

Spatial distribution and commercial catch composition of North Sea whiting (*Merlangius merlangus*) and haddock (*Melanogrammus aeglefinus*)

Evaluating real-time closures for whiting and haddock

Katinka Bleeker, Mariana De Matos Domingues, Chen Chun

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Summary

Real-time closures (RTCs) are temporary short-term bans on fishing in specific areas with the primary aim to protect juvenile and undersized fish. In 2010, an RTC was implemented in the North Sea for four gadoid species: whiting (*Merlangius merlangus*), haddock (*Melanogrammus aeglefinus*), cod (*Gadus morhua*) and saithe (*Pollachius virens*). Both whiting and haddock have undergone substantial changes in stock status over recent decades which raises broader questions about the continuing role and design of RTCs as a management measure. This study provides a scientific evidence base for evaluating the current North Sea RTC.

Fisheries-independent survey data (NS-IBTS in Q1 and Q3, 2016–2025) were used to assess the spatial and seasonal distribution of juvenile and adult gadoids, while commercial catch data from the Dutch demersal self-sampling programme (2019–2025) were retrospectively analysed to assess the composition in relation to the current RTC sampling and RTC trigger thresholds.

Survey data showed that juvenile whiting remain widely distributed throughout the North Sea, while juvenile haddock have expanded southwards in recent years alongside increasing stock abundance. The greatest spatial overlap between juvenile gadoid species occurred between whiting and haddock, with relatively limited overlap with cod and almost no overlap with saithe. Commercial catch data showed that catches exceeding the 200 kg gadoid sampling threshold became increasingly common in the BT2 and TR2 fleets. Of the 189 hauls that met the sampling threshold, 182 (96%) exceeded the current RTC juvenile trigger level of 10%, with juvenile whiting dominating the catches.

The results demonstrate that the RTC framework operates under different stock conditions than when it was introduces in 2010. The increased abundance and expanding distributions of whiting and haddock have led to larger catches of the species, exceeding RTC sampling thresholds. Juvenile proportions remain consistently high throughout the time series. As a result, adjusting the current juvenile trigger percentage alone may have limited effects on RTC outcomes. Instead, the findings support a reassessment of the RTC framework, including consideration of species-specific measures, adaptive triggers linked to stock status, and more targeted spatial or seasonal closures. Such an approach could maintain protection of vulnerable juvenile fish while improving the efficiency and proportionality of the RTC system under current stock conditions.

1 Introduction

Spatial management can be used in fisheries management as a tool to prevent overfishing and, to a lesser degree, to reduce by-catch (Dunn *et al.*, 2011). Real-time closures (RTCs) , which are temporary short-term bans on fishing in specific areas, are an example of such measures. Their primary purpose is to protect juvenile and undersized fish. In the North Sea such a legal framework for implementing RTCs was established in 2010 under Commission Regulation (EU) No 724/2010 (EU, 2010). The regulation applies to four gadoid species: whiting (*Merlangius merlangus*), haddock (*Melanogrammus aeglefinus*), cod (*Gadus morhua*) and saithe (*Pollachius virens*) caught by most fishing gears. Certain fisheries are exempt from the RTC regulation, including those using pelagic trawls, purse seines, driftnets and jiggers targeting herring, mackerel and horse mackerel, as well as fisheries employing pots, scallop dredges, and gillnets. Under the original provisions of the regulation, an RTC was triggered when juveniles constituted at least 15% by weight of the combined catch of whiting, haddock, cod and saithe in a sampled haul. For cod, a more strict threshold of 10% applied when cod represented more than 75% of the total catch of these four species. To determine whether these thresholds were exceeded, sampling was required whenever a haul was estimated to contain at least 300 kg of the four species combined. Samples had to contain a minimum of 200 kg and be representative of the species composition of the haul. Where appropriate, samples should be collected from the beginning, middle and end of the catch. The percentage of juveniles was then calculated for each species and for the total sample, and the results reported to the relevant coastal Member State.In the Netherlands, inspections on board fishing vessels are carried out by the Netherlands Food and Consumer Product Safety Authority (NVWA).

In 2011, the regulation was amended by Implementing Regulation (EU) 783/2011 and catch trigger levels were modified (EU 2011). Juvenile catch trigger levels were reduced to 10% of the combined catch and thresholds for cod were lowered to 7.5% when cod accounted for more than 75% of the sampled catch. In addition, the sampling procedure was simplified by reducing the minimum estimated quantity of the four species in the catch required before sampling from 300 kg to 200 kg. This aligned the trigger value for sampling with the minimum sample size required (200 kg), thereby streamlining the implementation of the RTC monitoring procedures. In 2026, an additional amendment was made for cod where the threshold was reduced from 75% to 25% between 1 January to 31 March. If the quantity of cod in the sample exceeds 25% of the total gadoid catch, the catch trigger level remains 7.5% by weight of juveniles (EU, 2026).

The rationale underpinning RTCs is closely linked to the population dynamics of gadoid species. Protection of juvenile fish is considered an important mechanism for maintaining strong year classes and safeguarding sustainable stocks in the long-term. By reducing fishing effort in areas with high densities of juveniles, the likelihood that young fish survive to maturity and contribute to future spawning biomass increases.

The present study focuses on whiting and haddock in the North Sea. Both species have undergone substantial changes in stock status over recent decades. The stocks discussed here are whiting in the North Sea and eastern English Channel (whg.27.47d) and haddock in the North Sea, West of Scotland and Skagerrak (had.27.46a20). Following periods of low abundance during the early 2000s and 2010s, both stocks have shown significant increase in spawning stock biomass (Figure 1). Furthermore, recruitment has increased and fishing pressure has been estimated to be below F_{MSY} for both stocks (ICES, 2025). As spawning stock biomass and recruitment increase, larger number of fish below the Minimum Conservation Reference Size (MCRS) threshold may be expected in the catch as a consequence of greater stock productivity. The recovery of the North Sea whiting and haddock stocks also raises broader questions about the continuing role and design of RTCs as a management measure. The RTC regulation was originally developed during a period when several gadoid stocks were at historically low levels and the protection of juvenile fish was considered a priority for stock rebuilding.

In this context, it is appropriate to evaluate the current RTC regulation and the necessity to continue to include whiting and haddock in the regulation. Furthermore, the occurrence of juvenile fish is expected to be linked to recruitment timing and seasonal distribution of fish. A more targeted seasonal approach, rather than a year-round RTC system, could achieve similar protection of juvenile fish while reducing operational impacts on fishing activities. The present study was initiated in response to these management questions with the aim to provide a scientific evidence base for evaluating the current RTC framework. To address these questions, both scientific survey data and commercial catch information are analysed.

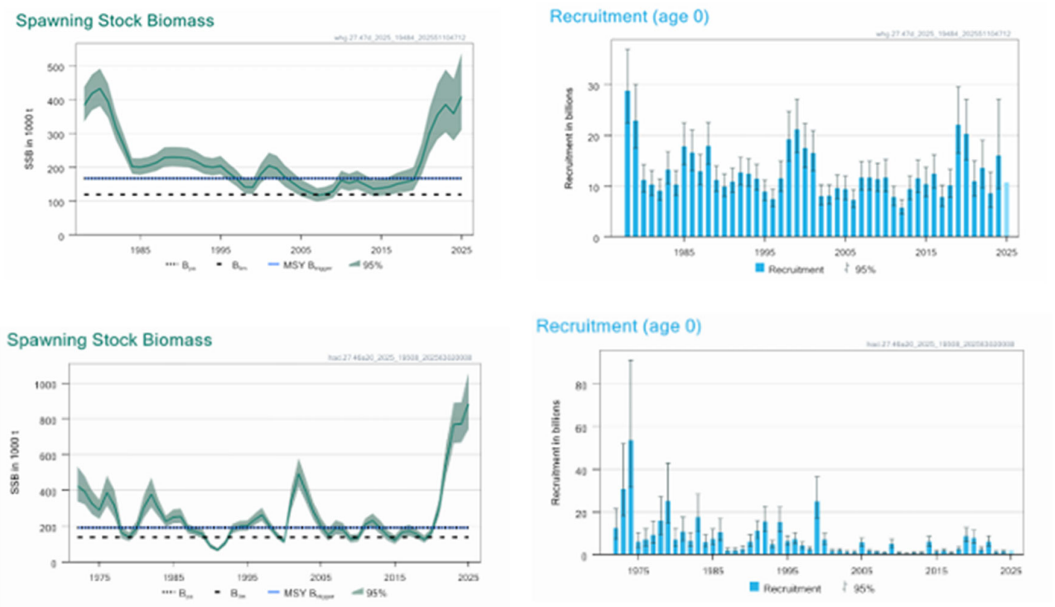


Figure 1: *Estimated spawning stock biomass (left) and recruiment (right) for Whiting in Subarea 4 and Division 7.d. (top) and Haddock in Subarea 4, Division 6.a, and Subdivision 20 (bottom). Figures copied from the 2025 assessment (ICES, 2025).*

2 Methods

2.1 North Sea International Bottom Trawl Surveys (NS-IBTS)

Fisheries independent survey data were used for analysing the spatio-temporal distribution of whiting, haddock, cod and saithe. The NSa-IBTS is a round-fish survey carried out in both quarter 1 (Q1) and quarter 3 (Q3). Survey data were downloaded from the ICES DATRAS database for both surveys and years 2016-2025. Only valid hauls were selected for further analysis. Length and biological information was filtered for the four species. Fish weight was estimated using a weight-length relationship: $W = a \cdot L^b$, where W is weight in grams, L is length in cm, and a and b are fitted parameters. The parameters a and b were estimated from biological samples for which both length and weight were available, pooled across 2016-2025. The weight-length relationships were then applied to the numbers at length to estimate their respective total weight. Number of fish caught at length were standardized to numbers per hour. Catch per unit of effort (CPUE) was expressed as biomass in kilograms per hour (kg h^{-1}), derived by multiplying the numbers per hour with the mean weight at length. Length frequency distributions were calculated per species as the proportion of each length-bin (1cm) relative to the total numbers within each survey and year.

The Minimum Conservation Reference Size (MCRS) of each species is used to group length classes in juvenile (below MCRS) and adult (at and above MCRS) life stages. Per-haul CPUE is computed for both life stages, including zero hauls (hauls where the species was not caught) to avoid positive bias. Per ICES statistical rectangle, average CPUE (kg h^{-1}) was calculated by taking the sum of CPUE and dividing by the numbers of hauls within the rectangle per survey, year, species and life stage. Furthermore, the timeseries was split into two five-year periods (2016-2020 and 2021-2025) and average CPUE (kg h^{-1}) was calculated for both periods, surveys, species and life stages.

Spatial composition of juveniles per ICES statistical rectangle was analysed by calculating the proportion of CPUE (kg h^{-1}) of each species relative to the total CPUE of all four species. This was done for the two five-year periods (2016-2020 and 2021-2025). Areas (rectangles) with more than two species present and each contributing at least 5% to the juvenile assemblage were identified.

2.2 Commercial catch

To retrospectively test RTC trigger thresholds in the Dutch demersal fleet, commercial catch data from the demersal discard self-sampling programme carried out under the Data Collection Framework (DCF) were used. In short, a reference fleet consisting of 20-25 demersal fishing vessels collect a representative discard sample (80 kg) of two hauls within a fishing trip through a standardized sampling scheme. Samples are collected in plastic bags, labelled and stored on ice. Haul specific information such total catch, total landings, fishing effort and fishing location are recorded. Upon return to the harbour, discard samples are collected and brought to the laboratory for further analysis. All fish species and other species of commercial interest (Norway lobster *Nephrops norvegicus*, brown crab *Cancer pagurus*) are length-measured. Other (benthos) species are counted only. Total weight of each species in the sample is also recorded. Discards are then raised to haul level using the volume of total catch (minus total landings) in the haul divided by the volume of the discards sample, multiplying by the numbers in the sample. Detailed information and the schematic overview of the raising procedures can be found in *Afranewaa et al.,* (2024).

Sampled hauls between 2019 and 2025 were selected for the analysis of commercial catch data. Métiers were grouped into the following fleet segments: BT1, BT2, TR1 and TR2. BT1 are beam trawlers using a mesh size ≥120 mm, while BT2 consists of beam trawlers using a mesh size range of 70-119 mm. TR1 fleet segments consists of otter trawlers with a mesh size ≥100 mm, and TR2 consists of otter trawlers with mesh sizes ranging between 70-99 mm.

Landings per haul and species were available in kilograms. Similar to survey data, discard weight-at-length for each species was calculated using the weight-length relationship ($W = a \cdot L^b$). Species were grouped into juvenile and adult life stages based on their MCRS and respective discard weights were aggregated. Total catch of the four gadoid species was calculated per haul by taking the sum of landings and discards. Hauls with ≥200 kg of gadoid species were selected for further analysis on RTC trigger events. The sum of juvenile weight per haul was taken to calculate the proportion of juvenile weight relative to the total gadoid weight in the haul.

3 Results

3.1 North Sea IBTS Q1 and Q3 surveys

3.1.1 ICES DATRAS

Data from the North Sea International Bottom Trawl Survey (NS-IBTS) quarter 1 (Q1) and quarter 3 (Q3) surveys were obtained from the ICES DATRAS database for whiting, haddock, cod and saithe. Analyses were conducted for the period 2016-2025 to investigate temporal and spatial patterns in species distributions and the degree of overlap in the juvenile distribution of the four species.

3.1.2 Length distribution

Length frequency distributions were examined for each species and NS-IBTS survey (Q1 and Q3) for all years between 2016-2025 to get insight into the size structure of the species. Figure 2 and 3 show the length distribution of whiting and haddock per year and survey, respectively, including the MCRS of the species. Length distributions of cod and saithe are not included in this results section but can be found in Annex I.

Figure 2 shows that the majority of whiting recorded in the two surveys were below their MCRS size of 27 cm while individuals at and above this size comprise a relatively small proportion of the population. In the Q3 survey newly recruited young fish are visible through the peaks in fish around 8-15 cm. There is variation between year classes, for example while 2022 and 2024 show high peaks in young fish (8-15 cm) in Q3, these years are followed by lower numbers in 2023 and 2025. In the Q1 survey, length distributions were shifted towards larger fish, with peaks around 18-25 cm.

Length distributions of haddock (Figure 3) showed greater variation across years, consistent with its sporadic recruitment. In earlier years of the time series, a larger proportion of fish were below the MCRS of 30 cm. However, in more recent years the distributions shifted towards larger size classes resulting in a lower proportion of fish below the MCRS. In the Q3 survey, newly recruited young fish show higher peaks between 2016-2022 but were largely absent thereafter. In 2020 and 2021 the proportion of fish below 30 cm was 80% or higher in both surveys, while these have decreased to 41.3 and 29.5% in Q1 and Q3, respectively.

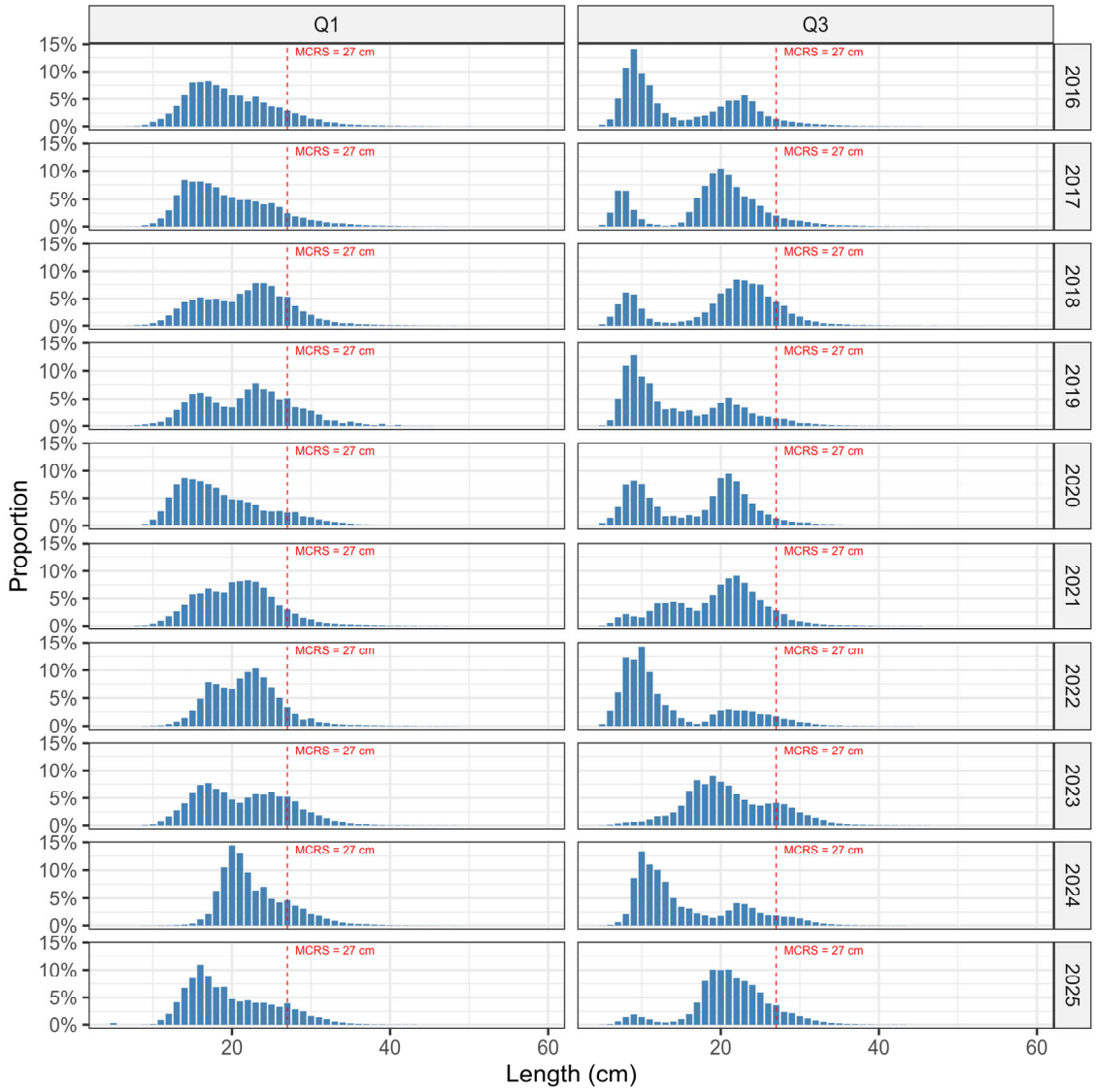


Figure 2: *Whiting length frequency distribution NS-IBTS Q1 (left panel) and Q3 (right panel) from 2016-2025. MCRS (27 cm) is indicated by the red dotted line.*

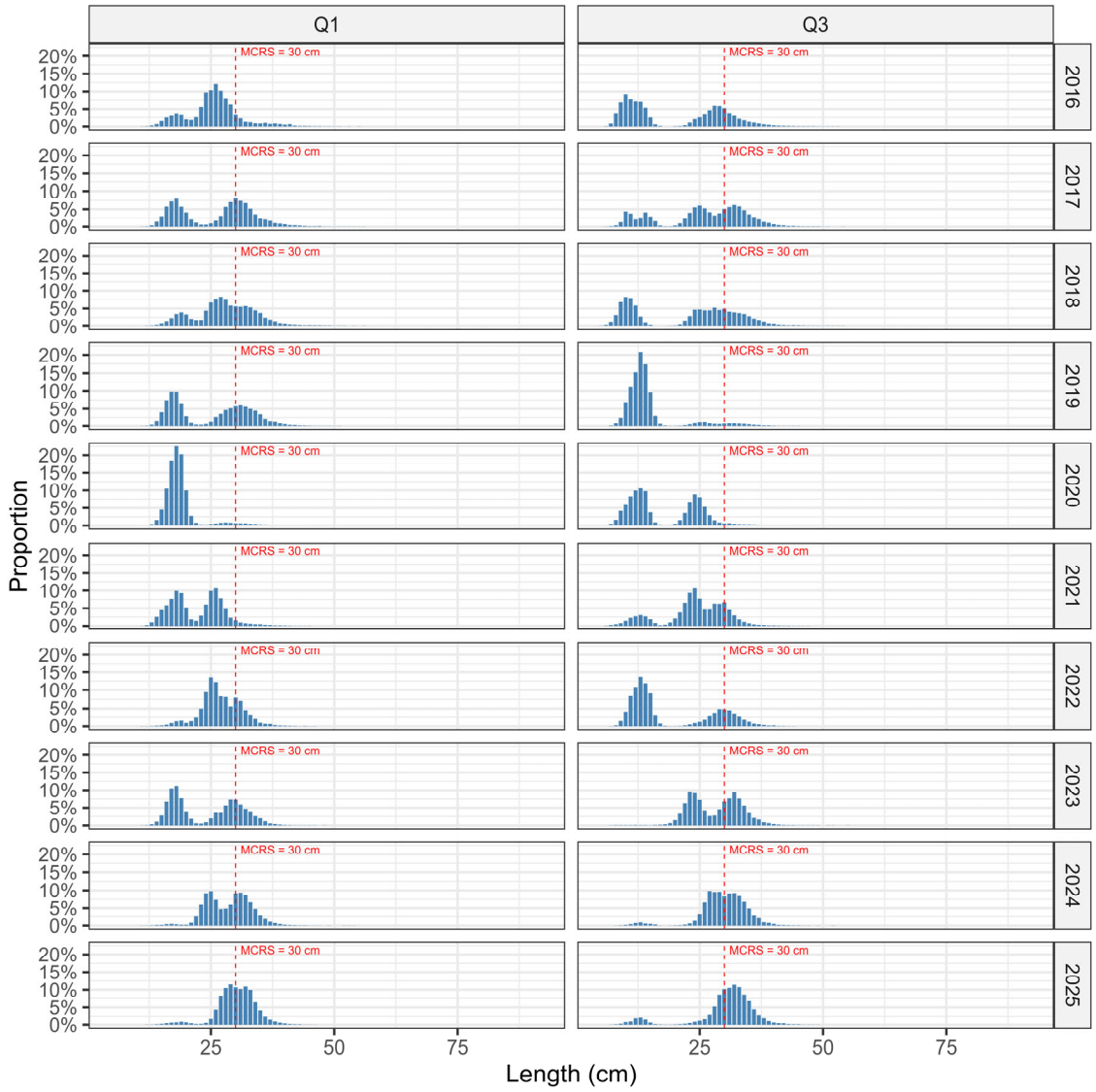


Figure 3: *Haddock length frequency distribution NS-IBTS Q1 (left panel) and Q3 (right panel) from 2016-2025. MCRS (30 cm) is indicated by the red dotted line.*

3.1.3 Spatial distribution

The spatial distribution was analysed using the catch per unit of effort (CPUE, kg h^{-1}) aggregated at the ICES statistical rectangle level. Maps were produced for each species and NS-IBTS survey aggregated into two five-year periods (2016-2020 and 2021-2025) to show broader spatial trends while reducing the influence of interannual fluctuations. Furthermore, maps were split between juvenile (below MCRS) and adult (at and above MCRS) fish to showcase potential differences in distribution. Maps of the annual spatial distribution (2016-2025) of whiting and haddock can be found in Annex II and are not further discussed in this section.
The spatial distribution of juvenile whiting is shown in Figure 4a and 4b, and for adult whiting in Figure 5a and 5b, where a is the NS-IBTS-Q1 survey and b the NS-IBTS-Q3 survey. Juvenile whiting is abundant throughout the entire North Sea Ecoregion, except for the most northern parts of the area (Figure 4a and 4b). Juvenile densities have increased in 2021-2025 as compared to 2016-2020 in both surveys. Areas of high densities are specifically in the central North Sea along the English coast and in the southern North Sea towards the English Channel.

Adult whiting is also found to be abundant throughout the entire North Sea Ecoregion. Unlike juveniles they are found farther north, and they are less common in the southeastern area (German Bight) (Figure 5a and 5b). The survey in Q1 shows higher densities of adults in CPUE in 2021-2025 as compared to 2016-2020 (Figure 5a). Furthermore the distribution has spread further towards the German Bight.

The spatial distribution of juvenile haddock (Figure 6a and 6b) has increased in 2021-2025 compared to 2016-2020 in both surveys (Figure 6a and 6b), and also shows an expansion of distribution towards the south, however this does not expand to the Eastern English Channel. Densities in the Skagerrak area have also increased substantially in the recent period. Adult haddock show similar patterns in the expansion of their distribution further south, as well as increasing densities in 2021-2025 (Figure 7a and 7b).

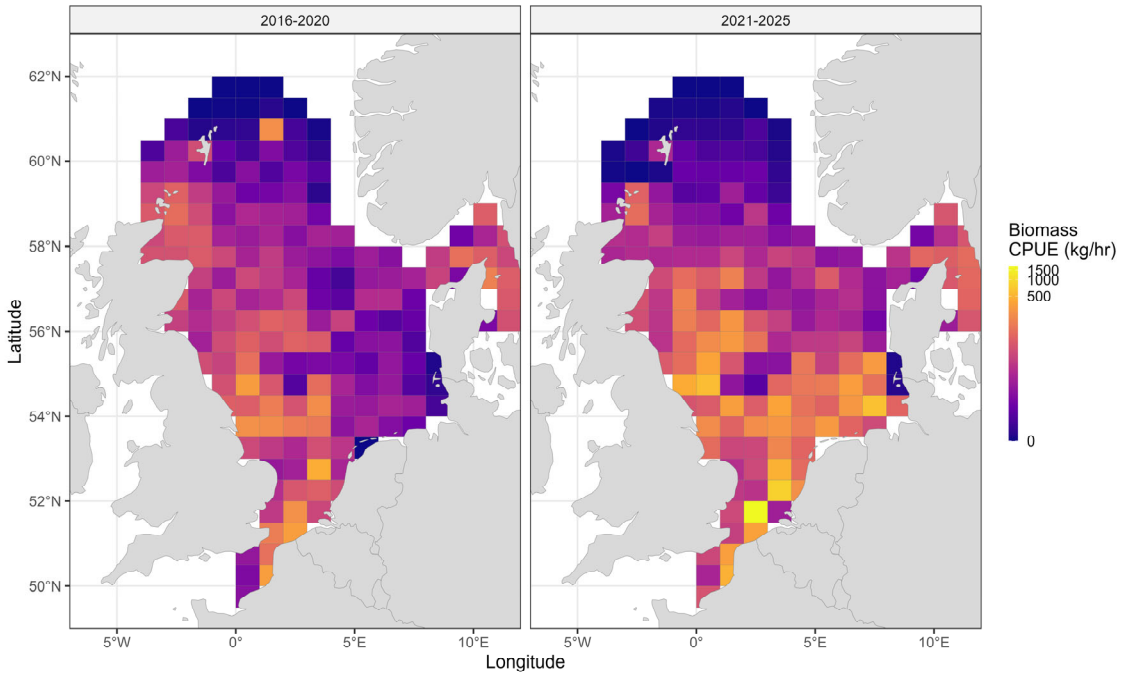


Figure 4a: *Spatial distribution of juvenile whiting (< 27 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q1 for two five-year periods: left panel 2016-2020, right panel 2021-2025.*

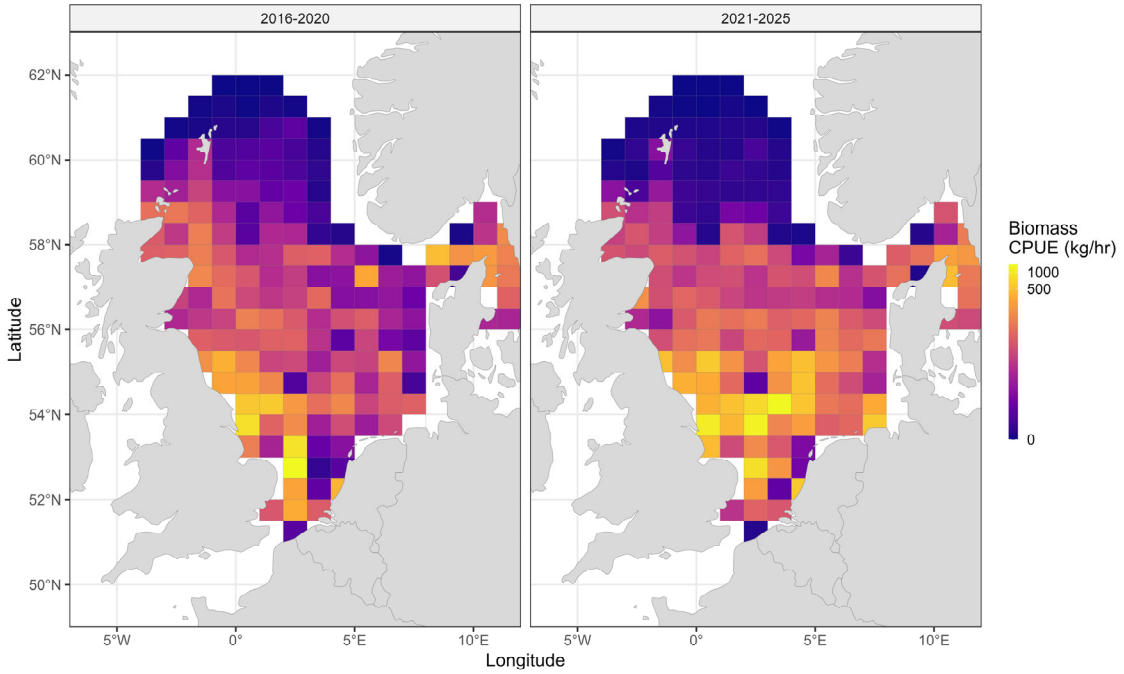


Figure 4b: *Spatial distribution of juvenile whiting (< 27 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q3 for two five-year periods: left panel 2016-2020, right panel 2021-2025.*

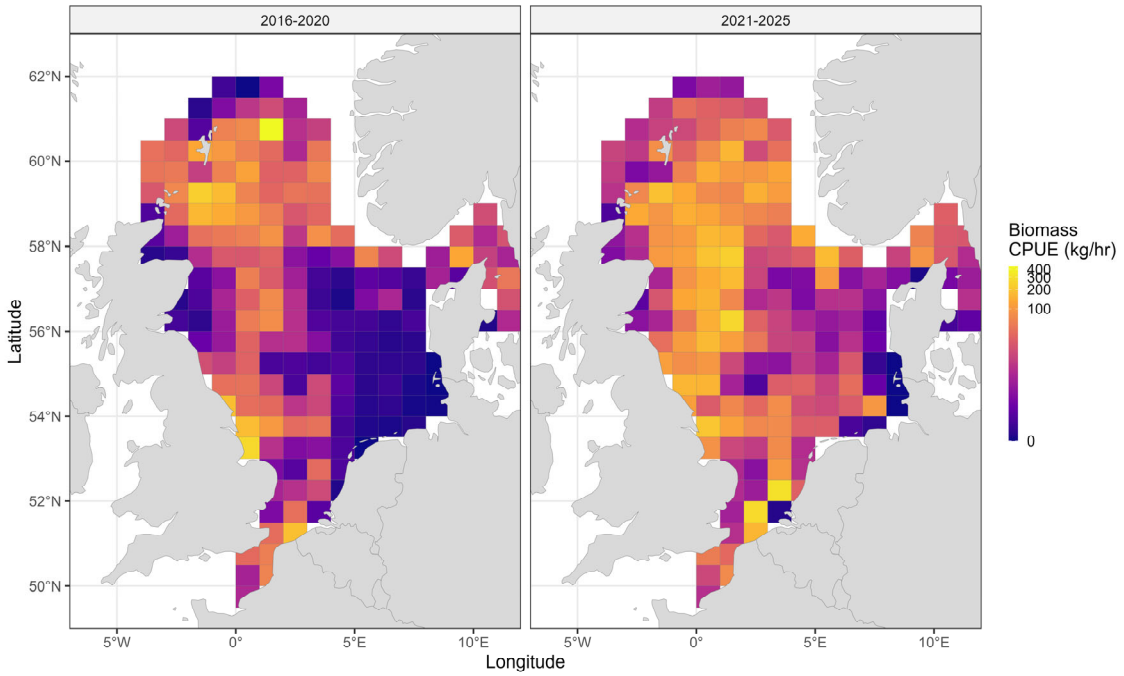


Figure 5a: *Spatial distribution of adult whiting (≥ 27 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q1 for two five-year periods: left panel 2016-2020, right panel 2021-2025.*

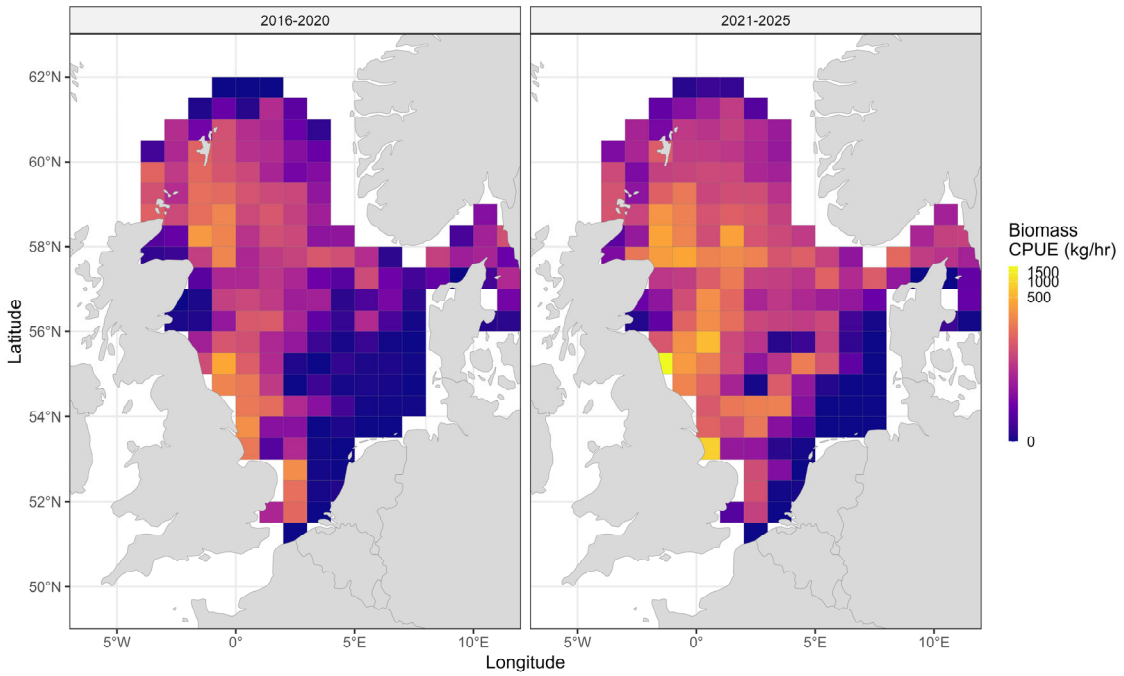


Figure 5b: *Spatial distribution of adult whiting (≥ 27 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q3 for two five-year periods: left panel 2016-2020, right panel 2021-2025.*

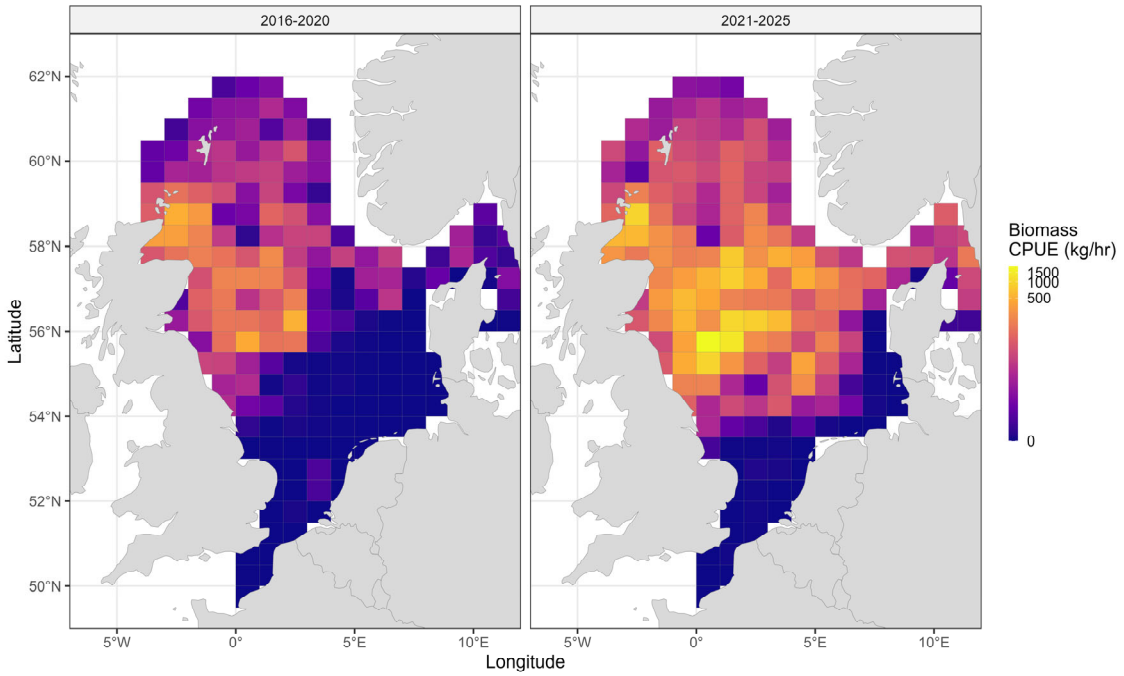


Figure 6a: *Spatial distribution of juvenile haddock (< 30 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q1 for two five-year periods: left panel 2016-2020, right panel 2021-2025.*

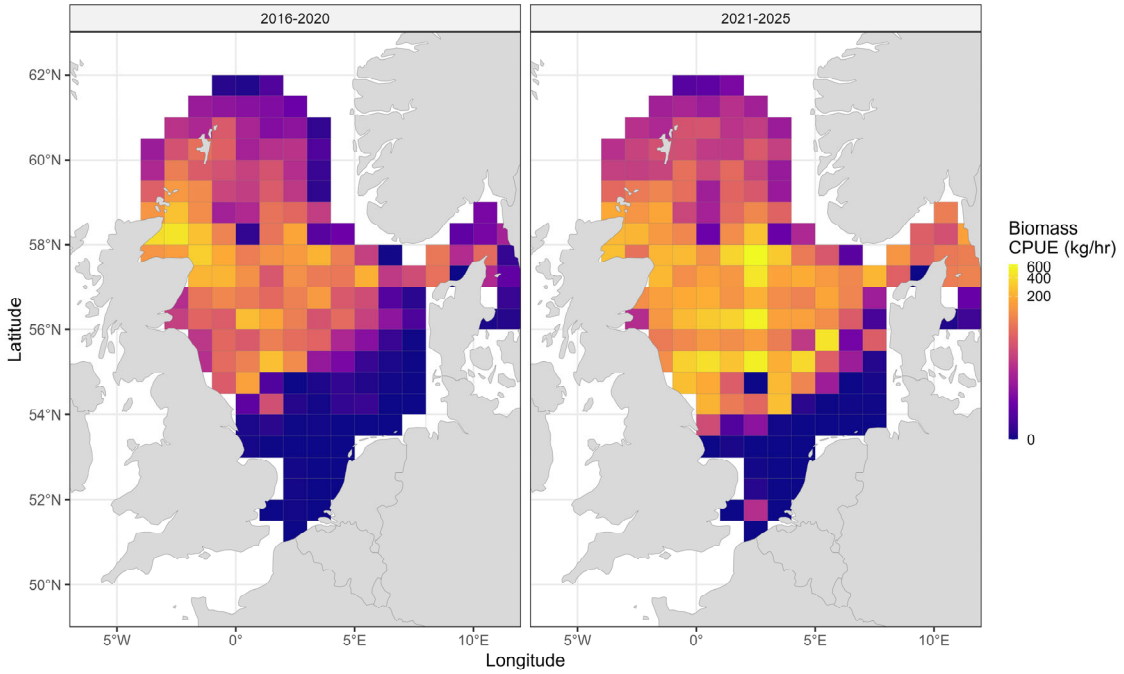


Figure 6b: *Spatial distribution of juvenile haddock (< 30 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q3 for two five-year periods: left panel 2016-2020, right panel 2021-2025.*

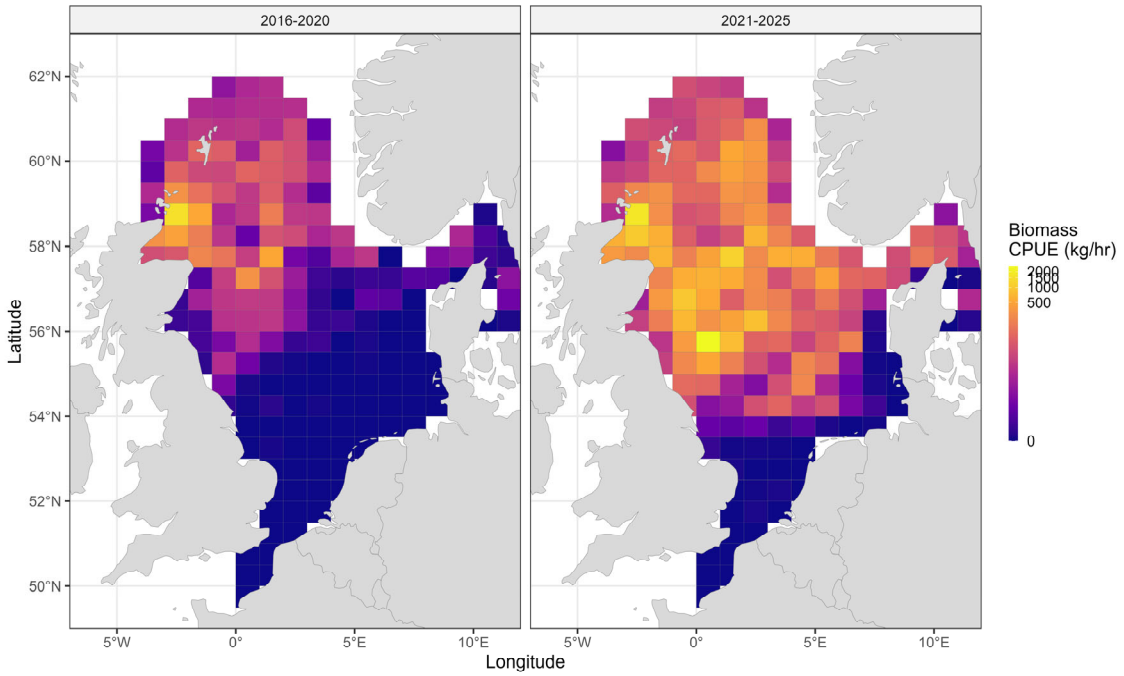


Figure 7a: *Spatial distribution of adult haddock (≥ 30 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q1 for two five-year periods: left panel 2016-2020, right panel 2021-2025.*

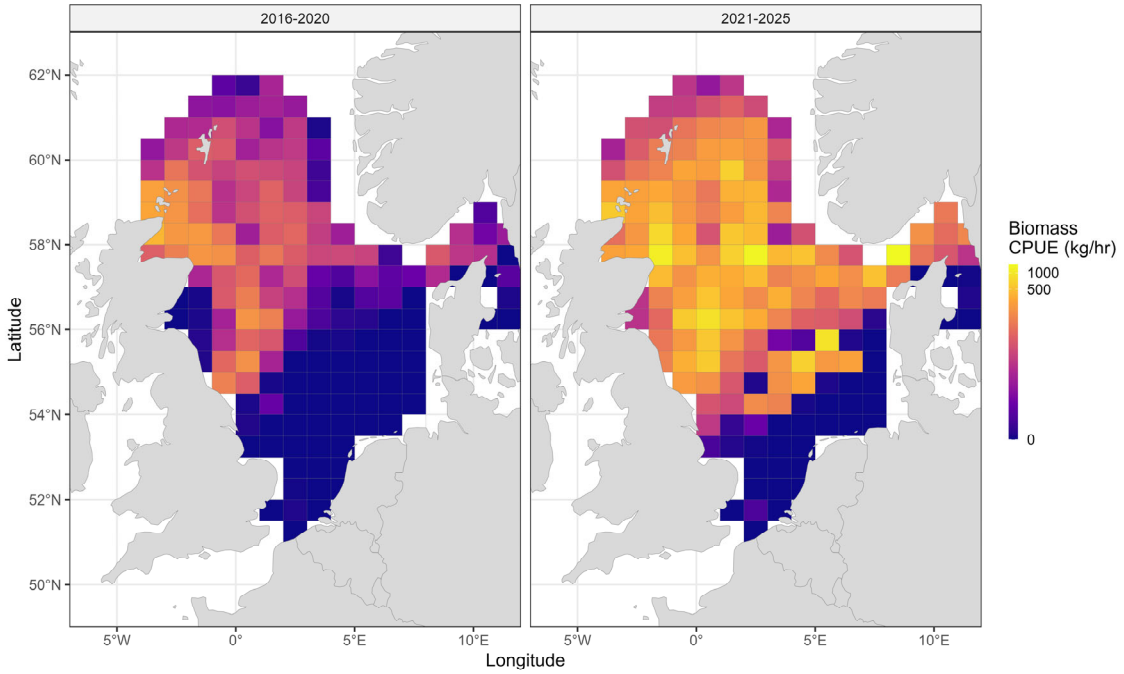


Figure 7b: *Spatial distribution of adult haddock (≥ 30 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q3 for two five-year periods: left panel 2016-2020, right panel 2021-2025.*

3.1.4 Overlap in juvenile distribution

To evaluate the degree of spatial overlap among juvenile fish distribution, the proportion of juveniles of each of the four species was calculated per ICES statistical rectangle. Pie-chart maps were produced for the two five-year periods (2016-2020 and 2021-2025), with each pie chart representing the relative contribution of whiting, haddock, cod and saithe juveniles in the total mean CPUE (kg h^{-1}) within a rectangle. These pie charts highlight areas where juveniles of the four species co-occur and the dominant species in the areas. Additionally, rectangles were highlighted in which more than two species were present and juveniles of each species contributed at 5% of juvenile assemblage.

The spatial overlap of juvenile fish in the NS-IBTS in Q1 is shown in figure 8. Juveniles of haddock and whiting are most abundant and have a shared spatial overlap mainly in the entire northern and central North Sea and Skagerrak, which has increased in later years of the timeseries (Figure 8, right panel). The southern North Sea and English Channel are dominated by juvenile whiting. There are a few rectangles where there is overlap of more than two species all contributing at least 5% in CPUE (Figure 8). These distributions have shifted from the northern North Sea along the Norwegian trench in 2016-2020 towards more overlap in the Skagerrak. These areas consist of whiting, haddock and cod. Saithe juveniles are mainly absent throughout the time series, which is a known fact for this species. Figure 9 shows the spatial overlap of juvenile fish in the NS-IBTS in Q3. Like in Q1, the majority of spatial overlap is contributed to whiting and haddock mainly in the central North Sea. In the southern North Sea, juvenile whiting is the main component (Figure 8). In the time period 2016-2021, there are more rectangles where there is overlap of more than 2 species contributing at least 5% in CPUE (Figure 9, left panel). These areas have reduced in the 2021-2025 time period. Similar to the Q1 survey, these areas consist mainly of whiting, haddock and cod. The Skagerrak is the main area where juveniles of cod have a larger share relative to the total CPUE.

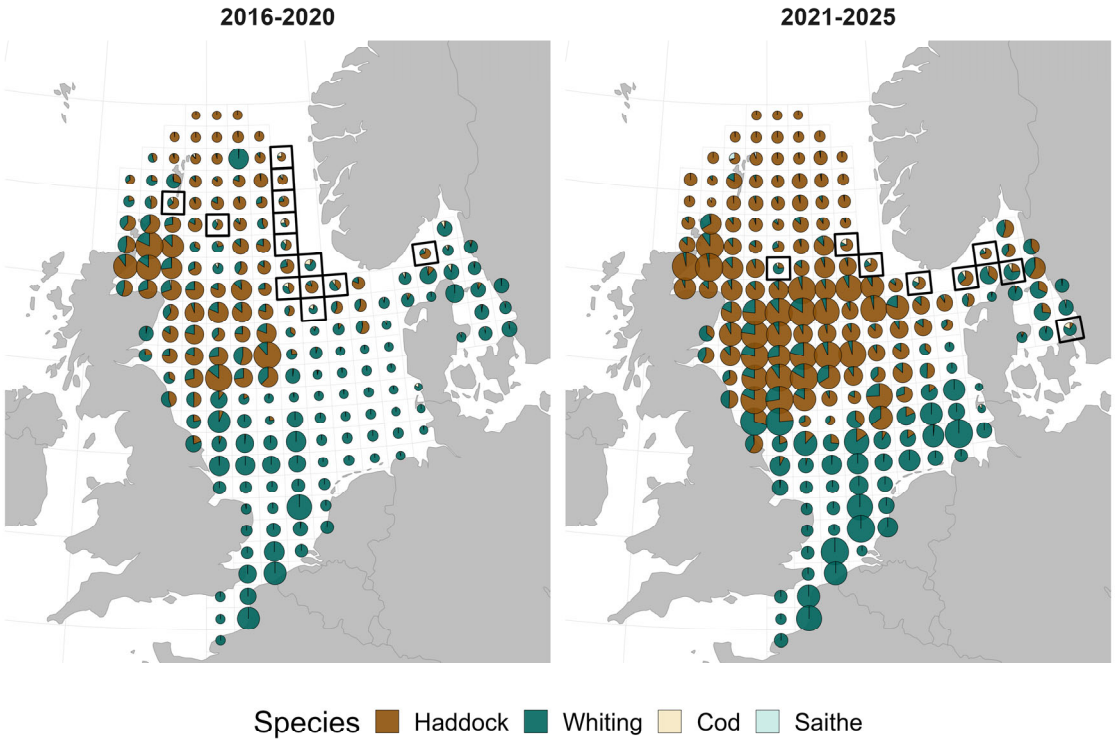


Figure 8: *Spatial overlap of juvenile whiting, haddock, cod and saithe in the Greater North Sea Ecoregion from the NS-IBTS Q1 for two five-year periods: left panel 2016-2020, right panel 2021-2025. Pie-charts in ICES statistical rectangles show the relative contribution of each species to the total average CPUE (kg h^{-1}) of the four species, where size of the pie-charts are scaled to CPUE densities. ICES statistical rectangles where three or four species share overlap with at least 5% of juveniles are highlighted with black borders.*

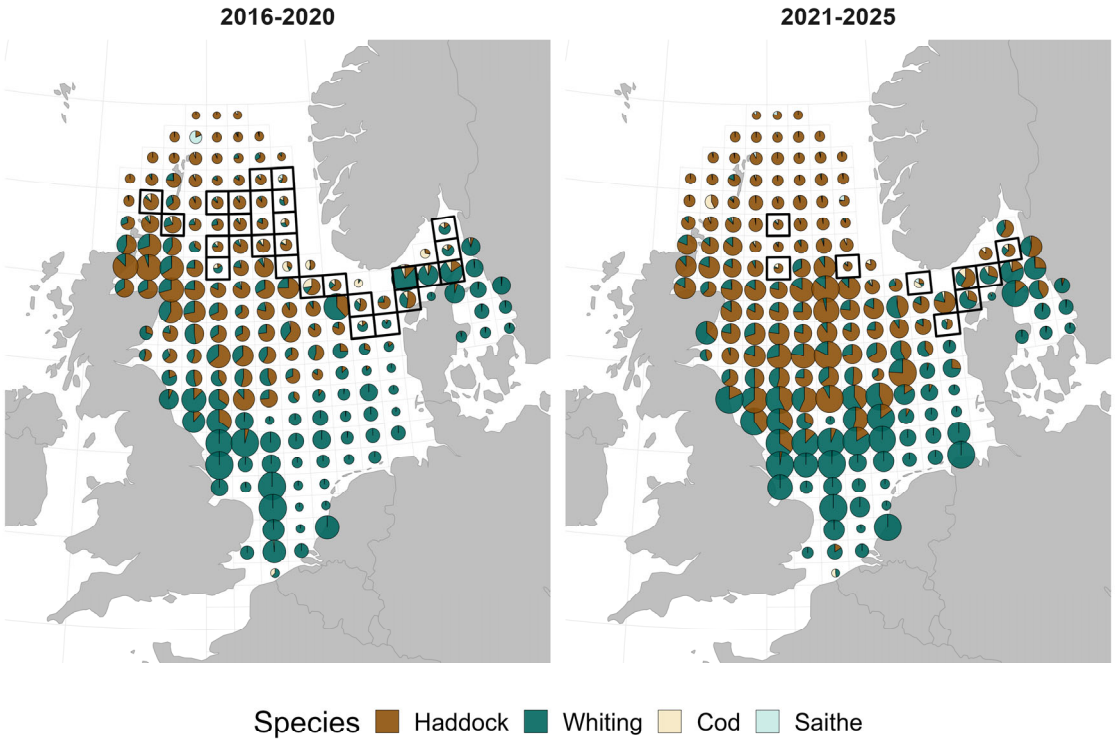


Figure 9: *Spatial overlap of juvenile whiting, haddock, cod and saithe in the Greater North Sea Ecoregion from the NS-IBTS Q3 for two five-year periods: left panel 2016-2020, right panel 2021-2025. Pie-charts in ICES statistical rectangles show the relative contribution of each species to the total average CPUE (kg h^{-1}) of the four species, where size of the pie-charts are scaled to CPUE densities. ICES statistical rectangles where three or four species share overlap with at least 5% of juveniles are highlighted with black borders.*

3.2 Commercial catch

3.2.1 Gadoid catch composition

The commercial catch of sampled hauls between 2019-2025 was analysed for four fleet segments: BT1, BT2, TR1 and TR2. BT1 and BT2 refer to beam trawlers with mesh sizes ≥120 mm and ≥70-119 mm, respectively. TR1 and TR2 refer to classifications of bottom trawls with a mesh size of ≥100 mm and ≥70-99 mm, respectively. Total number of sampled hauls per year and fleet segment are summarized in Table 1, including the percentage of hauls that contained catches of at least one of the four gadoid species in parentheses. The percentage of hauls with catches of at least one of the four gadoid species is high across all years for BT2 and TR2 gear types. BT1 shows more variation in the presence percentages, though the total number of sampled hauls for this fleet segment has been low (10 or less) for most years. TR1 shows an increasing trend in the percentage of hauls containing at least one of four species in the catch reaching 100% in 2025.

Table 1: *Total number of sampled hauls and percentage of hauls with catches of at least one of the four gadoid species (in parentheses) per fleet segment for 2019-2025.*

Year	BT1	BT2	TR1	TR2
2019	21 (62%)	237 (82%)	8 (38%)	46 (100%)
2020	10 (80%)	241 (82%)	22 (77%)	52 (100%)
2021	6 (67%)	250 (81%)	12 (58%)	71 (97%)
2022	4 (100%)	176 (85%)	14 (57%)	78 (97%)

2023	2 (100%)	143 (86%)	12 (75%)	85 (99%)
2024	2 (50%)	153 (90%)	26 (92%)	60 (100%)
2025	10 (100%)	178 (89%)	46 (100%)	114 (99%)
Total	**55**	**1378**	**140**	**506**

When comparing the catch composition of sampled hauls for the four gadoid species, it was found that whiting was the most frequently encountered species across the time series. Hauls containing whiting only (among the four gadoid species) were particularly common in BT2 (469 hauls) and TR2 (128 hauls). Furthermore, combinations of whiting-haddock, whiting-cod and whiting-haddock-cod were common in BT2 and TR2. Hauls containing haddock only was rare for all fleet segments. Saithe was only present in two hauls in the entire time series.

3.2.2 Simulation of RTC trigger events

The sampled hauls were used to simulate the RTC trigger events. The first step in the RTC control procedure is to determine whether the combined catch of whiting, haddock, cod and saithe exceeds the threshold of 200 kg. Figure 10 shows the percentage of the sampled hauls per year and fleet segment for which the combined catch of the four gadoid species was ≥200 kg.

Throughout the entire time series no hauls in BT1 met this criterion, while in TR1 only hauls from 2024 and 2025 contained ≥200 kg of the four gadoid species combined. In contrast, the proportion of hauls meeting the criterion increased over time in both BT2 and TR2, with TR2 gradually increasing since 2019 and BT2 showing a steep increase since 2022. By 2025, 21% of BT2 hauls and 40% of TR2 hauls contained ≥200 kg of the four gadoid species combined.

In total 189 out of the 2079 sampled hauls met the RTC trigger for sampling the haul. Of these, 79 occurred in BT2, 105 in TR2 and 5 in TR1.

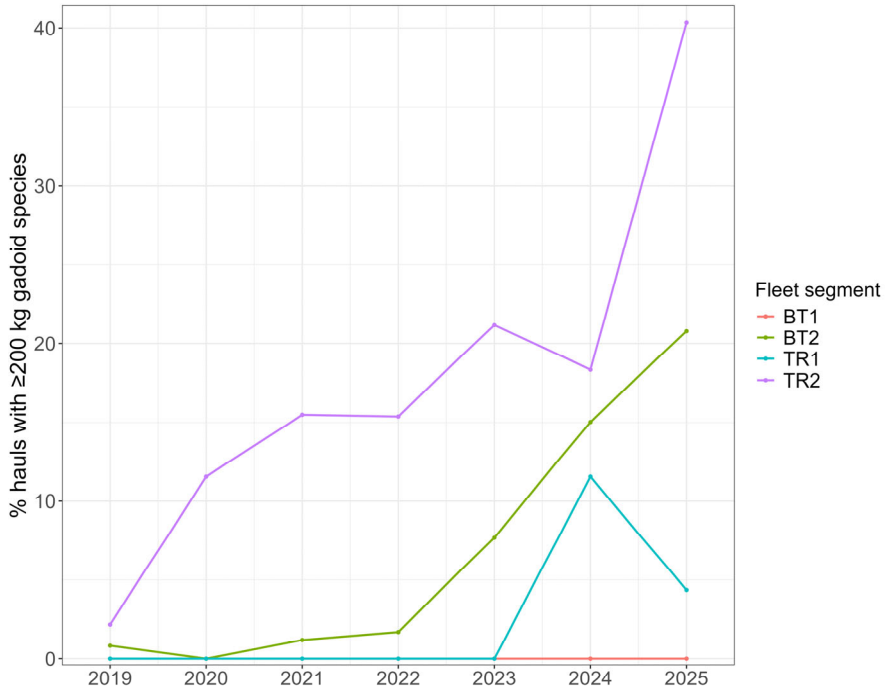


Figure 10: *Percentage of sampled hauls with ≥200 kg gadoid species (whiting, haddock, cod and saithe) in the catch per fleet segment and year.*

The next step in the RTC control procedure is to take a sample of the gadoid catch of at least 200kg and determine the percentage of juveniles by species and as a total of all four species. The catch level threshold for triggering an RTC is 10% by weight of juveniles as compared to the total of the four gadoid species. However, if the quantity of cod exceeds 75%, the trigger level for juveniles is 7.5%. Since 2026, the threshold of the quantity of cod in the haul has changed from 75% to 25% for catches between January and March (Council Regulation (EU) 2026/249). Juveniles are defined as individuals below the MCRS: 27 cm for whiting, 30 cm for haddock, and 35 cm for cod and saithe.

Out of 189 hauls with gadoids with ≥200 kg in the catch, a total of 182 hauls reached the threshold for triggering an RTC. All of these hauls met the condition of 10% by weight of juveniles, while there was no haul that met the condition of the quantities of cod in the catch. The share of juveniles in the 7 hauls which did not the threshold ranged from 0.5 to 9.7%. In hauls that met the conditions, the overall average juvenile percentage between 2019-2025 was 63.2% in BT2 and 65.1% in TR2. For TR1, data was available from only 5 hauls and juvenile percentages varied between 21-75%. Due to the low number of sampled hauls these are not further included in the results. Table 2 provides an annual summary per fleet segment with total number of hauls with ≥200 kg gadoid species and the number of hauls which reached the 10% juvenile threshold and the average juvenile percentage. The latter is calculated over all hauls with ≥200 kg gadoid species. For BT2 and TR2, the average juvenile percentages are high across years. In 2025, there is a lower average juvenile percentage with 43.6% for BT2 which is almost half of the amount in 2024. TR2 shows a gradual decrease since 2021, where the average was 91.2%, to 45.5% in 2025.

Table 2: *Annual summary of the number of hauls with ≥200 kg gadoid species, the number of hauls exceeding the juvenile threshold of 10% and the average juvenile percentage* for fleet segments BT2 and TR2 from 2019-2025. For empty fields there are no hauls with ≥200 kg in these years and fleet segments.*

Fleet segment		2019	2020	2021	2022	2023	2024	2025
BT2	**# hauls ≥ 200kg gadoid species**	2		3	3	11	23	37
	# hauls threshold 10% juveniles	2		3	3	11	23	31
	Average juvenile %	78.7		86.1	85.6	78.2	80.2	43.6
TR2	**# hauls ≥ 200kg gadoid species**	1	6	11	12	18	11	46
	# hauls threshold 10% juveniles	1	6	11	12	17	11	46
	Average juvenile %	68.5	87.3	91.2	88.3	78.5	61.1	45.5

* the average juvenile percentage is calculated from the total number of hauls with ≥200 kg gadoid species in the catch.

3.2.3 Species composition of hauls ≥200 kg gadoid species

When looking at the gadoid species composition of hauls with ≥200 kg gadoid species in the catch, the majority of hauls in BT2 are compiled of a combination of haddock and whiting (n = 39) or whiting only (n = 27). Cod is only present in combination with whiting (n = 5), and haddock and whiting (n = 8). In TR2 the majority of hauls contains cod, haddock and whiting (n = 51), followed by haddock and whiting (n = 23), whiting only (n = 23) and cod and whiting (n = 8). To gain more insight in the contribution of each species within the hauls and the contribution of juveniles per species, a summary of annual fleet segment estimates is provided in table 3.

The summary shows the proportion of each species relative to the total gadoid catch and the juvenile proportion of each species relative to the total catch of that species. Whiting is found to be the dominant species

throughout the time series and for both fleet segments. It ranges between 44.9 to 99.5% in BT2 and 42.5 to 100% in TR2. Haddock has a substantially lower share ranging between 0 to 54.7 for BT2 and 0 to 55.2% in TR2. Though cod is present for most years in TR2, the proportions of cod relative to the total gadoid catch are generally low, ranging between 0 to 2.29% in TR2. In BT2, cod proportions range between 0 and 2.09%.

The juvenile proportion of each species are relative to the total weight of that species in the catch. Overall, annual juvenile proportions are high for whiting and cod in both fleet segments. Haddock shows a decrease in the proportion of juveniles to total haddock catch in 2023-2025 in BT2 and 2024-2025 in TR2. Overall, proportions of whiting juveniles ranged from 75.9 to 90.6% in BT2 and 50.6 to 91% in TR2. Haddock juvenile proportions ranged from 5.7 to 100% in BT2 and 25.6 to 100% in TR2. Finally, cod juvenile proportions ranged from 65.9 to 100% in BT2 and 35.5 to 73.3% in TR2.

Table 3: *Annual fleet segment proportions of whiting, haddock and cod in the sampled hauls (hauls ≥200 kg), relative to the total gadoid catch (tonnes) sampled, and proportions of juvenile whiting, haddock and cod relative to the total weight of each species within the gadoid catch.*

Fleet	Year	Sampled hauls total gadoid catch (tonnes)	Whiting proportion	Haddock proportion	Cod proportion	Whiting juvenile proportion	Haddock juvenile proportion	Cod juvenile proportion
BT2	2019	0.6	99.5	0.0	0.5	78.2	-	100.0
	2020	-	-	-	-	-	-	-
	2021	0.9	72.9	26.6	0.5	90.6	78.3	100.0
	2022	0.7	97.3	0.6	2.1	86.0	100.0	100.0
	2023	3.3	75.2	24.8	0.0	84.9	66.4	-
	2024	9.4	89.0	11.0	0.0	87.1	26.4	-
	2025	16.7	44.9	54.7	0.3	75.9	5.7	65.9
TR2	2019	0.3	100.0	0.0	0.0	68.5	-	-
	2020	2.3	83.6	14.6	1.8	87.5	100.0	73.3
	2021	4.5	90.7	8.9	0.4	90.4	96.8	72.8
	2022	4.3	73.7	24.1	2.2	91.0	70.9	35.5
	2023	6.9	42.5	55.2	2.3	62.7	84.6	65.7
	2024	4.6	61.1	37.7	1.2	52.5	55.3	53.6
	2025	24.9	73.6	24.4	1.9	50.6	25.6	64.8

4 Discussion

This study set out to evaluate the current role and effectiveness of real-time closures (RTCs) for North Sea gadoids in light of recent stock developments, with a focus on whiting and haddock. The analysis combined fisheries-independent survey data (NS-IBTS) with commercial self-sampling data to assess (i) changes in spatial and size structure of populations, (ii) the distribution and overlap of juvenile fish, and (iii) the frequency and characteristics of simulated RTC trigger events. It highlights a significant shift (2015-2026) in the population dynamics of North Sea whiting and haddock compared to the period when the RTC regulation was first implemented (2010). Originally designed to protect the gadoid species at historically low levels, the current RTC framework now operates in a context of high productivity and expanding distributions for whiting and haddock.

The analysis of NS-IBTS data from 2016-2025 confirm that juvenile whiting and haddock are increasingly abundant and expanding in the North Sea. Juvenile whiting densities have surged in recent years, particularly in the central and southern North Sea. Similarly, juvenile haddock have not only increased in density but have also expanded their spatial range into the Skagerrak and further south in the North Sea throughout the time series, though recent years have shown a decreasing trend in juvenile abundance. These expansions are a direct result of strong recent recruitment and spawning stock biomass levels that are currently estimated to be well above MSY $B_{trigger}$. Importantly, juvenile overlap among gadoid species remained substantial in central North Sea areas, although the extent and spatial distribution varied over time.

The retrospective analysis of commercial catch data shows that there has been a steep increase since 2022 in the proportion of hauls meeting the ≥200 kg gadoid species sampling threshold, particularly in BT2 and TR2 fleet segments. By 2025, up to 40% of TR2 hauls met this threshold. Furthermore, within hauls containing ≥200 kg gadoid species, overall juvenile proportions were substantially higher than the 10% juvenile threshold set to trigger an RTC. Whiting was consistently the dominant component of the catch composition, followed by haddock. Cod occurred more sporadically and saithe was largely absent.

Taken together, these results indicate that the current RTC framework operates under substantially different stock conditions than when it was introduced. Since the introduction, whiting and haddock have recovered considerably, resulting in higher abundance, broader spatial distributions and increasing frequency of commercial catches with large quantities of gadoids in the catch. At the same time, juvenile proportions were consistently high in commercial catches throughout the time series. Consequently, RTC trigger events may occur more frequently due to an increase in overall growth of the populations rather than a shift towards younger fish.

From an RTC perspective, this implies that the rationale for protecting juvenile aggregations remains unchanged, as juveniles continue to represent a consistent fraction of catches. These findings suggest that the current framework for RTCs should be reassessed to ensure it remains effective under the current stock conditions. Increasing the juvenile threshold, for example from 10% to 25%, may have limited effect as juvenile proportions exceed 43% in both BT2 and TR2 fleet segments in 2025 and even higher in other years for those hauls where the ≥200 kg gadoid threshold was reached. This suggests that adjustments to the percentage threshold alone may not substantially change RTC outcomes under current high-abundance conditions.

Alternative approaches could therefore be considered. One option would be to reassess the inclusion of individual species withing the RTC framework and potentially move to species-specific frameworks. Such an approach could allow RTCs to remain focused on stock components where juvenile protection is most critical, such as cod. RTC threshold triggers could then be evaluated to species-specific levels as the retrospective analysis in this study has shown that cod thresholds (25 and 75% contribution of cod weight relative to the total gadoid weight in the haul) are not reached. An effective way could be to move to an adaptive framework linking stock status indicators. For example, the application of RTC measures could be reconsidered when

spawning stock biomass falls below defined reference levels ($MSYB_{trigger}$), or when fishing mortality approaches F_{MSY} levels. Furthermore, future studies could evaluate whether the current MCRS remains a suitable approach for defining juveniles, particularly under changing stock conditions where growth and maturation patterns may shift over time.

Finally, the seasonal patterns observed in juvenile distributions suggest that temporally targeted closures could provide an alternative to year-round measures. While this approach may be less suitable for juvenile whiting which are widespread with high abundance, it could improve efficiency for species with stronger seasonal aggregation patterns such as haddock. In addition, the spatial distribution of juveniles could be added into the RTC framework by identifying persistent juvenile hotspots, where high densities or multi-species aggregations occur. This could support a more adaptive approach where RTCs are triggered in areas of demonstrated biological importance. Overall, the results indicate that RTCs remain a valuable management tool, but that their implementation could benefit from greater flexibility to account for changes in stock status, species-specific dynamics, and spatial-temporal variation in juvenile distributions.

5 Quality Assurance

Wageningen Marine Research utilises an ISO 9001:2015 certified quality management system, certified since February 27, 2001 by DNV. ISO 9001 is an international standard for quality management, focused on the continuous improvement of processes and ensuring customer satisfaction.

The quality of all test methods used at the chemical and benthos laboratory of Wageningen Marine Research is guaranteed in various ways:

- First-line control: Control samples are taken with each series of measurements to immediately verify correctness and accuracy.
- Second-line control: An independent internal check is carried out by a colleague to provide additional assurance of calculations, input, and plausibility.
- Third-line control: The accuracy of analysis methods is regularly tested externally through participation in interlaboratory tests or proficiency tests.

Information on the performance characteristics of analytical methods are available from the laboratory upon request. In the event of uncontrolled quality, appropriate corrective measures will be taken.

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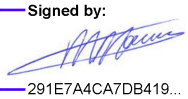
ICES 2025. Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK). ICES Scientific Reports. 07:57, 1122 pp. https://doi.org/10.17895/ices.pub.29085995

Justification

Report: C059/26
Project Number: 4318100589

The scientific quality of this report has been peer reviewed by a colleague scientist and a member of the Management Team of Wageningen Marine Research

Approved:	L. van de Pol MSc Researcher
Signature:	Ondertekend door: lennert van de Pol FE91EAD7DDB249C...
Date:	16 July 2026

Approved:	Cas Wiebinga, PhD Business Manager Projects i.a. Dr. A.M. Mouissie
Signature:	Signed by:  291E7A4CA7DB419...
Date:	16 July 2026

Annex 1 Length distribution

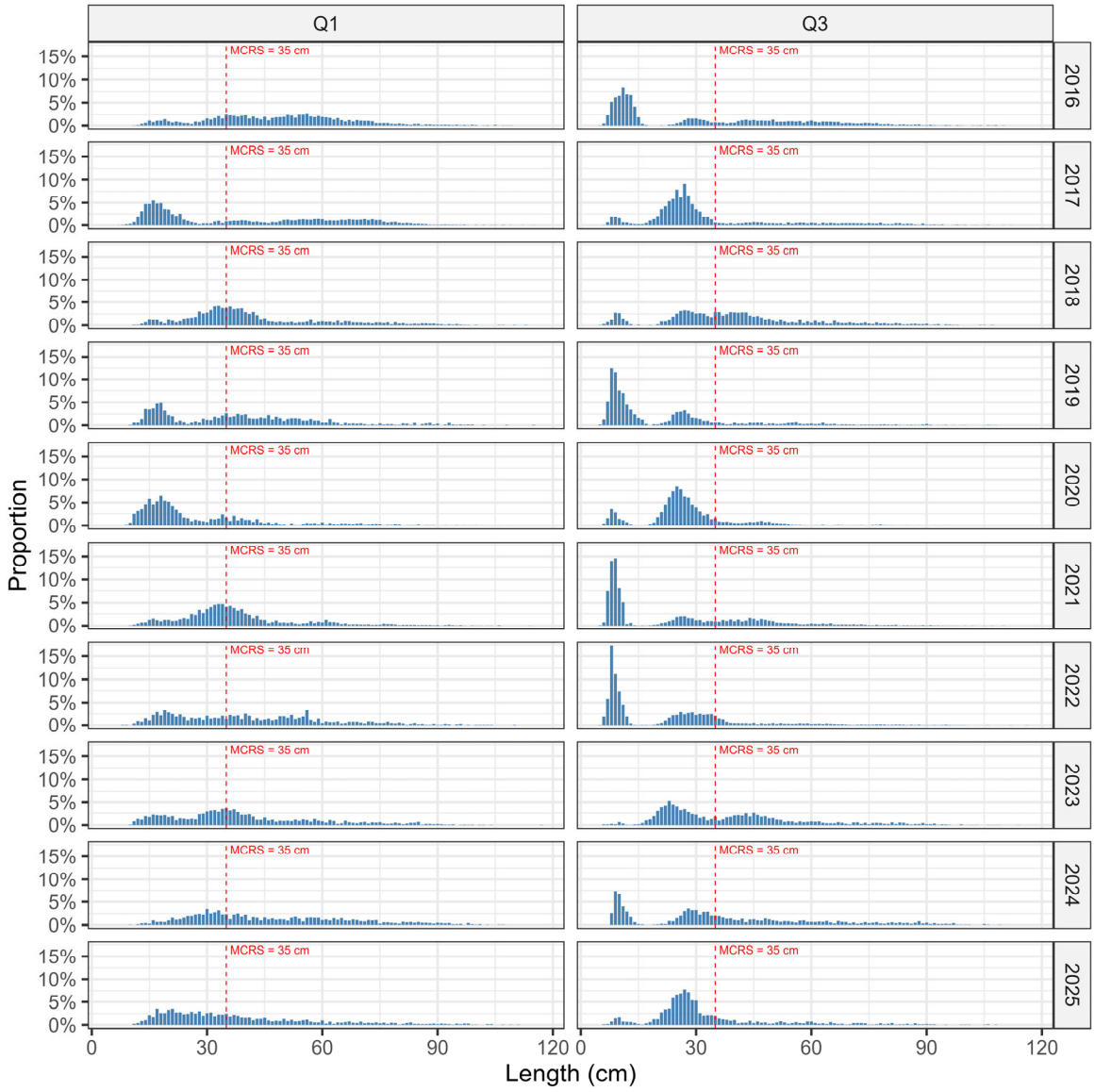


Figure A1.1: *Cod length frequency distribution NS-IBTS Q1 (left panel) and Q3 (right panel) from 2016-2025. MCRS (35 cm) is indicated by the red dotted line.*

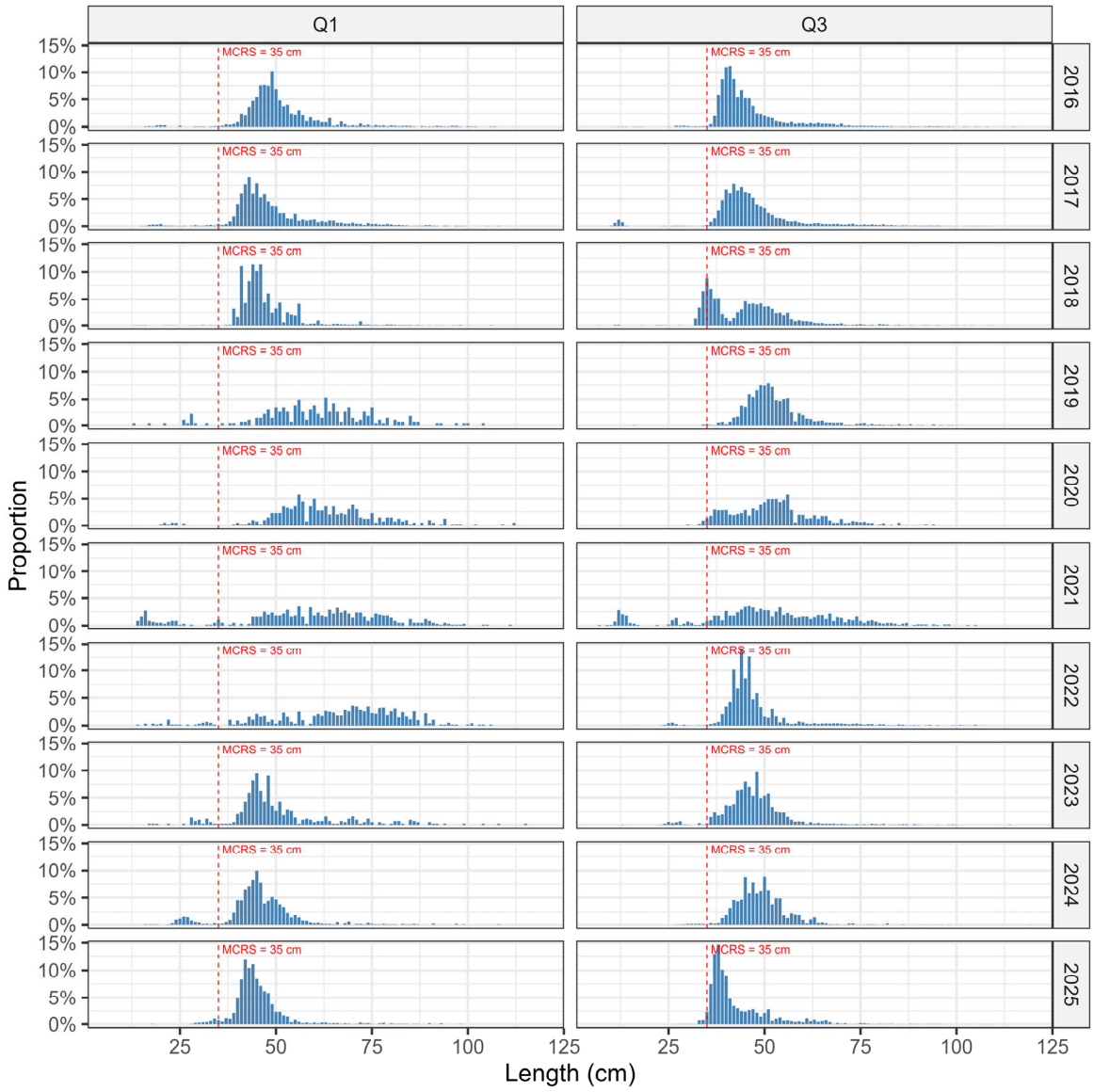


Figure A1.2: *Saithe length frequency distribution NS-IBTS Q1 (left panel) and Q3 (right panel) from 2016-2025. MCRS (35 cm) is indicated by the red dotted line.*

Annex 2 Spatial distribution

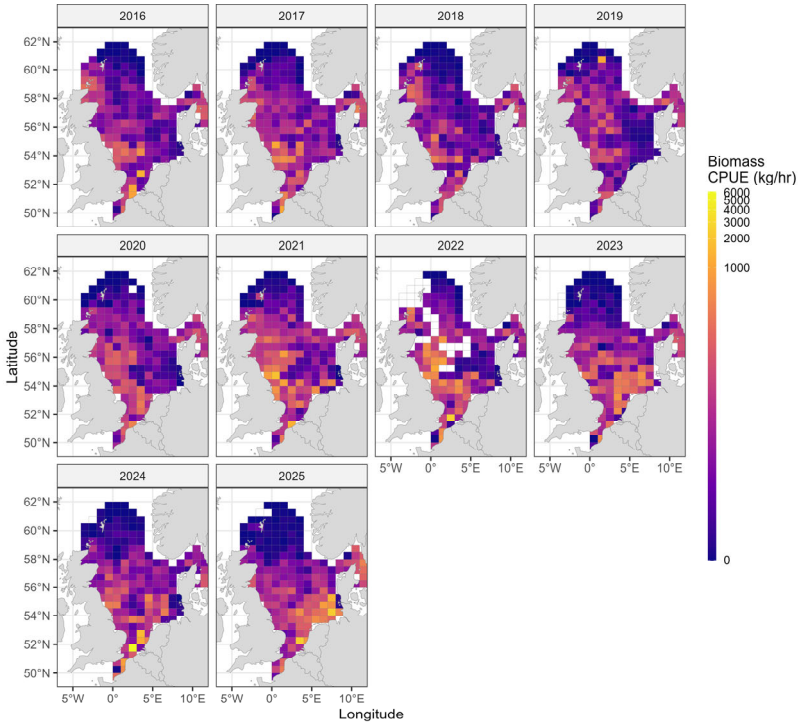


Figure A2.1: *Spatial distribution of juvenile whiting (< 27 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q1 for 2016-2025.*

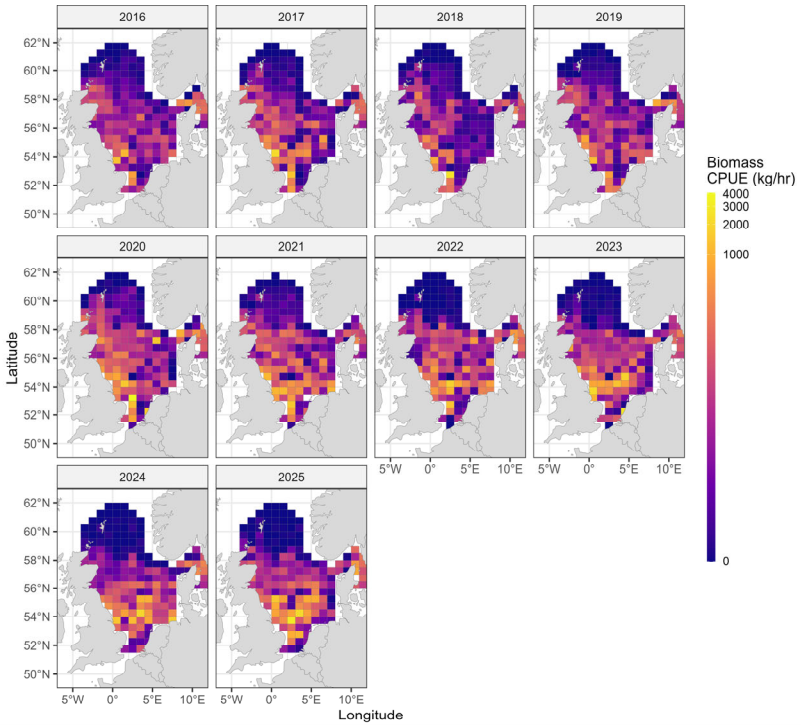


Figure A2.2: *Spatial distribution of juvenile whiting (< 27 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q3 for 2016-2025.*

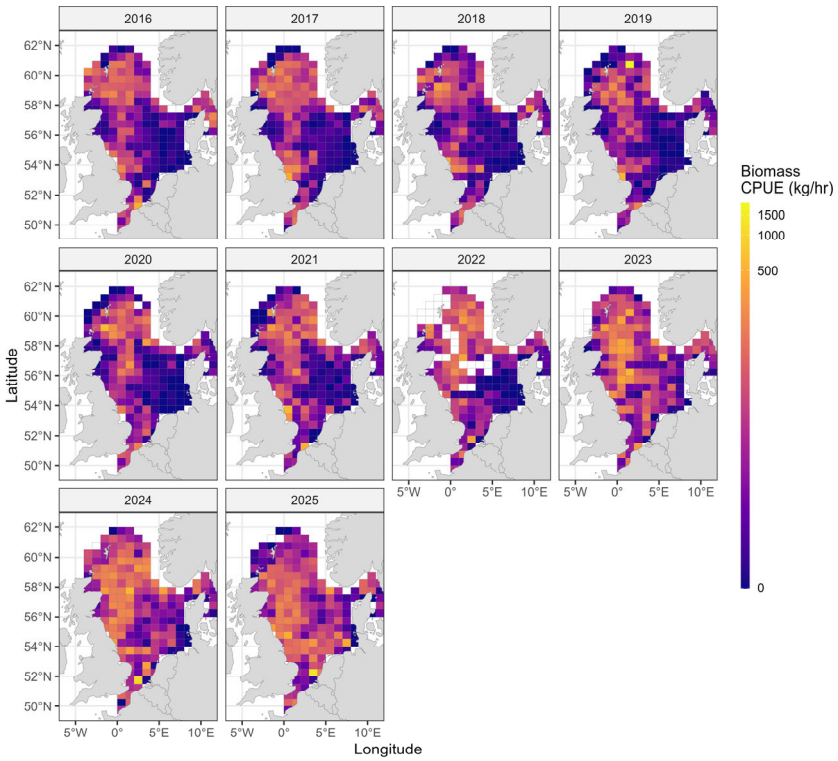


Figure A2.3: *Spatial distribution of adult whiting (≥ 27 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q1 for 2016-2025.*

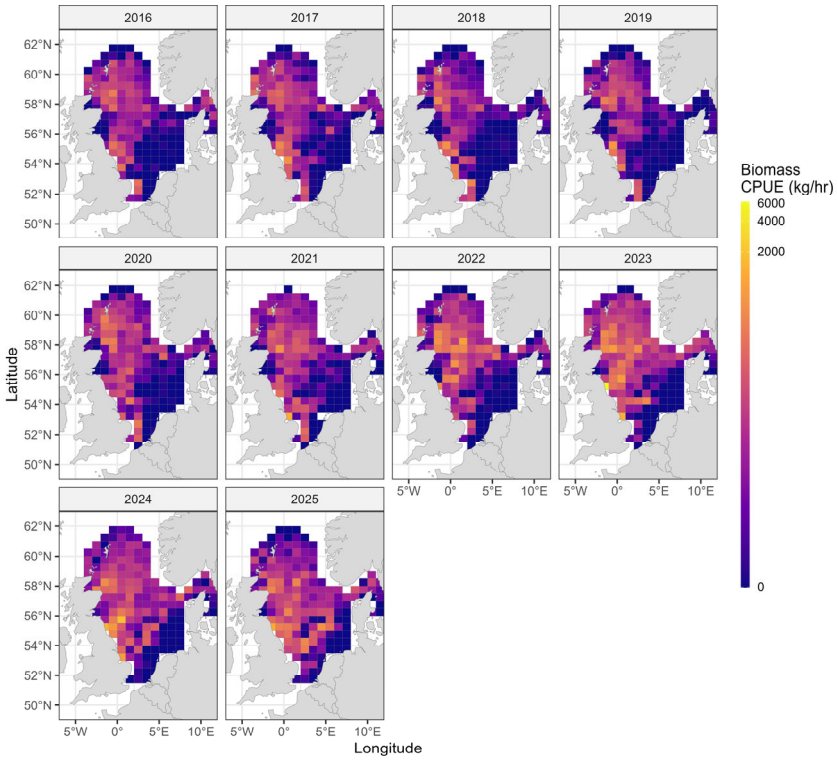


Figure A2.4: *Spatial distribution of adult whiting (≥ 27 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q3 for 2016-2025.*



Figure A2.5: *Spatial distribution of juvenile haddock (< 30 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q1 for 2016-2025.*

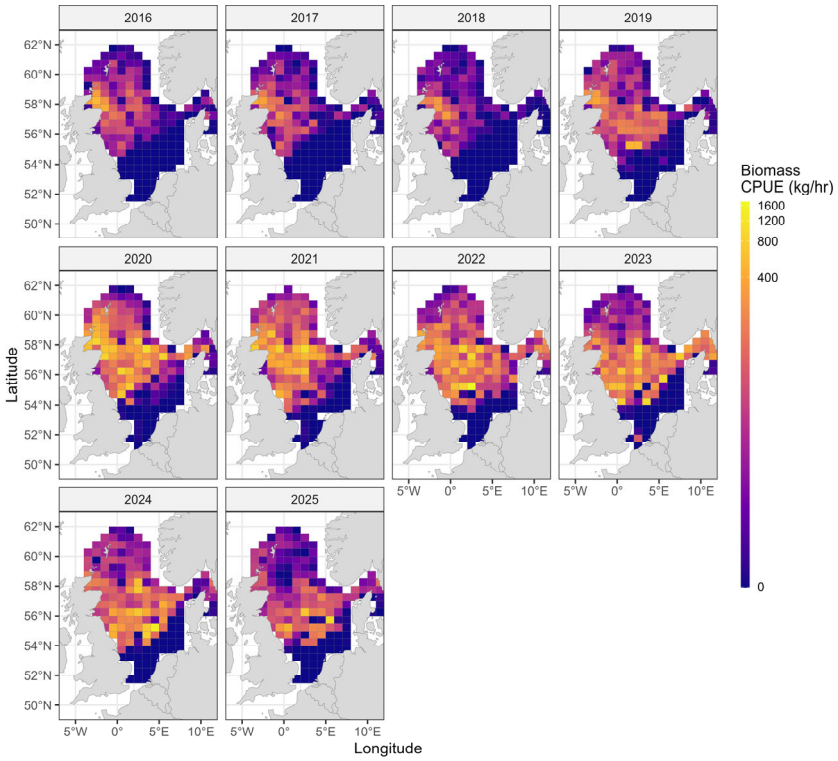


Figure A2.6: *Spatial distribution of juvenile haddock (< 30 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q3 for 2016-2025.*

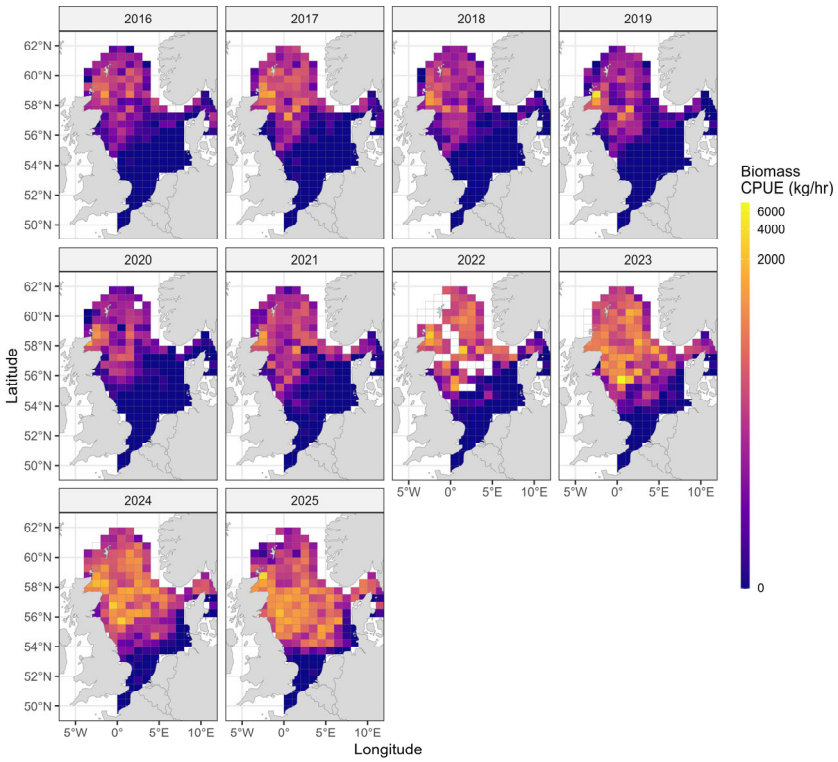


Figure A2.7: *Spatial distribution of adult haddock (≥ 30 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q1 for 2016-2025.*

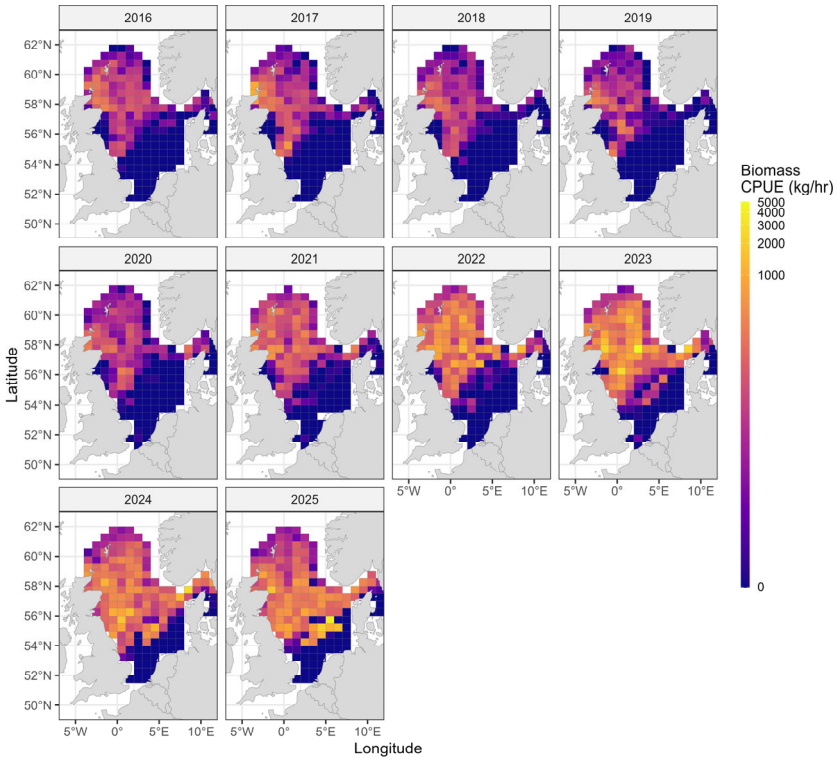


Figure A2.8: *Spatial distribution of adult haddock (≥ 30 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q3 for 2016-2025.*

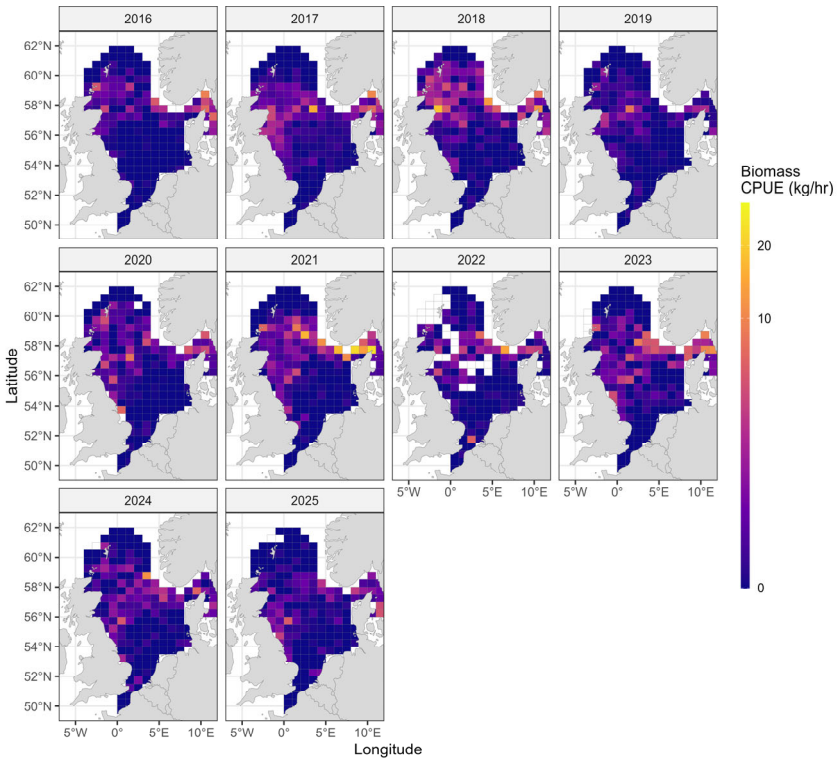


Figure A2.9: *Spatial distribution of juvenile cod (< 35 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q1 for 2016-2025.*

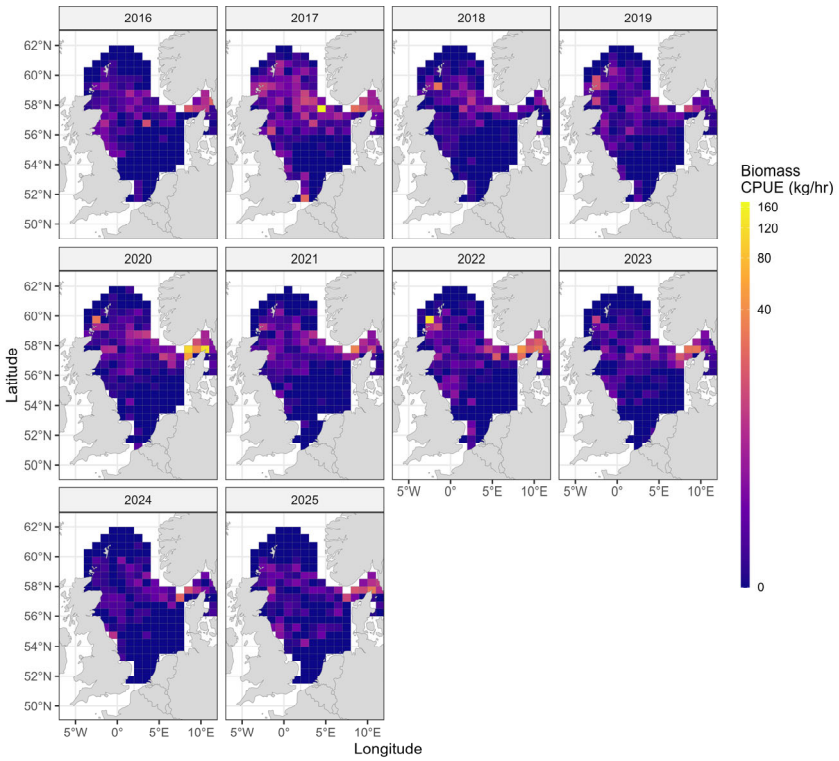


Figure A2.10: *Spatial distribution of juvenile cod (< 35 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q3 for 2016-2025.*

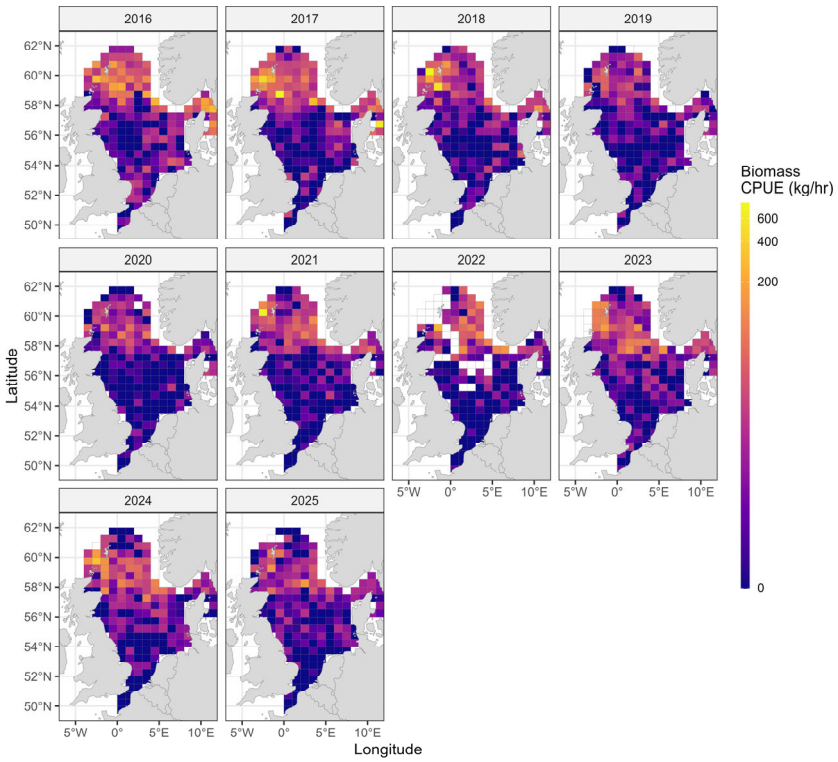


Figure A2.11: *Spatial distribution of adult cod (≥ 35 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q1 for 2016-2025.*

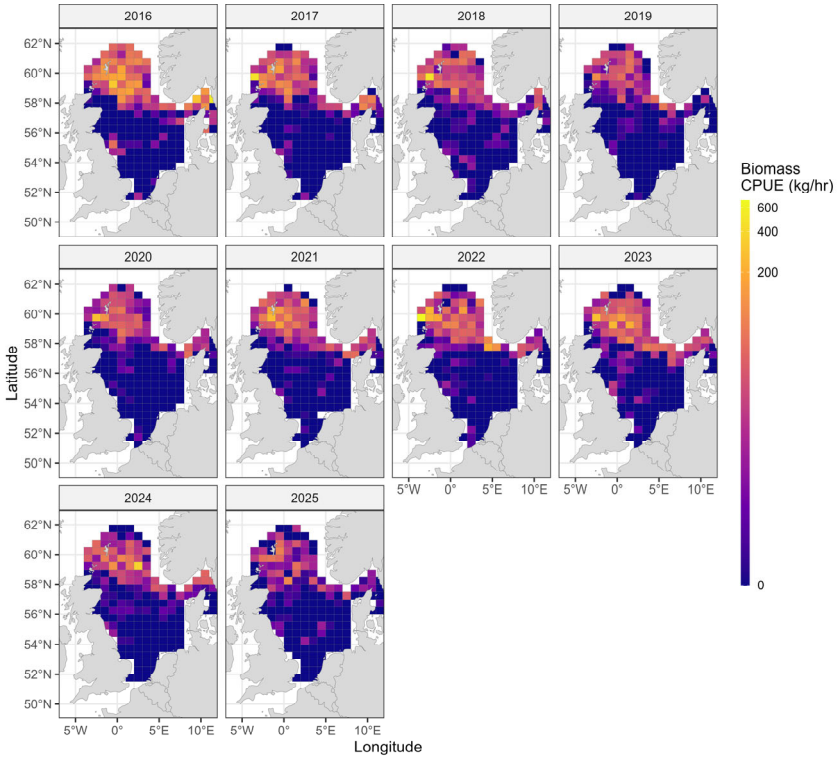


Figure A2.12: *Spatial distribution of adult cod (≥ 35 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q3 for 2016-2025.*

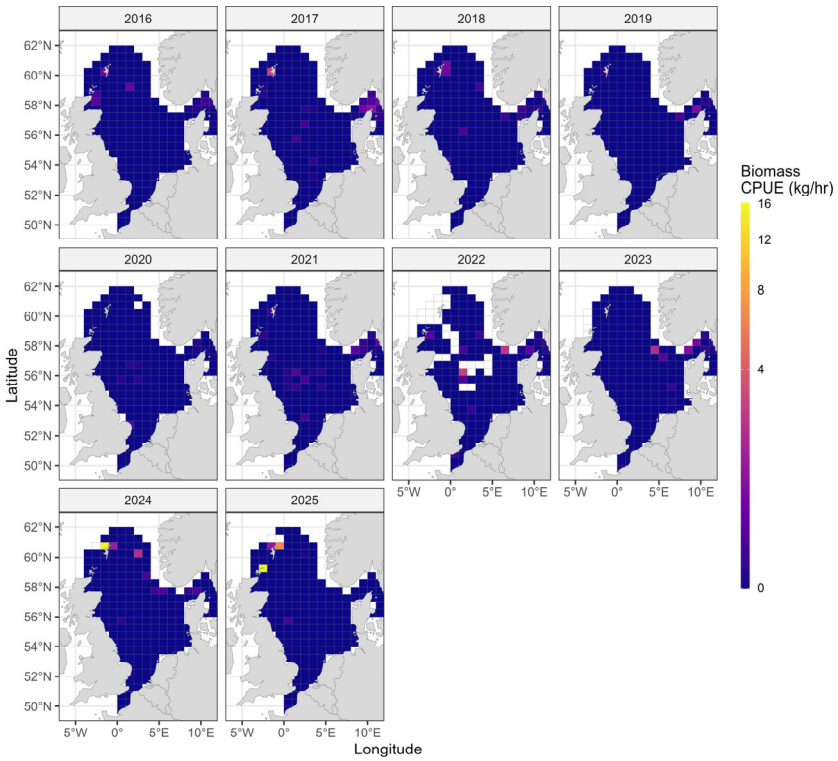


Figure A2.13: *Spatial distribution of juvenile saithe (< 35 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q1 for 2016-2025.*

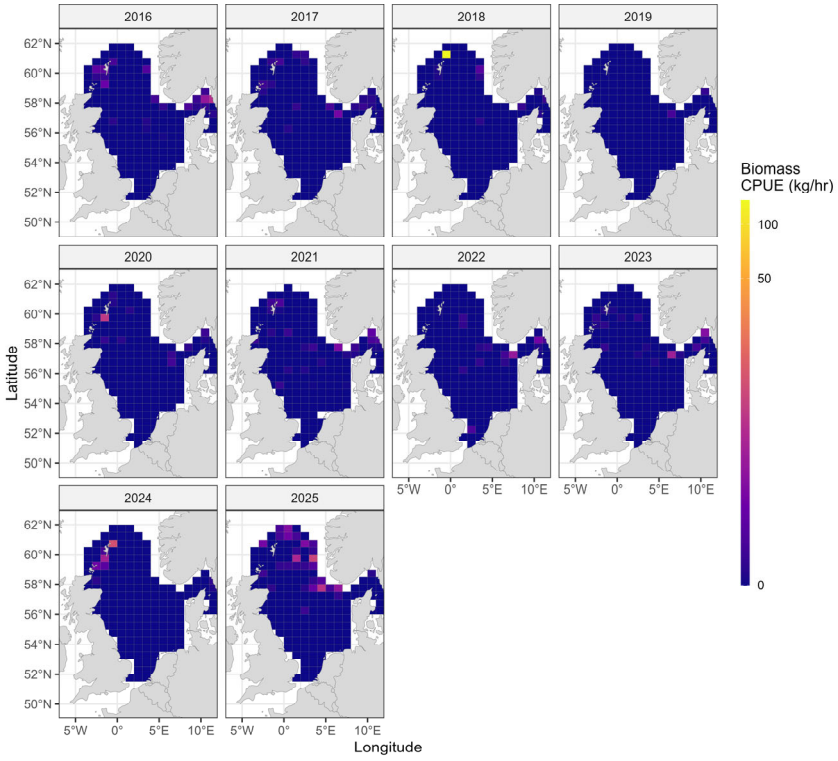


Figure A2.14: *Spatial distribution of juvenile saithe (< 35 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q3 for 2016-2025.*

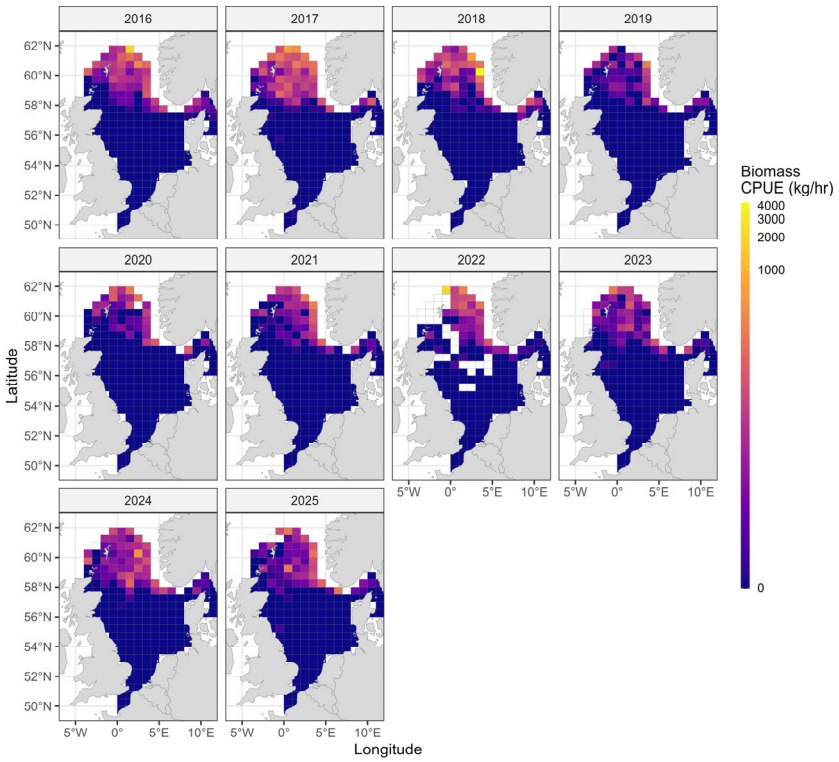


Figure A2.15: *Spatial distribution of adult saithe (≥ 35 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q1 for 2016-2025.*

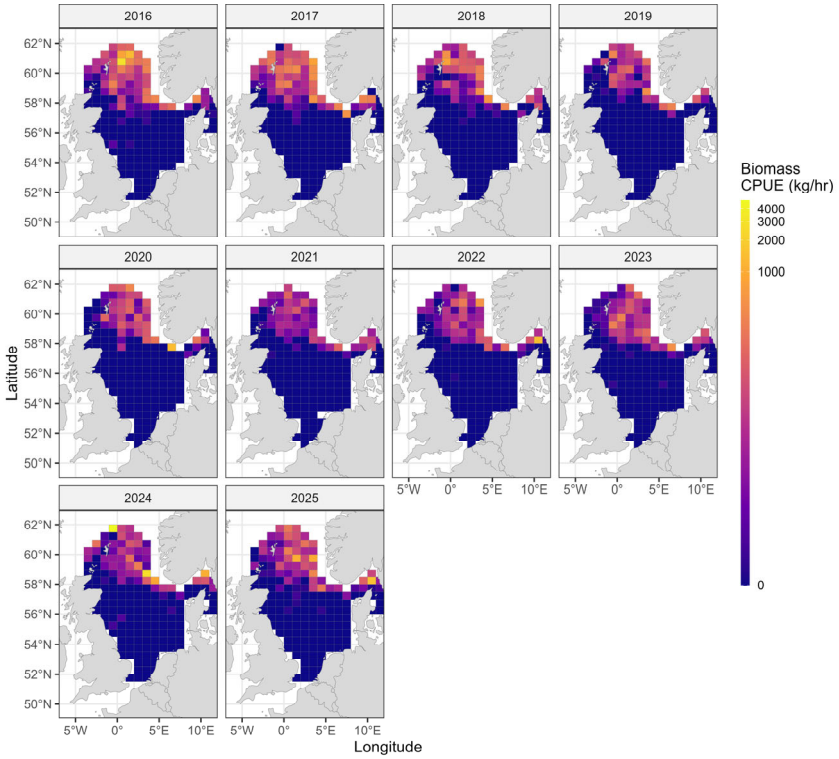


Figure A2.16: *Spatial distribution of adult saithe (≥ 35 cm, MCRS) in the Greater North Sea Ecoregion. Average CPUE (kg h^{-1}) from the NS-IBTS-Q3 for 2016-2025.*

To explore the potential of nature to improve the quality of life



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