

Using Northern Fulmars as an ecological monitor of marine litter in line with indicators set for UK Marine Strategy Descriptor 10

DEFRA Project code ME5227

Illustrated results with the: **Annual/Interim Project Report for Period 2020**

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08 Aug 2022

Cite as: Kühn, S. & Van Franeker 2022. *Using Northern Fulmars as an ecological monitor of marine litter in line with indicators set for UK Marine Strategy Descriptor 10. DEFRA Project code ME5227. Illustrated results with the: Annual/Interim Project Report for Period 2019. 10pp.* doi: <https://doi.org/10.18174/576300>



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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 2016-20, 85% of 98 investigated fulmars had some plastic in the stomach. Averaged over all individuals, stomachs contained 22.7 plastic particles, mostly small, with a combined average mass of 0.16 gram per bird. 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 0.1 g of plastic in the stomach must be reduced to under 10% for at least five consecutive years.

Currently, in most North Sea areas, around 50% of investigated fulmar stomachs have more than 0.1 g of plastic. Details for fulmars from the UK over the 2016-20 period are given in Table 1, showing 45% of birds having more than 0.1 g of plastic in the stomach. These values represent a small improvement to the previous report (in the previous period 2015-19, 48% of the fulmars exceeded the threshold), and thereby the current 5-year period (2016-20) is 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 all fulmars from the United Kingdom, 2016 to 2020. The EcoQ% gives the percentage of fulmars having more than 0.1 g in the stomach. The long term policy target is that this percentage should be reduced to under 10%.

United Kingdom		TOTAL PLASTICS			EcoQ%
All UK regions					
Year	n	%FO	average number n ± se	average mass g ± se	(% > 0.1g)
2020	8	100%	13.0 ± 6.3	0.06 ± 0.02	38%
period					
2016_20	98	85%	22.7 ± 3.9	0.16 ± 0.02	45%

Trends

Rather than the actual value at a specific moment, it is important to assess trends indicating whether environmental quality is improving or not. For the entire North Sea (including the UK), a significantly decreasing plastic mass has been detected in fulmars between 2009 and 2018, which indicates slow but robust improvement in environmental quality (Van Franeker et al. 2021). 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.

For the UK North Sea coast, over the 2011-20 decade, the available sample of fulmars is 173 birds. This number excludes a few incidental birds found on the UK west coast, as data from that region is insufficient for trend analyses. Over this period, all plastics combined and the sub-category user plastic have decreased significantly ($p=0.016$ and $p=0.015$ respectively). Industrial plastics show a downward trend, but this trend is currently not significant ($p=0.531$). Statistical trends require probabilities of the $p=0.05$ or smaller to reflect significance. When considering the entire sampling period from 2002-2020, all plastic decreases but not significantly ($p=0.335$), this is also true for the subcategories user and industrial plastics.

Figure 1. compares trends of the EcoQ performance in the UK with those in the Netherlands for the period since the start of the international Save the North Sea project in 2002. Trends in plastic mass for the Netherlands are significantly downwards (for recent decade and the full period; Kühn et al. 2021). For the UK, only the plastic mass in the recent 10-year period decreases significantly.

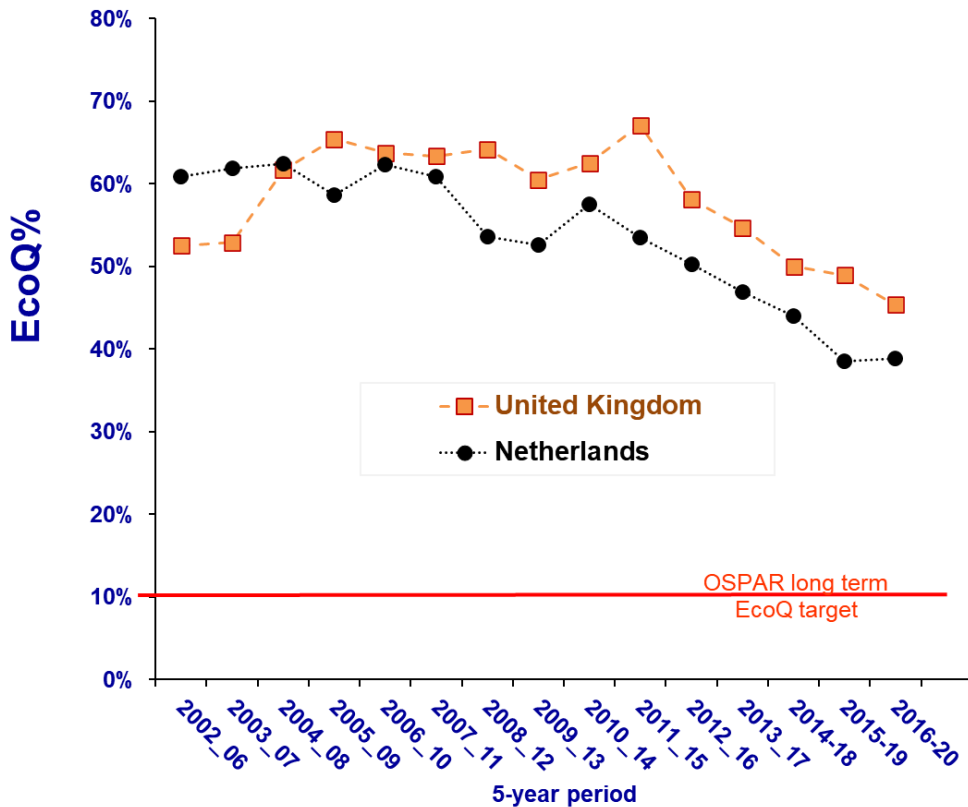


Figure 1. Comparative trends since 2002 for Netherlands and UK in EcoQ% (the proportion of fulmars having more than 0.1 g of plastic in the stomach). Data are illustrated by running 5-year average values, and by themselves do not represent statistical analyses. Data for the Netherlands from Kühn et al. (2021).

Substantial regional variations exist within the three main subareas of the monitoring program, which may explain the fact that a significant decrease has reached years later than data from the Netherlands and the entire North Sea region.

While a significant decline in ingested plastic over the 2010-2019 decade had been observed on the Orkney Islands, the English and Scottish mainland North Sea coasts indicated decline, but not on a statistically significant level and no trend was seen in the Shetlands Islands. For the most recent period (2011-2020) overall plastic mass in fulmars is decreasing significantly, however, when analysed separately none of the main regions reached significance.

The Shetlands are the only sub-region showing an increase of plastic mass in all plastic categories (user, industrial and thus all plastics combined). We have no good explanation of why Shetland, which was the cleanest location in 2002, is not following the larger scale patterns. When referring to EcoQ performance however, the Shetlands are now the closest to the OSPAR long term target (41% of the birds exceed the 0.1 g threshold) within the UK, as shown in Figure 2.

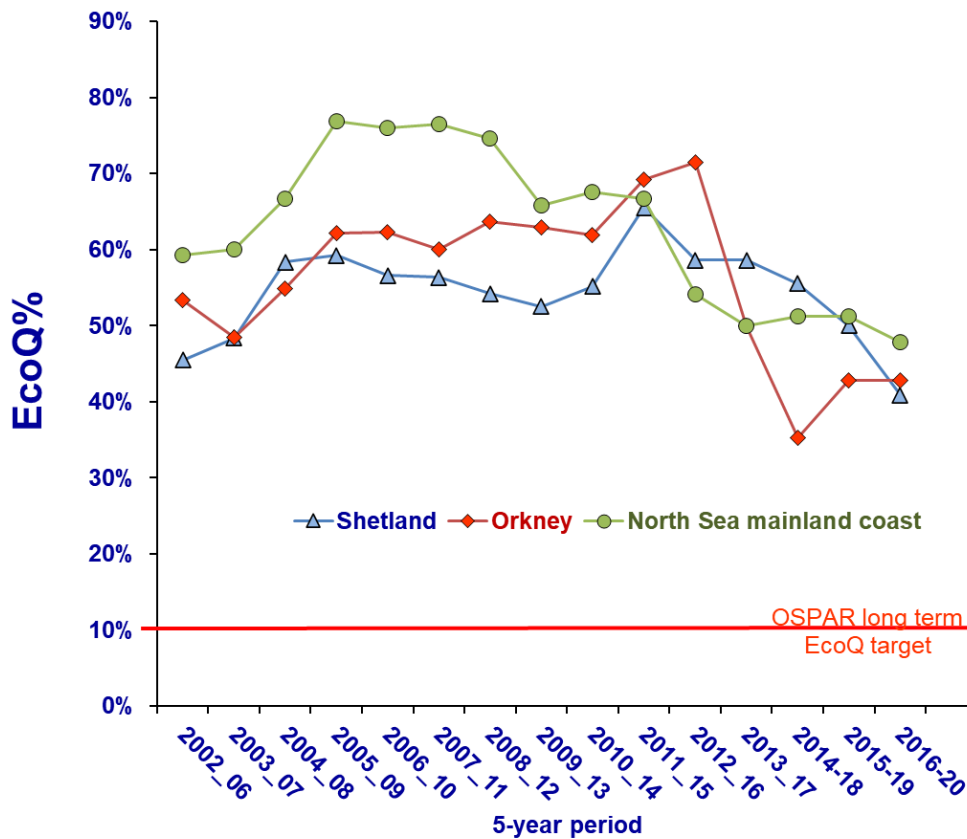


Figure 2. Trends in Fulmar EcoQ% in the three main study regions in the UK since 2002. Data are illustrated by running 5-year average values, and by themselves do not represent statistical analyses.

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

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 0.1 g of plastic in the stomach.

Over the current 2016-2020 period, 98 fulmar stomachs were investigated, among which 85% contained some plastic. Each fulmar on average had 23 plastic pieces in the stomach weighing 0.16 g. Overall, 45% of UK fulmars had more than 0.1 g 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 but a significant decreasing trend in user and overall plastic mass.

Considerable time has been dedicated to increase sampling effort at the different locations in the UK. Likely due to Covid restriction, in 2020 only 8 fulmars became available for the monitoring series. An additional single fulmar from the north-eastern England region could not be included in the data analysis, as the fulmar did not contain a stomach.

Our data currently hold four birds found on the western coast of the UK plus two from Ireland, however, these birds are 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, if travel restrictions in relation to Covid allow.

In order to stimulate support we made an illustrated report on dissection details and stomach contents of fulmars from UK in 2019 (Van Franeker et al. 2020) and have done so for the current data year 2020 (Van Franeker and Kühn 2022). As this is unpaid work, the release date is not known yet and depends on available time of the authors. 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.

Results in datafiles

Raw data on individual birds and ingested plastics, which DEFRA must submit to the OSPAR secretariat, have been provided as separate file OSPARsourcedata_2020_GBR.xlsx (also added as comma separated text file csv). This file contains results for 8 fulmars found during year 2020.

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08 August 2022

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 within the UK North Sea area are shown in the lower table on the following page. Tests are performed according to the standard methodology in the fulmar monitoring program (OSPAR 2015 Guidelines), that is by linear regression using In-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.

UK North Sea 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%
2016_20	97	86%	22.9 ±3.9	0.16 ±0.02	45%

A. LONG TERM TREND 2002 to 2020
plastics in fulmar stomachs in the UK North Sea

	<i>n</i>	constant	slope	se	t	p	
Industrial Plastics (lnGIND)	469	28.1	-0.0164	0.0185	-0.89	0.376	<i>n.s.</i>
User Plastics (lnGUSE)	469	25.1	-0.0138	0.0172	-0.80	0.423	<i>n.s.</i>
All plastics combined (lnGPLA)	469	31.1	-0.0167	0.0173	-0.97	0.335	<i>n.s.</i>

B. RECENT TREND 2011 to 2020
plastics in fulmar stomachs in the UK North Sea

	<i>n</i>	constant	slope	se	t	p	
Industrial Plastics (lnGIND)	173	63.0	-0.0337	0.0537	-0.63	0.531	<i>n.s.</i>
User Plastics (lnGUSE)	173	263.0	-0.1316	0.0535	-2.46	0.015	↓ -
All plastics combined (lnGPLA)	173	259.0	-0.1298	0.0534	-2.43	0.016	↓ -

SHETLAND ISLANDS

Shetland Islands		Total plastics			
PERIOD	<i>n</i>	%FO	average number <i>n</i> ± se	average mass g ± se	EcoQ% (over 0.1g)
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%
2016_20	22	86%	30.5 ±12.9	0.23 ±0.06	41%

ORKNEY ISLANDS

Orkney Islands		Total plastics			
PERIOD	<i>n</i>	%FO	average number <i>n</i> ± se	average mass g ± se	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%
2016_20	28	75%	13.6 ±4.7	0.16 ±0.04	43%

NORTH SEA COAST MAINLAND UK

UK Mainland North Sea

Total plastics

PERIOD	<i>n</i>	%FO	average number <i>n</i> ± se	average mass <i>g</i> ± se	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%
2016_20	46	91%	24.8 ±4.7	0.13 ±0.02	48%