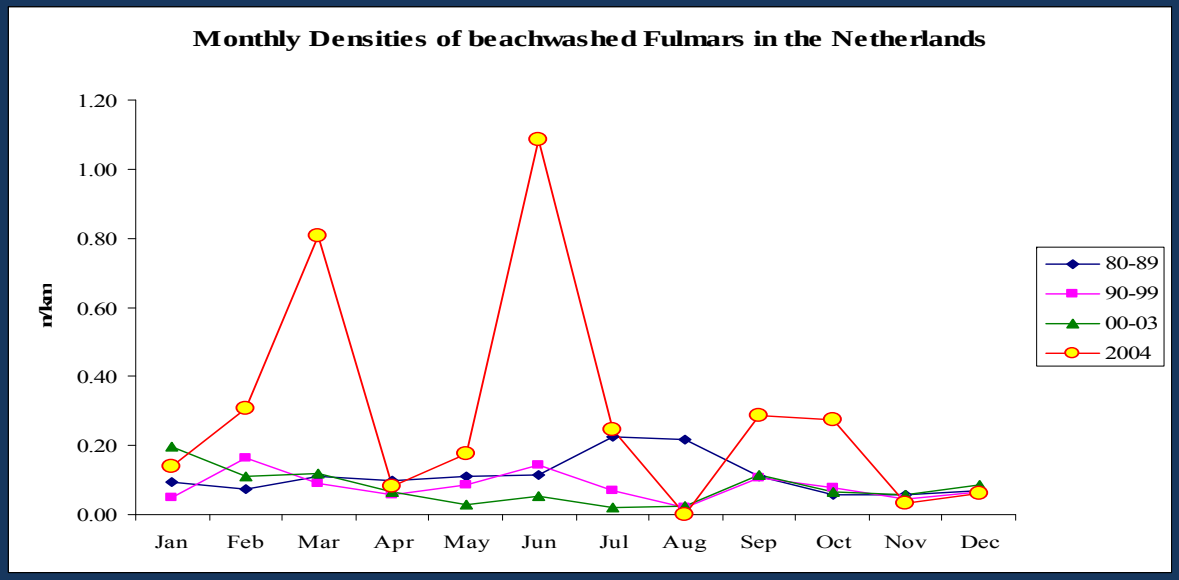


Unusual 1:

- **Unprecedented density**

Unusual 2:

- **Continued in summer**



Unusual 3:

- **extreme proportion of adult females *(around 80% in peak of the wreck)***

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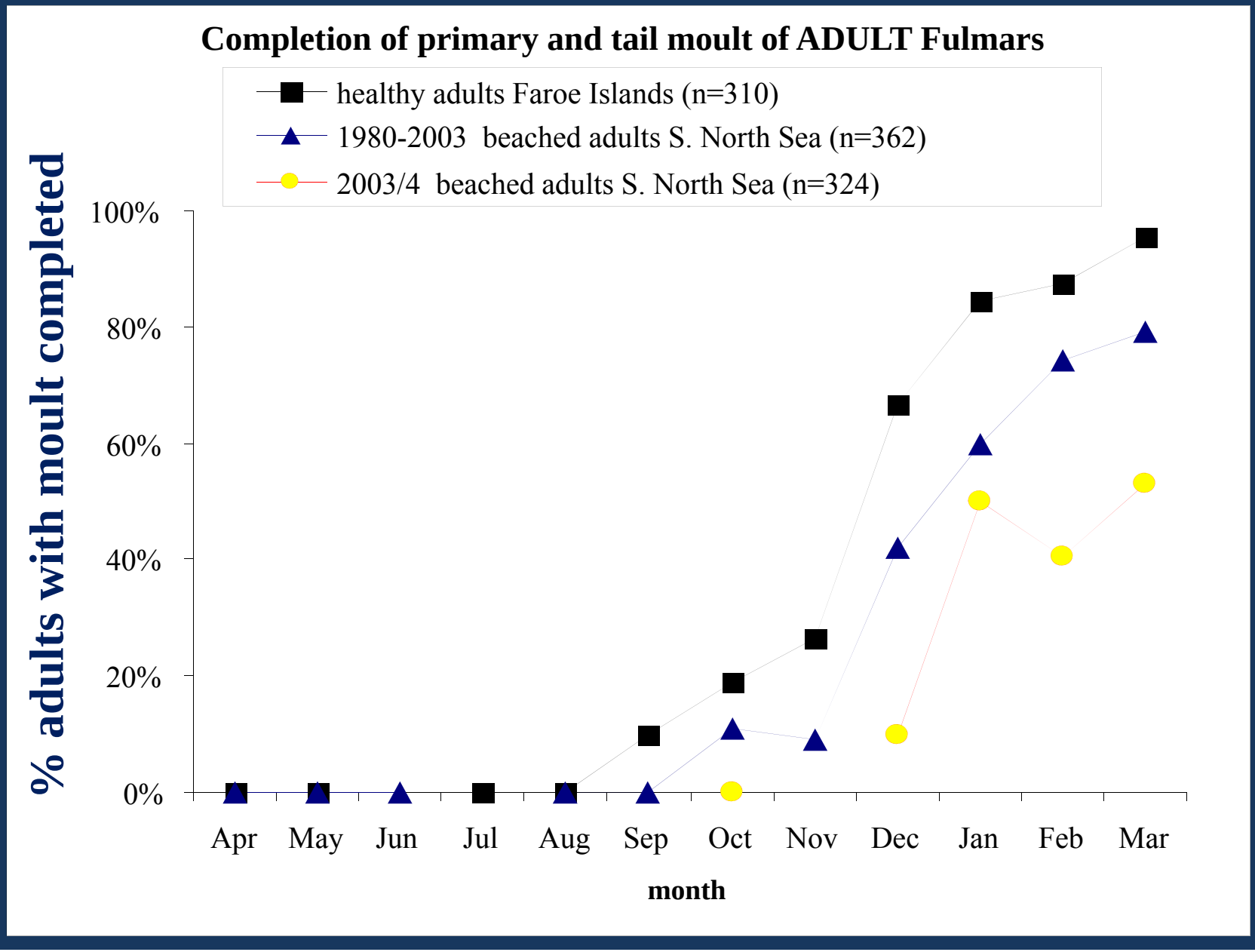
Unusual 4:

- **Majority of wrecked birds showed delayed or arrested moult of flight feathers, tail and coverts and extreme wear of plumage**

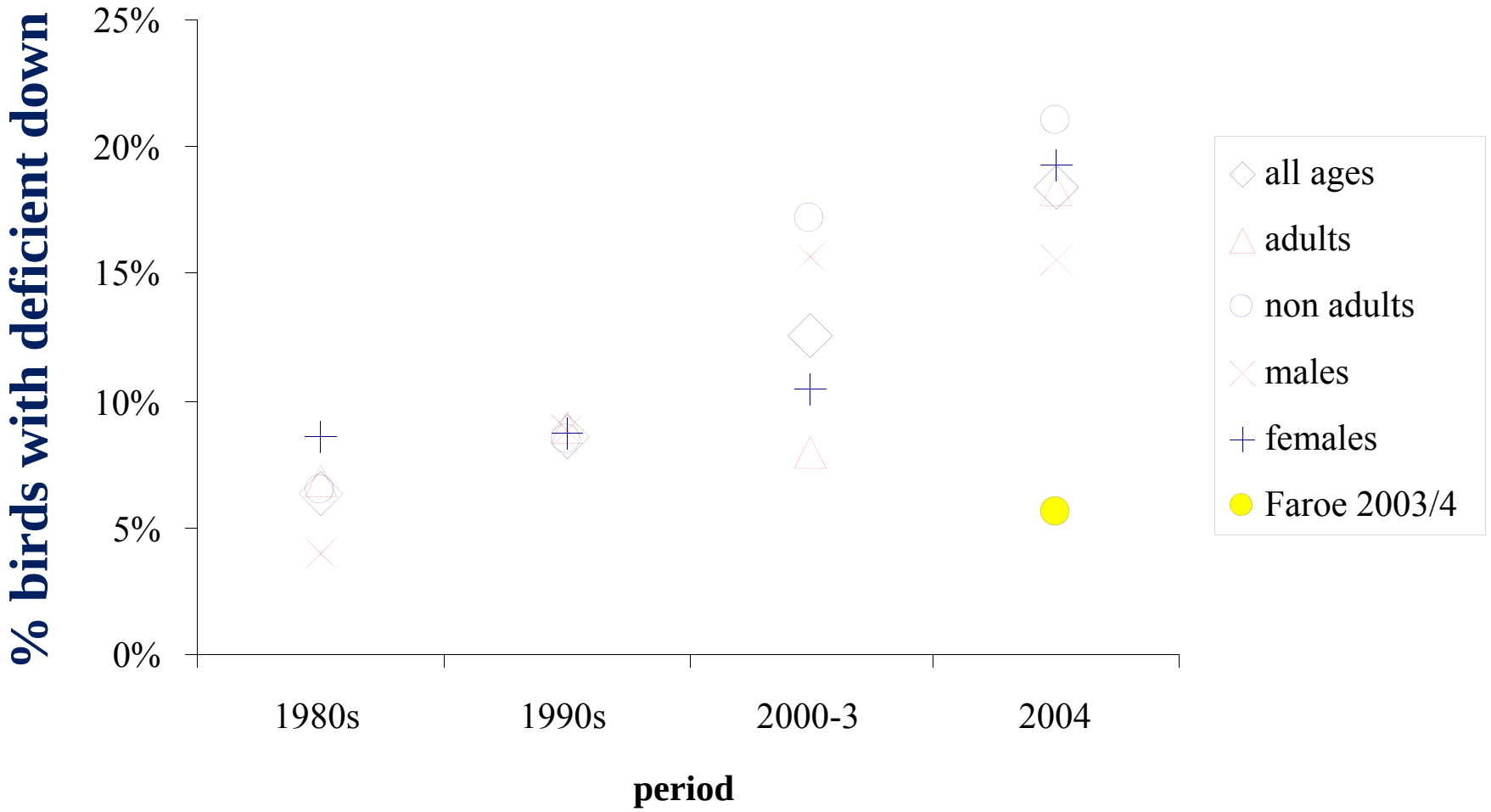
Deficiencies in moult show that the wreck was triggered by poor conditions in the autumn of preceding year!



Unusual 5:

- Many birds suffered from very poor down feathering

Proportion of Fulmars in Southern North Sea having poor or almost absent down cover on breast and belly



Unusual 6:

- **Several summer wreck birds had fully developed eggs** *(reproductive effort is unusual when in poor body condition; extreme distance from colonies)*

Of 42 adult females found May-Jun 2004:

- 4 died with fully developed egg inside, and
- at least 17 had laid egg shortly before death

CONCLUSION:

- highly unusual sex & age composition
- serious deficiencies in down plumage
- illogical reproductive decisions

all raise suspicion towards a disturbed endocrine hormonal system !

Hormonal disruptions are a known effect of the types of contaminants accumulated by fulmars through food and/or plastic ingestion

Why in 2004? Apparently, similar effects of contaminants are not clearly 'expressed' during short periods of reduced body condition (breeding shifts, winter storms) and may only take effect during prolonged periods of exposure.

If all this is true, the effects of plastic ingestion may not be gradual, but can take sudden dramatic effect.

speculative ? …. Yes

firm scientific evidence showing harm to natural populations is near impossible

Each of us and all of us will have to decide on

- Reasonable doubt ….
- Common sense …
- Precautionary approach ….

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Priority Actions

Actions to reduce marine debris from 2011-2021

1) Use common sense in addition to scientific evidence

2) Support seabird research (beached bird surveys and autopsies) to substantiate the urgency of reducing marine debris.

3) Make strong legislation on toxicity of compounds used in plastic production (also of non-food plastics)

REDUCE – REUSE – RECYCLE

www.imares.wur.nl *Click dossiers .... Plastic.....*

www.zeevogelgroep.nl *Click downloads ... Fulmar study*

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Priority Actions

REDUCE – REUSE – RECYCLE

- **Make deposit & return systems legally required**: high deposit fees for ALL products containing plastic must be standard.
- **Forbid the production of so-called degradable or compostable packaging** for both fossil- or bio-sourced plastic: ***Let plastic be plastic!***

Create value on plastic ‘waste’

Population effects of wrecks are very hard to detect in long-lived seabirds

European fulmar populations grew strongly in last two centuries; in the UK breeding numbers almost doubled from 1960s to early 1980s, but have since started a gradual decline and reduced breeding success.

Following the 2004 wreck, UK populations experienced the lowest reproductive success on record

www.jncc.gov.uk/page-2868