

Using Northern Fulmars as an ecological monitor of marine litter in line with indicators set for MSFD descriptor 10.

DEFRA Project code ME5227

Illustrated results with the: **Annual/Interim Project Report for Period 2019**

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19 Sep 2020

Current situation

Because annual data may show strong variation due to smaller sample size or other reasons, the fulmar monitoring program mostly considers data over 5 year periods. For the United Kingdom, over the 5 year period 2015-19, 85% of 98 investigated fulmars had some plastic in the stomach. Averaged over all individuals, stomachs contained 24 plastic particles, mostly small, with a combined average mass of 0.23 gram. The major figure to consider in terms of national and international policy, is that of the EcoQ Performance (EcoQ%), the percentage of birds exceeding the level of 0.1 gram plastic in the stomach. OSPAR has formulated a long term policy target for ecological quality in relation to plastic marine litter, which states that the percentage of fulmars with more than 0.1g of plastic in the stomach must be reduced to under 10% for at least five consecutive years.

Most likely this long term OSPAR target, will be copied as the so-called 'Fulmar Threshold Value (*Fulmar-TV*)' into EU MSFD aims for Good Environmental Status (GES). Intermittent shorter term policy targets may be defined within MSFD GES.

Currently, in most North Sea areas, 50 to 60% of investigated fulmar stomachs have more than 0.1g of plastic. Details for fulmars from the UK over the 2015-19 period are given in table 1, showing 48% of birds having more than 0.1g of plastic in the stomach.

These values represent a small improvement to the previous report, and thereby again the best on record for the UK since the start of these studies in 2002. This suggests slow gradual improvement in environmental conditions. However, the North Sea including the marine sectors adjacent to the UK, is still distant from OSPAR's ecological target for marine litter.

Table 1 Current annual and five year average plastic ingestion level for fulmars from the United Kingdom, 2015 to 2019). The EcoQ% gives the percentage of fulmars having more than 0.1g in the stomach. The long term policy target is that this percentage should be reduced to under 10%.

United Kingdom (North Sea)

		TOTAL PLASTICS			
		average number		average mass	EcoQ%
Year	n	%FO	n ± se	g ± se	(% > 0.1g)
2019	19	74%	22.1 ± 7.1	0.22 ± 0.06	58%
period					
2015_19	98	85%	23.9 ± 3.9	0.23 ± 0.05	48%

Trend

Rather than the actual value at a specific moment, it is important to assess trends indicating whether environmental quality is improving or not. In recent years in the Netherlands a statistically significant downward trend in EcoQ% has been observed, which indicates slow but robust improvement in environmental quality (Van Franeker & Kühn 2020). Following the OSPAR Guidelines (OSPAR 2015) trends are evaluated over the most recent decade, by linear regression analysis of log transformed individual plastic mass data against the year of collection of each bird.

In the UK, over the 2010-19 decade, the available sample of fulmars is 184 birds. Over this period regression lines are negative for all plastics and the separate categories of industrial and user plastic, suggesting decreases in plastic abundance, but none is significant. For the whole of the UK the test for decline in total plastic mass results in a probability of $p=0.063$ (statistical trends require probabilities of the $p=0.05$ or smaller to reflect significance).

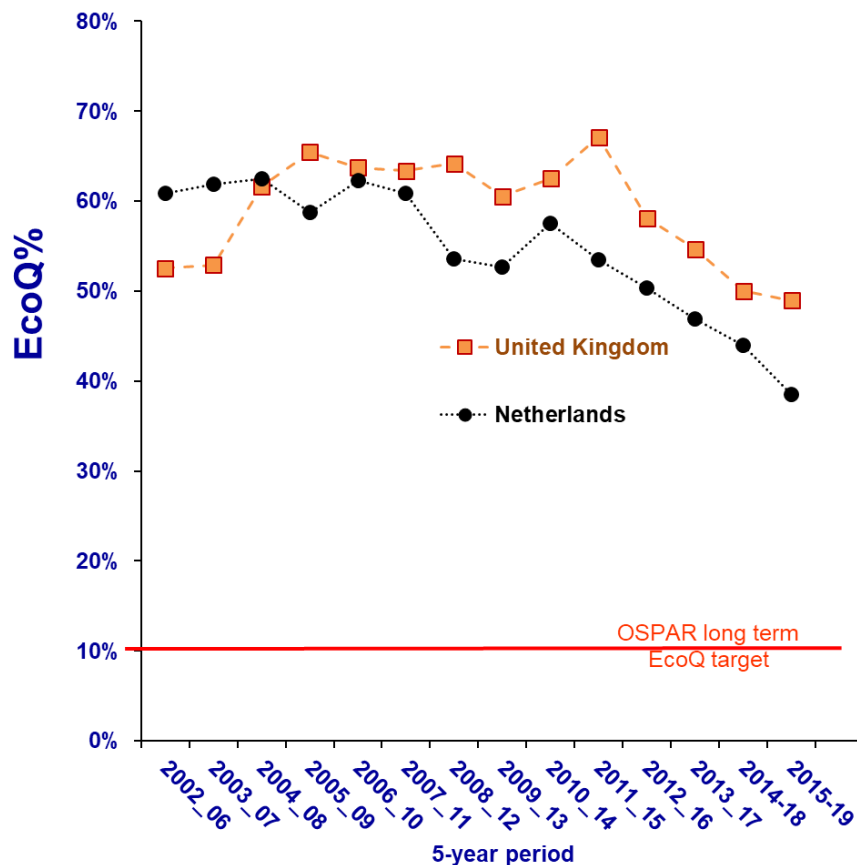


Figure 1 Comparative trends since 2002 for Netherlands and UK in EcoQ% (the proportion of fulmars having more than 0.1g of plastic in the stomach). Data are illustrated by running 5-year average values, and by themselves do not represent statistical analyses. Data for the Netherlands from Van Franeker & Kühn (2020).

Substantial regional variations within UK may explain the lack of statistical significance in the observed overall pattern. Fig. 2 shows the data for the three main subareas in the monitoring program. A significant decline in ingested plastic over the 2010-2019 decade has been observed on the Orkney Islands ($p=0.047$). Also the English and Scottish mainland North Sea coasts indicate decline, but not on a statistically significant level ($p=0.269$). No trend is seen in the Shetlands Islands ($p=0.644$) and the longer term since 2002 even suggests increase in consumer type plastic debris around Shetland. We have no good explanation of why Shetland, which was the cleanest location in 2002, is not following the larger scale patterns.

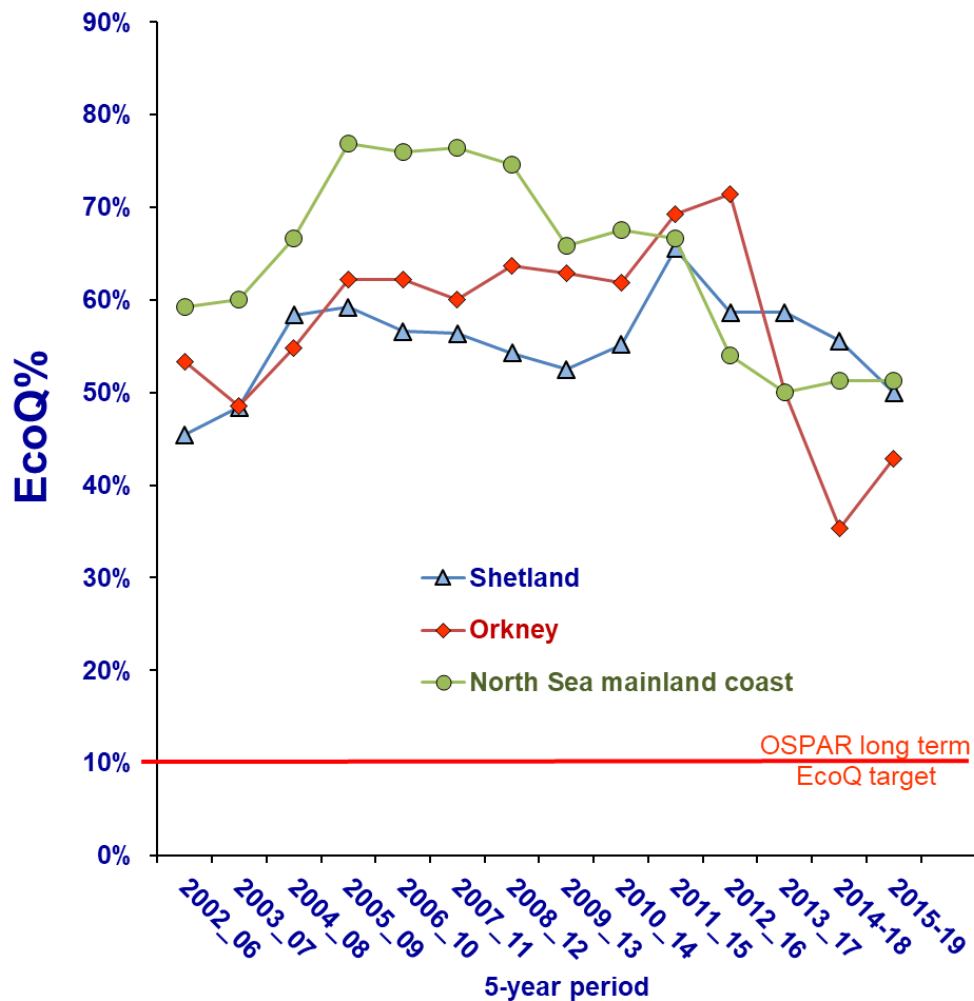


Figure 2 Trends in Fulmar EcoQ% in the three main study regions in the UK since 2002. Data are illustrated by running 5-year average values, and by themselves do not represent statistical analyses.

Data for 5 year averages as used in Figures 1 and 2 and results of statistical tests are provided in supplementary tables, together with details on numerical and mass abundance of plastics in fulmar stomachs, specified for industrial and consumer plastic.

Conclusion

Fulmars from the UK (mainly birds from NE England, Orkney Islands and Shetland Islands), show declines in plastic mass in their stomachs, but are still far off the OSPAR long term policy target which requires that at most 10% of birds may exceed the level of 0.1g of plastic in the stomach.

Over the current 2015-2019 period, 98 fulmar stomachs were investigated, among which 85% contained some plastic. Each fulmar on average had 24 plastic pieces in the stomach weighing 0.23 g. Overall, 48% of UK fulmars had more than 0.1g of plastic in the stomach.

The pattern over time in UK appears similar to that in the Netherlands (Fig.1) in that the marine litter situation seems to be improving. Over the past 10 years, UK data suggest a (non-significant) decrease in ingested industrial plastic pellets as well as in plastic consumer waste.

Considerable time has been dedicated to increase sampling effort at the different locations in the UK. In 2019 a total of 18 fulmars was added to the monitoring series. For unclear reasons (surveys were conducted) no fulmars with intact stomachs were found on the Shetlands this year. A single fulmar found on the UK west coast has not been included in the data analysis, and is not included in the OSPAR raw data. Our data currently hold four of such birds plus two from Ireland, too few to be analysed separately and potentially confusing if included. In years to come, it remains an important task to maintain and where possible extend the network of beach surveyors. For this reason, in September 2019, Jan van Franeker travelled to the Orkney Islands for a combined Orkney-Shetland training workshop, and a public lecture was organised to increase local surveyor support. On an opportunity basis similar trips may be organized in future, although the Covid situation makes that near impossible for some time to come. In order to stimulate support we have made an illustrated report on dissection details and stomach contents of fulmars from UK recently analysed (Van Franeker et al., 2020). Without the many volunteers surveying beaches, a project like this is impossible. We are truly grateful for all their support, and hope that they will continue the work until our seas are free, or at least almost free, of marine plastic litter.

References

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19 September 2020

Supplementary data tables

Supplementary tables on the following pages show the details for overall UK fulmar monitoring, and for each of the three main subregions: Shetland Islands, Orkney Islands, and the mainland North Sea coast of England and Scotland (which is mainly represented by NorthEast England).

The first table on each page shows running 5 year average data since the start of the Save the North Sea project in 2002. Data are provided for industrial plastics, user plastics, and their combination of total plastic, and provide averages with standard error for numerical abundance, mass, and the EcoQ%, the proportion of fulmars having over 0.1 g of plastic in the stomach.

When distributing information on the 'current situation', it is the most recent 5-year average data-line that should be used. Annual data, certainly on subregional scales, often have too low sample size and also may be subject to unexplained interannual variations. The running 5 year data are often used to provide a graphical impression of trends (see main report), but by themselves have no statistical meaning.

Statistical tests for trends are shown in the lower table on each page. Tests are performed according to the standard methodology in the fulmar monitoring program (OSPAR 2015 Guidelines), that is by linear regression using ln-transformed mass of plastic of each individual bird against its year of collection. Tests are done for industrial plastics and user plastics, and for their combination. Tests are repeated for the long term dataset (since 2002), and for the most recent decade. The decadal change is the major output considered in the monitoring program.

GREAT BRITAIN ALL DATA COMBINED

UK (North Sea)

Total plastics

PERIOD	<i>n</i>	%FO	average number <i>n</i> ± <i>se</i>	average mass <i>g</i> ± <i>se</i>	EcoQ% <i>(over 0.1g)</i>
2002_06	139	93%	23.8 ±3.2	0.22 ±0.03	53%
2003_07	155	93%	25.1 ±3.3	0.22 ±0.02	53%
2004_08	193	94%	30.4 ±3.1	0.30 ±0.04	62%
2005_09	165	93%	31.3 ±3.2	0.36 ±0.05	65%
2006_10	171	93%	30.0 ±3.1	0.35 ±0.05	64%
2007_11	172	92%	29.6 ±3.0	0.35 ±0.05	63%
2008_12	162	94%	30.1 ±2.9	0.38 ±0.05	64%
2009_13	114	93%	37.6 ±9.4	0.34 ±0.05	61%
2010_14	88	94%	39.1 ±12.0	0.32 ±0.05	63%
2011_15	76	95%	45.5 ±13.8	0.42 ±0.08	67%
2012_16	74	95%	41.8 ±14.2	0.38 ±0.08	58%
2013_17	64	92%	39.2 ±16.2	0.33 ±0.09	55%
2014_18	94	88%	23.2 ±3.9	0.25 ±0.06	50%
2015_19	96	85%	24.3 ±3.9	0.24 ±0.06	49%

A. LONG TERM TREND 2002 to 2019 plastics in fulmar stomachs in the UK North Sea

	<i>n</i>	constant	slope	se	t	p	
Industrial Plastics (InGIND)	461	19.1	-0.0119	0.0193	-0.62	0.536	<i>n.s.</i>
User Plastics (InGUSE)	461	12.0	-0.0073	0.0179	-0.41	0.683	<i>n.s.</i>
All plastics combined (InGPLA)	461	19.0	-0.0107	0.0180	-0.59	0.553	<i>n.s.</i>

B. RECENT TREND 2010 to 2019 plastics in fulmar stomachs in the UK North Sea

	<i>n</i>	constant	slope	se	t	p	
Industrial Plastics (InGIND)	184	46.8	-0.0257	0.0482	-0.53	0.594	<i>n.s.</i>
User Plastics (InGUSE)	184	170.1	-0.0858	0.0477	-1.80	0.074	<i>n.s.</i> ↓
All plastics combined (InGPLA)	184	176.3	-0.0887	0.0475	-1.87	0.063	<i>n.s.</i> ↓

SHETLAND ISLANDS

Shetland Islands		Total plastics			
PERIOD	<i>n</i>	%FO	average number <i>n</i> ± <i>se</i>	average mass <i>g</i> ± <i>se</i>	EcoQ% <i>(over 0.1g)</i>
2002_06	55	91%	14.9 ±2.2	0.18 ±0.04	45%
2003_07	62	94%	15.0 ±2.0	0.17 ±0.03	48%
2004_08	72	96%	22.9 ±3.9	0.29 ±0.07	58%
2005_09	76	92%	23.1 ±3.9	0.30 ±0.07	59%
2006_10	76	92%	23.0 ±3.9	0.29 ±0.06	57%
2007_11	71	92%	23.4 ±4.1	0.31 ±0.07	56%
2008_12	59	93%	25.5 ±4.8	0.35 ±0.09	54%
2009_13	40	93%	42.1 ±23.8	0.29 ±0.07	53%
2010_14	29	100%	48.3 ±32.7	0.33 ±0.09	55%
2011_15	29	100%	53.2 ±32.5	0.52 ±0.18	66%
2012_16	29	100%	51.0 ±32.6	0.50 ±0.18	59%
2013_17	29	93%	48.2 ±32.7	0.43 ±0.17	59%
2014_18	36	92%	27.2 ±8.0	0.39 ±0.14	56%
2015_19	26	88%	32.5 ±10.9	0.43 ±0.19	50%

Shetland Islands

A.	LONG TERM TREND 2002 - 2019						
	FOR PLASTICS IN FULMAR STOMACHS						
	<i>n</i>	constant	slope	se	t	p	
Industrial Plastics (lnGIND)	172	-21.0	0.0078	0.0331	0.24	0.814	<i>n.s.</i>
User Plastics (lnGUSE)	172	-134.1	0.0654	0.0322	2.03	0.044	* ↑
All plastics combined (lnGPLA)	172	-125.4	0.0612	0.0322	1.90	0.059	<i>n.s.</i> ↑

B.	RECENT TREND 2010 - 2019						
	FOR PLASTICS IN FULMAR STOMACHS						
	<i>n</i>	constant	slope	se	t	p	
Industrial Plastics (lnGIND)	55	-100.0	0.0470	0.1040	0.45	0.655	<i>n.s.</i>
User Plastics (lnGUSE)	55	17.0	-0.0096	0.0985	-0.10	0.923	<i>n.s.</i>
All plastics combined (lnGPLA)	55	55.0	-0.0284	0.0968	-0.29	0.770	<i>n.s.</i>

ORKNEY ISLANDS

Orkney Islands		Total plastics			
PERIOD	<i>n</i>	%FO	average number <i>n</i> ± <i>se</i>	average mass <i>g</i> ± <i>se</i>	EcoQ% (over 0.1g)
2002_06	30	93%	31.7 ±8.8	0.28 ±0.07	53%
2003_07	33	88%	26.2 ±7.8	0.27 ±0.06	48%
2004_08	31	87%	22.5 ±7.9	0.40 ±0.16	55%
2005_09	37	86%	26.7 ±7.2	0.48 ±0.16	62%
2006_10	45	89%	23.7 ±6.0	0.45 ±0.13	62%
2007_11	50	88%	21.3 ±4.4	0.42 ±0.12	60%
2008_12	44	91%	23.3 ±5.0	0.46 ±0.14	64%
2009_13	35	91%	26.4 ±6.1	0.39 ±0.11	63%
2010_14	21	90%	18.9 ±5.4	0.30 ±0.09	62%
2011_15	13	92%	26.2 ±8.3	0.38 ±0.12	69%
2012_16	7	86%	17.3 ±7.1	0.38 ±0.18	71%
2013_17	8	88%	10.4 ±4.1	0.26 ±0.12	50%
2014_18	17	76%	10.1 ±2.9	0.18 ±0.07	35%
2015_19	28	75%	14.6 ±4.7	0.19 ±0.05	43%

Orkney Islands

**A. LONG TERM TREND 2002 - 2019
FOR PLASTICS IN FULMAR STOMACHS**

	<i>n</i>	constant	slope	se	t	p	
Industrial Plastics (InGIND)	111	88.5	-0.0466	0.0348	-1.34	0.183	<i>n.s.</i>
User Plastics (InGUSE)	111	82.7	-0.0425	0.0387	-1.10	0.275	<i>n.s.</i>
All plastics combined (InGPLA)	111	105.2	-0.0536	0.0389	-1.38	0.171	<i>n.s.</i>

**B. RECENT TREND 2010 - 2019
FOR PLASTICS IN FULMAR STOMACHS**

	<i>n</i>	constant	slope	se	t	p	
Industrial Plastics (InGIND)	49	97.0	-0.0506	0.0738	-0.69	0.496	<i>n.s.</i>
User Plastics (InGUSE)	49	226.0	-0.1136	0.0859	-1.32	0.192	<i>n.s.</i>
All plastics combined (InGPLA)	49	240.0	-0.1203	0.0875	-1.38	0.175	<i>n.s.</i>

NORTH SEA COAST MAINLAND UK

UK Mainland North Sea Total plastics

PERIOD	<i>n</i>	%FO	average number <i>n</i> ± <i>se</i>	average mass <i>g</i> ± <i>se</i>	EcoQ% <i>(over 0.1g)</i>
2002_06	54	94%	28.5 ±6.0	0.22 ±0.03	59%
2003_07	60	95%	35.0 ±6.9	0.23 ±0.03	60%
2004_08	90	96%	39.1 ±5.2	0.27 ±0.03	67%
2005_09	52	98%	46.5 ±6.4	0.36 ±0.06	77%
2006_10	50	98%	46.2 ±6.7	0.34 ±0.07	76%
2007_11	51	98%	46.4 ±6.7	0.35 ±0.07	76%
2008_12	59	97%	39.7 ±5.1	0.35 ±0.06	75%
2009_13	38	95%	43.3 ±12.3	0.36 ±0.09	66%
2010_14	37	92%	43.4 ±12.6	0.34 ±0.08	68%
2011_15	33	91%	46.6 ±14.1	0.36 ±0.08	67%
2012_16	37	92%	39.3 ±12.7	0.29 ±0.07	54%
2013_17	26	92%	38.0 ±16.8	0.25 ±0.08	50%
2014_18	41	90%	25.1 ±5.1	0.17 ±0.05	51%
2015_19	41	90%	25.7 ±5.1	0.14 ±0.03	51%

England and Scotland mainland North Sea

A.	LONG TERM TREND	2002	-	2019			
	FOR PLASTICS IN FULMAR STOMACHS						
	<i>n</i>	constant	slope	se	t	p	
Industrial Plastics (InGIND)	176	54.3	-0.0292	0.0313	-0.93	0.353	<i>n.s.</i>
User Plastics (InGUSE)	176	91.6	-0.0469	0.0253	-1.85	0.066	<i>n.s.</i> ↓
All plastics combined (InGPLA)	176	91.4	-0.0466	0.0255	-1.83	0.070	<i>n.s.</i> ↓
B.	RECENT TREND	2010	-	2019			
	FOR PLASTICS IN FULMAR STOMACHS						
	<i>n</i>	constant	slope	se	t	p	
Industrial Plastics (InGIND)	78	175.0	-0.0891	0.0781	-1.14	0.257	<i>n.s.</i>
User Plastics (InGUSE)	78	203.0	-0.1021	0.0741	-1.38	0.172	<i>n.s.</i>
All plastics combined (InGPLA)	78	193.0	-0.0971	0.0732	-1.33	0.189	<i>n.s.</i>