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REGIONAL VARIATION ON THE FISH PREY OF BEACHED NORTHERN FULMARS ACROSS THE NORTH SEA

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ABSTRACT

This study investigates the variation in the fish prey of stranded northern fulmars (*Fulmarus glacialis*) across the North Sea. In the 463 analyzed stomach contents, 45 different fish species were found, with glacier lanternfish (*Benthosema glaciale*), Norway pout (*Trisopterus esmarkii*), and whiting (*Merlangius merlangus*) being the most frequent. Our findings reveal regional differences in diet composition, reflecting the biogeographical gradients in fish availability. Poor cod and bib (*Trisopterus minutus; T. luscus*) dominated the diet in southern regions, whiting peaked in central regions, and Norway pout was more abundant in northern regions. The reliance on fishery discards is evident, particularly because most of the species have a demersal lifestyle and for the size distribution of whiting (less than 27cm, the legal minimum landing size). This study highlights the interactions between natural prey availability and fisheries discards in shaping the feeding ecology of Northern fulmars in the North Sea, providing essential insights for future population development.

INTRODUCTION

The northern fulmar (*Fulmarus glacialis*) is a Holarctic, boreal and temperate seabird with a wide geographic range and one of the most numerous seabirds in these parts, with an estimated population of circa 7 million pairs in the North Atlantic (Burnell et al. 2023). Globally, fulmar numbers are probably increasing, but in some southern parts of their range, such as the North Sea numbers have been decreasing recently (Mitchell et al. 2004; Burnell et al. 2023). Numbers in the North Sea have shown a remarkable increase over the last two centuries. In the Atlantic, fulmars were found only in Arctic regions in the early 19th century, but began spreading to more southern regions, via, successively, Iceland, Faroe, and St. Kilda (Fisher, 1952). In the 20th century nearly all suitable cliff coasts around the British Isles were colonized, and on mainland Europe the species now breeds from Norway to Brittany, providing that cliffs are available (Salomonsen et al. 1965; Burnell et al. 2023). This expansion shows the adaptability and resilience of this seabird and raises the question of how fulmars could expand in e.g., the temperate North Sea, from their original Arctic environment. The species occurs in the North Sea year round, and today is one of the most abundant seabirds here (Skov et al. 2007, Burnell et al. 2023).

Four theories have been offered to explain this spectacular development. Fisher (1952) proposed a bottom-up scenario in which fulmars took advantage from an increase in food availability, of offal and discards, first from whaling and later from fisheries. Salomonsen (1965) and Brown (1970) challenged this theory and suggested that availability of natural prey had increased, in response to a warming climate. A third theory was put forward by Wynne-Edwards (1962). He proposed that behavioural changes may have driven the range expansion. Finally, Thompson (2006) pointed out that intensive hunting had suppressed population development (top-down) for centuries and that the species expanded its range and numbers once it became better protected. It is important to note that these theories are not mutually exclusive. An interplay of all four mechanisms likely contributed to shaping the fulmars abundance as we see it today.

Fulmars are strong fliers, allowing them to travel long distances for food. However, they are not good divers and are restricted to feeding at the sea's surface (Gustafson et al. 2007). Fulmars rely on food that is available at the surface, and are generalistic feeders, taking anything from zooplankton to fish and carrion. They are known to seek out productive areas with abundant food resources where they can maximize their intake (Brown et al. 1970; Skov & Durinck, 2001).

The northern fulmar has a diverse diet that varies geographically. In the Arctic crustaceans and fish are important prey, the latter contributing most of the energy to the diet (Mallory et al. 2010).

Further south, in boreal-temperate regions, crustaceans are less important, and fish are the most common prey. Important fish prey are mesopelagics, sandeels and clupeids, but also a range of other species, taken from fisheries as offal and discards (Furness and Todd et al. 1984, Phillips et al. 1999, Ojowski et al. 2001, Danielsen et al. 2010). Relatively little is known about the diet of fulmars in the North Sea; data are limited to the discards studies conducted at sea, by Camphuysen et al. (1997), and a few studies in breeding colonies (Furness and Todd et al. 1984, Phillips et al. 1999, Ojowski et al. 2001). Thus, the natural diet of northern fulmars in the North Sea during most of the year is poorly known.

The North Sea, near the southern limit of their distribution, holds a population of 1.800.000 northern fulmars in the non-breeding season (Skov et al. 2007). It is a very productive sea that also sustains intensive fisheries. These remove some 30-40% of the total fish biomass each year (Gislason et al. 1994) and produce large amounts of discards (not targeted fish species, undersized fish) and offal (Garthe et al. 1996; Sherley et al. 2019). The total amount of fishery waste in the North Sea was estimated to be 789 000 tonnes (in 1996), which could sustain 5.9 million marine avian scavengers (Garthe et al. 1996), including large numbers of fulmars (Camphuysen et al. 1997; Furness et al. 2007). However, discarding has been declining in recent decades, both globally (Zeller et al. 2018) and in the North Sea, where the amount has halved between 1990 and 2010 (Sherley et al. 2019). Scavenging seabirds that can be sustained by this practice have been declining in concert (Sherley et al. 2019; Burnell et al. 2023), suggesting that bottom-up control of their numbers does occur. Recent studies show that the North Sea population of fulmars is decreasing (Burnell et al. 2023).

Northern fulmars are a visible component of the avian community around discarding fishing vessels (Brown et al. 1968, Camphuysen et al. 1995, Garthe et al. 1996). However, even though they clearly benefit from fishery waste, their distribution is better predicted by hydrography than by the presence of fishers (Brown et al. 1970; Camphuysen et al. 1997; Skov & Durinck et al. 2001). This raises the question of how important fishery waste is for fulmars and what the relative importance of natural food is in the North Sea. Another question would be whether there are regional differences in the relative importance of discards for fulmars in the North Sea, as was suggested for a wider geographical range (Camphuysen et al. 1997) and what the main prey species are across the North Sea.

METHODS

We used fish sagittal otoliths ("ear stones"), fish jaws, vertebrae and other characteristic prey hard parts from the stomach contents of fulmars that had stranded around the North Sea. In addition, we used the stomach contents of birds caught in long-line fisheries around the Faroe Islands. All these birds were part of the OSPAR plastic monitoring program; stranded fulmars were collected to be examined for plastics in their stomachs, using a standardized protocol (Kühn et al. 2023).

In addition to plastic monitoring, scientists involved in the program collected fish otoliths and bones from these fulmars and forwarded them to the Netherlands for subsequent analysis. 463 of the 3699 stranded birds collected for the plastic program had otoliths or other fish hard parts in their stomachs that we could identify, while about 93% of the birds had plastic (See Table 1). The researchers noted hard parts of other prey as well, i.e., squid beaks and polychaete jaws, but these items were not kept, just counted. Therefore, only numbers are known for these prey groups, and we don't know the species, sizes or masses.

Table 1: Years of dead birds collection, the total number of birds collected for the plastic monitoring program for each region. Among these birds some had fish remains that are used in this project. Subsequently, the frequency of occurrence (relative numbers of stomachs) of squid, crustaceans, polychaetes and fish found in all the birds collected for the plastic monitoring.

Region	Years of collection	Total number of birds (Plastic monitoring)	Birds studied (this project)	with squid (%)	with crustaceans (%)	with polychaetes (%)	with fish (%)
France (FRA)	2004-2019	153	9	57,52	0,65	21,57	9,15
Belgium (BEL)	2002-2022	278	26	60,43	4,68	14,39	11,51
Netherlands (NET)	1979-2023	1338	112	50,37	3,06	11,29	10,24
Germany (GER)	1993-2021	861	35	49,36	1,16	16,72	4,53
Northeastern England (NEE)	2003-2021	131	17	48,85	2,29	14,50	14,50
Southeastern England (SEE)	2004-2019	48	1	64,58	4,17	10,42	4,17
Eastern Scotland mainland (ESC)	2012-2021	16	3	50,00	0,00	6,25	25,00
Orkney Islands (ORK)	2002-2022	125	20	64,00	1,60	4,80	18,40
Shetland Islands (SHE)	2002-2022	181	25	66,30	1,66	9,94	16,02
Denmark (DEN)	2002-2021	188	36	50,00	7,98	17,55	20,74
Southern Norway (NOR)	2003-2022	102	13	43,14	1,96	7,84	13,73
Faroe Islands (FAE)	2012-2021	276	87	77,17	10,51	2,54	39,86

The minimum number of fish present in each stomach was estimated after pairing left and right otoliths and combining these with any other fish hard parts present. The otoliths and bones were identified to species using Harkönen et al. (1986), Pierce and Boyle et al. (1991) and Leopold et al. (2001). Each otolith was measured using a Zeiss Discovery.V8 SteREO microscope with AxioCam MRc5 and ZEN 3.0 measuring software.

Otolith size and fish size are strongly correlated (Leopold et al. 2001). In most cases, a simple linear regression was used to calculate fish length: FL = a + b * OS, where (FL) represents fish total length, OS represents otolith length or width, and a and b are parameters that are specific for each species (see table A1).

Otoliths in a predator's stomach are rarely pristine; despite being the densest structures of teleost fish, they wear down during the digestive process, which involves chemical and mechanical digestion of ingested prey. In case of wear, otolith sizes were corrected, following (Leopold et al. 2015), before calculating fish size and mass. For otoliths that were so badly worn that we could not rely on the measurements, we used the average fish size of the same fish species in the same bird, or in the same batch of birds.

For each fish, one to four estimates for fish length were available from the otoliths: one if, e.g., only one otolith was found for which only the width could reliably be measured; four when length and width could be measured in both otoliths of a presumed pair. We used the average estimated fish length of these 1-4 estimates as the fish length and used this to estimate fish mass, using FM = (a * FL)^b, following Leopold et al. (2001), where (FM) represent fish mass, FL (estimated total fish length) (see table A1). This procedure yielded the number of fish (per species), their sizes, and their mass for each fulmar stomach. In rare cases, fish size could also be estimated from other hard parts found.

To analyse regional variation, we recorded the frequency of occurrence and the number of individuals in each fish species. To visualize this, we employed non-metric multidimensional scaling (NMDS) based on the Bray-Curtis dissimilarity index, allowing us to compare the dietary overlap and differences among regions. We performed a size-frequency distribution analysis to assess the impact of fishery discards on fulmars' diets. Then, fish lengths were compared against the legal minimum landing sizes to determine the prevalence of undersized fish. Additionally, we used descriptive statistics to summarize the overall composition of the diet.

RESULTS

We examined the stomachs of 463 fulmars and found remains of 1056 fish, from 45 different species. The most prevalent fish species observed in the overall study area is the glacier lanternfish *Benthosema glaciale*, accounting for 30.2%N of the total numbers, followed by the Norway pout *Trisopterus esmarkii* (17%N). Whiting *Merlangius merlangus* comprises 14.4%N of total fish numbers, but represents the highest total biomass of 8945.9 grams. Poor cod/bib *T. minutus/luscus*, with 9.2%N of total fish numbers, were also highly present in the stomachs and together represented a high biomass, of 3201.3 g. Sandeel species with a 5.7%N and other fish prey, such as gobies, clupeids, and flatfish, show a low numerical frequency, ranging from 1.5%N to 0.1%N, highlighting their comparatively minor role in the fulmar diet within the study area.

Table 2: Frequency of occurrence of the total numbers of fish (%N) and the total mass of each fish species found in the stomachs for the overall study area.

	Mass (g)	Frequency of occurrence (%)
Merlangius merlangus	8945.9	14.4
Trisopterus minutus/luscus	3201.3	9.5
Trisopterus esmarkii	2266.1	17.0
Pollachius pollachius	1422.9	0.7
Gadus morhua	1339.1	1.2
Micromesistius poutassou	1015.6	4.5
Limanda limanda	800.7	0.8
Clupea harengus	635.5	1.3
Benthosema glaciale	412.2	30.2
Argentina silus	489.7	0.5
Gobiusculus flavenscens	376.4	0.7
Ammodytes sp.	372.9	5.7

Trachurus trachurus	368.4	0.8
Pleuronectes platessa	224.2	0.7
Belone belone	166.9	0.1
gadoid sp	299.8	1.5
Chelidonichtys lucerna	139.9	0.2
Gadiculus argenteus	126.3	1.1
Dicentrarchus labrax	104.8	0.2
Lampanyctus crocodilus	103.8	1.0
Melanogrammus aeglefinus	50.2	0.2
Glyptocephalus cynoglossus	49.4	0.3
Osmerus esperlanus	41.1	0.7
Solea solea	40.6	0.4
Hyperoplus lanceolatus	39.7	0.1
gurnard sp.	30.4	0.1
Pomatoschistus microps	27.6	1.4
Sprattus sprattus	14.5	0.1
Atherina boyeri	13.2	0.6
Mullus surmuletus.	12.4	0.1
Buglossidium luteum	12.1	0.3
Sebastes marinus	9.5	0.2
Aphia minuta	9.3	0.4
Hippoglossus hippoglossus	4.8	0.1
Gobius niger	4.5	0.1

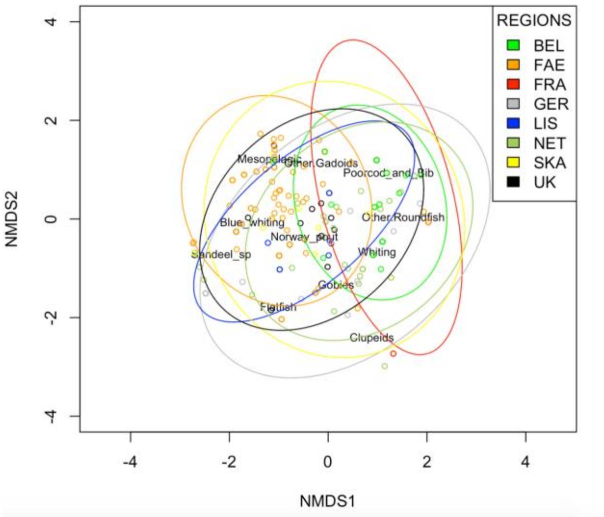

Figure 1: NMDS analysis of fish species distribution across the studied regions POSAR QE ES QUE.

The differences in relative occurrences of the various fish species in fulmar's diets across the North Sea and Faroe Islands are depicted in a Non-Metric Multidimensional Scaling (NMDS) plot (Figure 1). The analysis shows a considerable overlap across the different regions, but also differences. Diets in France (FRA) and the Faroe Islands (FAE) are the most distinct. Diets in Germany (GER) and the Netherlands (NET) almost completely overlap, indicating similarity, while United Kingdom (UK) and Southern Norway (LIS) diets also show a large overlap. The yellow ellipse representing Denmark (SKA) overlaps with almost all the other regions.

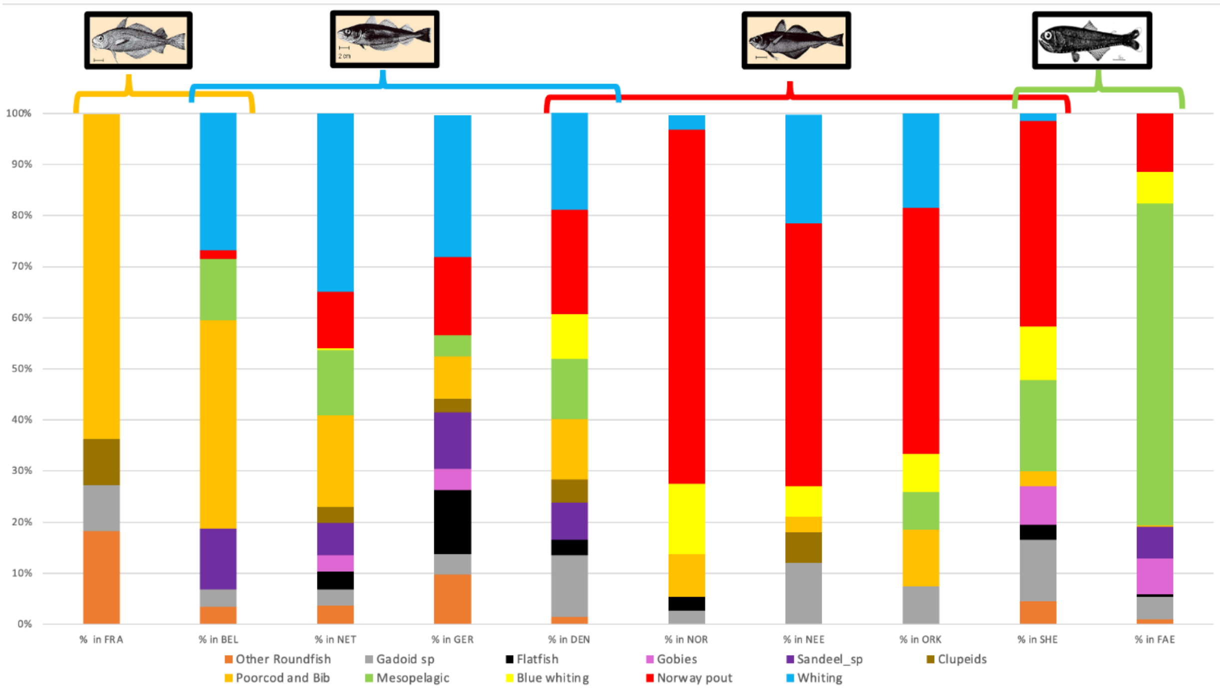

Figure 2: Relative percentages of total numbers (%N) of 11 representative fish species found for each region, moving from the southernmost location France (left) to Belgium, Netherlands, Germany, Denmark, Norway, Nort-East England, Orkney Islands, Shetland Islands to the most northernmost location Faroe Islands.

When we compared the occurrences of prey across the different regions studied, we found a gradual change in the prey spectrum from South to North (Figure 2). In France, the southernmost location, the highest percentual occurrence of poor cod/bib was found (63.5%N). Moving further North, their occurrence is progressively declining, going from 17.9 %N in the Netherlands to 2.9%N in Shetland, which is the northernmost sampling site within the North Sea. At the Faroe Islands, North of the North Sea, poor cod and bib were rarely found (0.3%N occurrence).

Whiting replaces poor cod and bib in the central part of the study area, with 34.9%N of occurrence in the Netherlands and 27.7%N in Germany. Further North, whiting is still present, but its occurrence is decreasing, via 19.1%N in Denmark to 1.5%N in Shetland. Whiting was not found in the Faroe Islands or France. While whiting is less important in the Northern North Sea, Norway pout becomes the dominant species here. Norway pout shows a substantial increase in relative abundance from South to North. The lowest occurrence is in France (0) and Belgium (1.7%N) and the highest occurrence was found in birds found in Southern Norway (69.4%N).

Mesopelagic species, mostly glacier lanternfish, had the highest prevalence (63%N) in the Faroe Islands, i.e. North of the North Sea. However, glacier lanternfish was also found in birds from the central North Sea, but with lower occurrences (e.g., 12.6%N in birds stranded in the Netherlands). For the less abundant species, it is interesting to highlight the blue whiting *Mecromesistius poutassou*, which was predominantly found in Norway (13.8%N) and Shetland (10.5%N). Blue whiting and Norway pout were often found together, in the same bird. Most flatfish was found in Germany (12.5%N); sandeels were relatively abundant in birds from Shetland (7.5%N) and Northeast England (6.0%N).

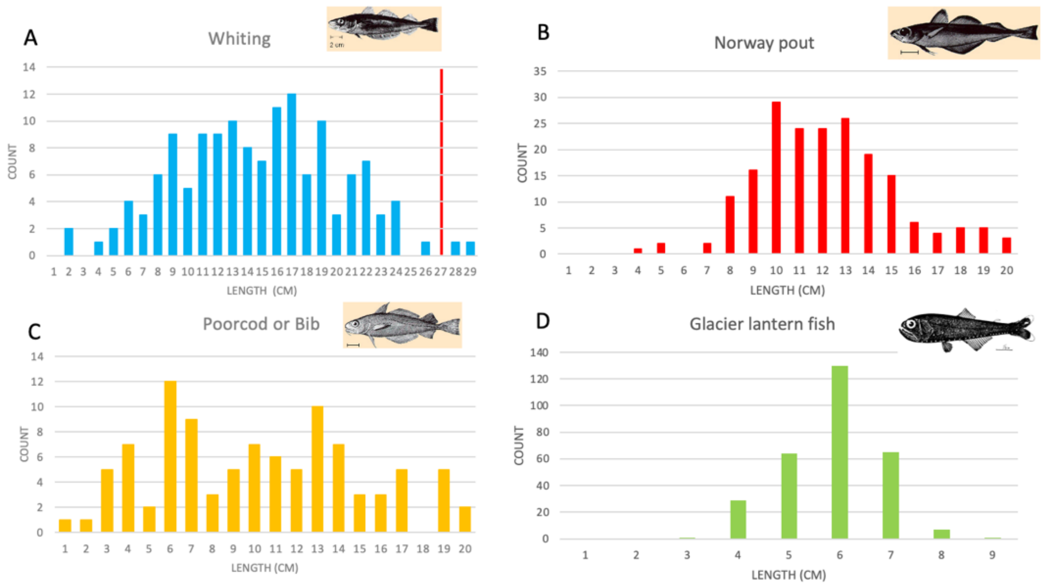

Figure 3: Size frequency distribution for whiting (A) red line represents minimum landing size, Norway pout (B),poor cod or Bib (C) and glacier lanternfish (D).

For the four most common species, we conducted a size-frequency distribution analysis. The majority of the whiting found (Figure 3.A) was below the legal minimum landing size of 27 cm (ICES/CIEM), with a median of 18 cm. Poor cod/bib and Norway pout were mostly of smaller sizes. The median length is 12.5 and 11.8 for Poor cod/bib and Norway pout, respectively. Glacier lanternfish were of much smaller size, with a median of 5.5 cm.

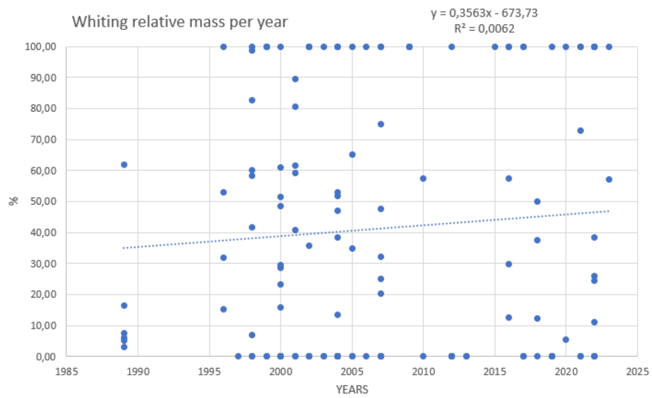

Figure 4: Scatter plot of the percentage of whiting biomass (%M) found in each bird over time (Netherlands only).

Differences over time (1989-2022) were studied for whiting found in birds that had been stranded in the Netherlands. These comprised the largest size range, in combination with the longest time span and relatively large sample size (112 birds). 64 of these 112 birds had whiting remains in their stomach. No trend over time was found in the relative amounts of whiting, based on relative prey masses over time (Figure 4), indicating that the relative importance of whiting did not change during the last three decades in the southeastern North Sea.

DISCUSSION

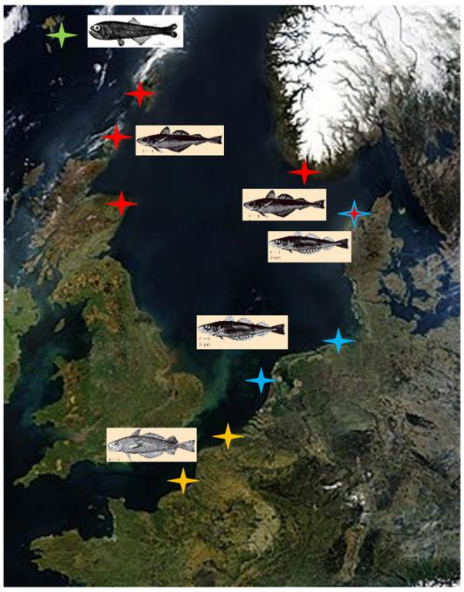

Figure 5: Main fish speciesfor by region. Yellow stars indicate Poorcod, blue stars for whiting, red stars for Norway pout and green for Glacier lanternfish. In denmark the star is blue and red because there is equal amount of whiting and Norway pout.

The data indicates a biogeographical gradient in food availability across the North Sea: poor cod dominates the southern regions, whiting peaking in the central regions, Norway pout becoming more relevant in the northern regions, and abundant glacier lanternfish in the Faroe Islands, i.e., for the North Atlantic (Figure 5). This shift indicates that the diet composition of the fulmars is closely linked to the regional distribution of fish species.

Norway pout is a boreal species that inhabits deep waters and is highly abundant from the Norwegian coast to the northeast coast of England, extending into the Atlantic (Garthe et al. 1996; Heesen et al. 2015), and is the most abundant prey in beached fulmars from this region. Whiting are among the most widely distributed and most abundant gadoid species in the North Sea (Garthe et al. 1996; Heesen et al. 2015). It is present from Belgium to Shetland, and according to Heesen et al. (2015), the highest abundance was observed in central regions. Poor cod is also widely distributed. However, the highest densities are on the west coast of England and the English Channel, and is hardly found in leaving the central-northern parts (Heesen et al. 2015).

The NMDS plot (Figure 1) demonstrated that regions close to each other have more similarity than regions far from each other such as France and Faroe Islands. This suggest that, as fulmars are opportunistic feeders, local prey availability strongly influences their diet. And, the gradual shift in prey species abundance from south to north also underscores the importance of regional fish community structures in shaping fulmar diets.

The results of our study also highlight the relationship between fulmar diets and fisheries catches. The predominance of certain fish species in fulmar diets, such as whiting, poor cod/bib, and Norway pout, aligns closely with the catch rates observed in fisheries surveys conducted across the North Sea (Heesen et al. 2015). Whiting, in particular, which was frequently found in fulmar stomachs, often appeared in sizes below the legal minimum landing size (27cm), suggesting a significant reliance on fishery discards. The depth distribution of the fish species also supports this conclusion. Poor cod/bib (*Trisopterus minutus/luscus*) inhabits depths of 25-300 meters, Norway pout (*Trisopterus esmarkii*) is found at 10-550 meters, and whiting (*Merlangius merlangus*) ranges from 1-551 meters (Heesen et al. 2015). Given that fulmars cannot dive deeply, the presence of these demersal fish in their diet suggests they are primarily accessing individuals that are discarded by fisheries rather than catching them in their natural, deeper habitats (Darby et al. 2021). Contrasting with the Faroe Islands, where the most abundant prey is glacier lanternfish, which is not commercially exploited in this area and shows diurnal migration, so reaching up to the sea surface during the night (Danielsen et al. 2010).

According to Camphuysen et al. (1997) and Skov & Durinck et al. (2001), fulmar distribution is better predicted by hydrographic conditions than by the presence of fishing vessels. However, according to our results fishing vessels provides an essential food source for the fulmars in the North Sea, while self-feeding appears more important around the Faroe Islands.

Several limitations must be acknowledged in our study. Our method of analyzing the stomach contents of beached fulmars only provides a snapshot of the birds' last meals, potentially biased towards individuals that were already in poor health. Many of the fulmars in our study likely died from starvation, which could skew the dietary data towards prey that are more readily available or easier to catch when the birds were weakened.

Additionally, we cannot ascertain the overall diet of the fulmar populations or their broader dietary habits from this method alone. This limitation underscores the need for complementary studies involving live, healthy fulmars to gain a more comprehensive understanding of their feeding ecology.

CONCLUSION

Northern fulmars have a fairly varied diet. Although they can catch some fish by themselves, the presence of fishing vessels gives them an additional food source. Since North Sea fish are highly exploited and target specific fish (i.e., flatfish and large gadoids) are removed in bulk, there are also a lot of discards that fulmars could use, helping them to expand their population in this temperate region. Because they spend most of their lives at sea, it is difficult to investigate their dual reliance on artificial and natural food sources. However, the analysis of beached fulmars provide an overview of their diet while fending for themselves, rather than for chicks during breeding.

Our study underscores the significant regional variation in the diet of Northern fulmars across the North Sea, driven by the availability and distribution of various fish species in fisheries bycatches. The reliance on fishery discards is evident and are consistent with data from fisheries surveys in the North Sea (Heesen et al. 2015). Non-commercial species, like poor cod/bib and

Norway pout and whiting smaller than the minimum landing size were taken in large numbers. In contrast, outside the North Sea, at the Faroe Islands, glacier lanternfish were found as the most abundant prey, indicating self-feeding. These findings highlight the interplay between natural prey availability and human activities, such as fishing, in shaping the feeding ecology of fulmars.

The relative importance of whiting in the southeastern North Sea did not change during the last three decades and has been roughly 50% over the last 40 years, indicating consistent discarding practices over this period. It remains to be seen if the EU discard ban, also called the landing obligation, implemented in 2015 (Church et al. 2019; Sherley et al. 2019) will have much effect, both on fisheries practices and on the fulmar diet.

Understanding the regional dietary patterns found in this study is crucial for predicting the effects of environmental changes and fisheries management on fulmar populations in the North Sea. Fulmars clearly rely on fisheries, so any change in the practice of discarding will likely result in a change in their population size, as suggested by Sherley et al. (2019) and Burnell et al. (2023).

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ANNEX

Table A1: Linear regressions for each fish used in this study. Using otolith length (OL) and otolith width (OW). And, power law relationship to correlate fish length to mass.

FISH NAME	FISH LENGTH (OL) =	FISH LENGTH(OW)=	MASS =
WHITING	0.81+1.73*OL	-2.97+6.74*OW	(0.19*FL)^3.09
RED MULLET	-3.26+7.22*OL	-4.91+10.67*OW	(0.21*FL)^3.34
ATLANTIC HORSE MACKEREL	-0.9+3.29*OL	-3.1+7.67*OW	(0.21*FL)^2.97
POORCOD	-3.84+2.61*OL	-2.98+5.22*OW	(0.21*FL)^3.1
GLACIER LANTERN FISH	2.8696*OL+1.1949	2.3487*OW+0.8452	0.0115*FL^2.814
NORWAY POUT	2.28*OL	5.36*OW	(0.18*FL)^3.15
SANDEEL SP.	2.1+4.91*OL	0+11.46*OW	(0.13*FL)^3.37
BIB	-5.4+2.99*OL	-3.21+5.82*OW	(0.21*FL)^3.1
BIG-SCALE SANDMELT	2.8253*OL^1.0928	4.5221*OW^0.988	0.0075*FL^2.8177
BLUE WHITING	-5.65+2.66*OL	-9.65+9.11*OW	(0.19*FL)^2.84
POLLACK	-9.38+3.96*OL	-9.98+9.98*OW	(0.18*FL)^3.31
HERRING	-1.93+6.29*OL	-6.36+15.51*OW	(0.19*FL)^3.09
ATLANTIC COD	-6.64+3.49*OL	-5.51+7.84*OW	(0.19*FL)^3.26
HADDOCK	-3.27+2.53*OL	-4+6.99*OW	(0.19*FL)^3.19
DAB	-3.49+5.43*OL	-5.4+8.88*OW	(0.22*FL)^3
SILVERY POUT	1.9212*OL^1.01	4.8027*OW^0.675	0.0027*FL^3.4312
TWO-SPOT GOBY		(-3.89+44.93*OW)/10	(0.3345*FL^3.121)/10
POLAR COD	(16.849+20.86*OL)/10		3.6*(10^-6)*(10*FL)^3.12
BASS		-9.88+8.61*OW	(0.21*FL)^3
GARFISH	10.38+10.62*OL	13.06+18.34*OW	(0.09*FL)^3.28
SMELT	-1.63+3.97*OL	-4.29+7.51*OW	(0.17*FL)^3.4
PLAICE	-2.07+4.85*OL	-4.7+8.15*OW	(0.22*FL)^3.02

TUB GURNARD	-5.31+8.28*OL	-5.95+10.4*OW	(0.22*FL)^3
SOLENETTE	-1.42+5.05*OL	-1.73+5.83*OW	(0.21*FL)^3.17
SPRAT	0+6.87*OL	-1.41+11.92*OW	(0.19*FL)^3.09
SAND GOBY	-0.43+3.92*OL	-1.74+5.27*OW	(0.21*FL)^2.83
SOLE	-2.65+8.18*OL	-4.72+10.32*OW	(0.2*FL)^3.05
TRANSPARENT GOBY	1.32+4*OL	1.53+3.24*OW	(0.19*FL)^4.17
PEARLSIDES	(9.82+28.75*OL)/10		(0.3737*FL)^2.503
WITCH	(-100.65+78.29*OL)/10		(0.077*FL)^4.633