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Analysis of the Flemish Cap cod fishery: monitoring of the consequences of the management decisions

by

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Abstract

The objective of this document is to present the necessary information to the SC to monitor the consequences of the implementation in 2021 by the Commission of the technical measures in fisheries targeting cod in Div. 3M. The technical measures implemented were the closure of the cod directed fishery in Div. 3M in the first quarter of the year and the use of sorting grids in the cod trawl fishery. Data from the haul by haul database in the period 2016-2024 provided by the NAFO Secretariat have been used to study the situation before (2016-2020) and after (2021-2024) the measures were in place in the cod directed fisheries and in the fisheries with bycatch of cod. Also, the length and age distributions used in the assessment of this stock have been analysed.

It should be noted that, apart from the technical measures implemented since 2021, in the 2021-2023 period the TAC of 3M cod suffered a large reduction due to the stock situation. This large reduction in the TAC may interfere in the interpretation of the changes observed in the fisheries after 2021.

Prior to 2021, most of the cod catches from the directed fisheries were taken in the first quarter and in the east and southwest of the bank by the longliners and in the southwest by the trawlers. Since 2021 catches are mainly taken in the second quarter and they are concentrated in the central part of Flemish Cap bank for the lonliners and in the southwest of Flemish Cap for the trawlers. Almost 100% of the cod catches made with longline gear have been made in hauls targeting cod before and after the technical measures were implemented. In the case of cod catches made in trawl hauls targeting cod that percentage dropped from over 94-97% in the 2016-2020 period to 76-86% in the 2021-2024 period. No significant change has been observed after the implementation of the technical measures in the catch composition and bycatch levels of the hauls directed to cod by longliners. In the case of the trawlers, an increase in redfish bycatches has been observed in sets targeting cod after implementing the technical measures. In both directed fisheries, longliners and trawlers, the percentage of catches and effort inside the VME polygons in 2021-2024 is much lower than in 2016-2020. No hauls have been performed inside the closed areas.

The cod bycatch in the longline hauls targeting other species is negligible in the whole period 2016-2024. Cod bycatch in trawl hauls targeting other species, mainly redfish, increased significantly after the technical measures were implemented, mainly in 2022 and 2024. No major change has been observed in the spatial-temporal pattern of sets catching cod as bycatch before and after the implementation of the technical measures. The impact on VMEs of longline sets catching cod as bycatch is minimal in both periods. Regarding the trawl hauls catching cod as bycatch, it should be noted the increase in effort carried out within the VME polygons after the implementation of the measures.

From the analysis of the total length and age distribution of the cod catches, no significant changes have been observed before and after implementing the technical measures. In the case of trawl catches, a slight decrease can be observed in the catches of individuals smaller than 41 cm and those aged 3 and younger.

Introduction

In 2020 the Commission adopted technical measures, in force since January 2021 (NAFO, 2021a), to try to protect the productivity of Division 3M cod stock. These measures include the closure of the directed fishery of the 3M cod during the first quarter of the year, as well as the mandatory use of sorting grids in this fishery. The NAFO CEM establishes in its article 5 the closure of the cod directed fishery in Div. 3M during the first quarter and in its article 13 that "*Each Contracting Party shall ensure that its trawl vessels conducting a directed fishery for cod in Division 3M, use a sorting grid for the purpose of reducing the catches of smaller individuals of cod. The minimum bar spacing of the sorting grid shall be 55 mm. The sorting grid must be placed in the top-side panel of the trawl preceding the codend"*.

To study the effects of these management measures, the Commission made a Request during September 2020 as: *The Commission requests Scientific Council, jointly with the Secretariat, to conduct ongoing analysis of the Flemish Cap cod fishery data by 2022 in order to:*

a. *monitor the consequences of the management decisions (including the analysis of the redistribution of the fishing effort along the year and its potential effects on ecosystems, the variation of the cod catch composition in lengths/ages, and the bycatch levels of other fish species, benthos in general, and VME taxa in particular), and*
b. *carry out any additional monitoring that would be required, including Div. 3M cod caught as bycatch in other fisheries during the closed period.*

The SC responded in 2021 (NAFO, 2021b) that as only one year of data with the new measures was available for this evaluation by June 2022, the analysis that SC would present in 2022 would have to be completed in subsequent years as the relevant dataset increases. The evaluation will compare the situation before and after the measures were in place, and will include analyses of, at least, the following aspects:

- Fishing pattern (e.g. spatial and temporal distribution of catch and effort).
- Impact of the fishing activity on VMEs.
- Length / age composition of the cod catch.
- Bycatch levels of 3M cod and distribution in other fisheries.
- Bycatch levels of other species in the 3M cod fishery.

The SC responded in 2022 (NAFO, 2022) that the analysis of the Flemish Cap cod fishery data was postponed until two years of haul by haul data are available following the implementation of the management measures, and proposed monitoring the consequences of management decisions every two years afterward, if required.

In 2023, the analysis requested by the Commission was presented (Garrido *et al.*, 2023) and the SC, based on this analysis, responded as follows to the Commission request: "*After the implementation of the technical measures, changes have been observed in the size and age composition of the catches. The decrease in small sizes and young ages in trawler catches could be related to the sorting grids. The rest of the observed changes are more difficult to interpret and associate with any of the technical measures.*

In addition to the technical measures implemented since 2021, substantial reductions in TAC of Div. 3M cod were made. This may affect the results of this analysis. In order to assess the effects of the technical measures, a longer observation period is needed. An updated analysis will be provided in 2025, consistent with the two-year advice interval previously defined."

The Commission requested SC (Commission Request #9) in 2024 that ongoing analyses of cod fishery data from the 3M Division be carried out by 2025 in order to:

a) monitor the consequences of the management decisions (including the analysis of the redistribution of the fishing effort along the year and its potential effects on ecosystems, the variation of the cod catch composition

in lengths/ages, and the bycatch levels of other fish species, benthos in general, and VME taxa in particular); and

b) carry out any additional monitoring that would be required, including Division 3M cod caught as bycatch in other fisheries during the closed period.

The aim of this document is to present the necessary information so that the SC can prepare the answer to Commission Request 9.

Material and Methods

Data from the haul by haul (HxH) database provided by the NAFO Secretariat have been used to study the effort, catch and bycatch of the different fisheries that caught cod in NAFO Division 3M. As the HxH database is only fully available since 2016, data from 2016 to 2024 were used. To the database used in the 2023 analysis (Garrido *et al.*, 2023), the data for 2023-2024 have been added. From the HxH database, the hauls corresponding to Div. 3M with cod catches in the period 2016-2024 were selected. From this set of hauls, a debug similar to that made by Garrido *et al.* (2020a) was performed. As part of the data debug, trawl hauls with negative effort or greater than 24 hours have been removed. Removals of this type had a great impact on the percentage of data analysed in 2021 due to the low number of total sets. Table 1 contains the HxH information analysed in this document. It contains the total number of hauls and the total catch of cod in the HxH database. The table also shows the data kept after the preliminary analysis. The number of hauls analysed are between 43% in 2021 and 99% in 2016, and the catches of cod analysed represent a percentage of the total that oscillates between 49% in 2021 and 100% in 2016.

The entire analysis was made for the directed fisheries (trawl and longline) and for the non-directed fisheries catching cod as bycatch in NAFO Div. 3M. It is considered that a haul is targeting a particular species when, as defined in Article 5.2 of the NCEM, this species represents the highest percentage, in weight, in the total catch of the haul. The rest of the species that appear in the total catch composition of the haul are considered bycatch of the directed fishery.

The total length and age composition of the catches used as inputs in the stock assessment of 3M cod (Garrido *et al.*, 2025) were analysed before and after implementing the management measures to study the consequences of the implementation of those measures on the size and age composition of the catch.

In the NRA there are defined Vulnerable Marine Ecosystems (VMEs) polygons from seven indicator species of VMEs: sponges, small gorgonians, large gorgonians, sea pens, black corals, bryozoans and boltenia. Both bryozoans and boltenia are not present in the Flemish Cap area (NAFO, 2020). The VMEs polygons (outside the closed areas, where no fishing is carried out) are the ones that have been used to study the impact of the fishing activity on VMEs.

It is remarkable that no bycatch of benthos is registered in the analyzed HxH data, which means that the analysis of the bycatch of benthos in general, and VMEs in particular, cannot be addressed in this analysis with these data.

Despite that, the position of the sets in the map reveals that some sets are conducted inside VME polygons (but outside the closed areas). The analysis of the evolution of the effort in the VME polygons, if it has increased or decreased since the technical measures are in force, may be considered as an indicator of the potential effects on VMEs as a result of the redistribution of the effort due to the application of these technical measures.

Results

General analysis of the cod fisheries in 3M

Garrido *et al.* (2020b) described as follows the cod fisheries in the Flemish Cap: *There are two fisheries targeting cod that carry out more than the 90% of the annual total catches, the first with trawlers (around 65%) and the second with longliners (around 30%). There is another fishery (mainly redfish fishery) that catches cod as by-catch*

(around 5%). The main part of the annual total catches of cod in Div. 3M takes place in the first quarter (around 65%). Catches of the second (around 20%) and third quarters (around 10%) are considerably smaller and practically residual in the fourth quarter (around 5%).

Table 2 shows the total catches of cod in Div. 3M in the analyzed data by year and gear, as well as the percentage carried out by each fishing gear by year. It can be observed that annual cod catches in Div. 3M have been quite variable due to the state of the stock and have declined markedly in the 2021-2023 period. These catches have been made with two different gears (trawl and longline) and the annual percentage that each gear represents to the total has also varied substantially in the period analyzed. The longline percentage depends on Norway, that fishes one year with longliners and the next one with trawlers. The percentage of longline in the total catch in the 2016-2020 period varied between 28-39%, with the exception of 2017 when it was only 8%. In the period 2021-2024, the percentage of total catches made by the longliners (35-49%) has been a bit larger than in previous years in the analyzed data.

1.) Monitoring the cod target fisheries in Div. 3M

Catches and bycatch analysis

Table 3 contains, by year and gear, the total catch in tons of cod in the area in the data analyzed, as well as the catch of the hauls directed to cod in tons and in percentage of the total catch and the bycatch in tons of cod in hauls not targeting cod by gear and year. This table shows that 3M cod is caught with two different gears: longline and trawl. Most of these catches are taken in directed fisheries. Around 100% of the longline cod catches were obtained in hauls targeting cod in both periods. Regarding the trawl catches, in the 2016-2020 period the directed fishery has always represented, at least, the 94% over the total, while in the 2021-2024 period it dropped to 75-86%. In the period 2016-2020 the percentage of directed cod catches over the total is greater than 96% while in the period 2021-2024 this percentage has dropped to 85-92%.

Bycatch levels of other species in the 3M cod target fisheries.

Table 4 and Figure 1 present the species catch composition in the cod directed longline fishery in 3M. In this fishery, cod represents between 94% of the catch in 2024 and 99% in 2016 to 2018. The level of bycatch of other species in the 2016-2020 period ranged from 3% to less than 1% of the total catch, while in the 2020-2024 period it was between 3-6%. The Atlantic halibut is the main bycatch of this fishery, representing less than 1% of the cod fishery catch in the 2016-2020 period and between 2-4% in the 2021-2024 period. It seems to be a slight increase in the level of bycatch since 2021 of the main species in the bycatch, the Atlantic halibut.

Table 5 and Figure 2 present the catch composition in the directed cod trawl hauls in Div. 3M. It can be observed that in the period 2016-2020, the percentage of bycatch varied between 4 and 9% and the main species caught as bycatch was redfish with percentages from 2 to 7%. In the 2021-2024 period, the bycatch percentage was between 7 and 18%, remained the redfish as main bycatch species with percentages between 8 and 14% over the past three years. In this case there is a clear increase in the percentage of the bycatch in the total catch after establishing the technical measures.

Fishing pattern (e.g. spatial and temporal distribution of catch and effort).

Figure 3 shows the maps with the distribution of hauls directed to cod by year and gear for the period 2016-2020 and 2021-2024. A decrease in the number of sets of longline and trawl fisheries targeting cod in the period 2021-2023, due to the decrease in the TAC, can be observed. This reduction had the effect of concentrating sets in a much smaller area than in the 2016-2020 period, especially in the trawl fishery. A shift of effort from the southwest to the center of the Flemish Cap following the implementation of technical measures can also be observed, mainly in the longline fishery.

Table 6 shows the percentage of the annual cod catches and effort by quarter for directed Div. 3M cod fisheries for the period 2016-2024 based on the HxH information. The effort is measured in hours and number of hauls for the trawl fishery and in number of hauls for longline, since the duration of the sets is not an adequate

measure of the effort for this gear and the number of hooks by haul is not available in the HxH. Percentages are estimated relative to the total values (catch or effort) of the directed fishery by gear and year.

According to Table 6 and Figure 4, in the period 2016-2020 the main part of the annual cod catches in the directed fisheries in Div. 3M took place in the first quarter. Catches of the second and third quarters were considerably smaller and practically residual in the fourth quarter. In the period 2021-2023, after the reduction of catches and the implementation of technical measures, almost 100% of the longline effort and catches were made in the second quarter whereas in 2024 catches are more evenly distributed among the different quarters, although the second quarter is still the one with the highest percentage (around 70%). In the trawl directed fishery the second quarter presented the highest percentage of catches in the 2021-2024 period. In general, effort is more spread out among the different quarters than catches.

Impact of the fishing activity on VMEs.

As commented before, the analysis of the evolution of the effort in the VME polygons may be considered as an indicator of the potential effects on VME. The analysis of the catches inside the VME polygons is also presented.

Table 7 contains, by year and gear, the catch of cod and effort (both in absolute numbers and percentage over the total of each year and gear) of hauls directed to cod that have been conducted inside the polygons of each VME indicator species. It must be noted that the hauls are inside the polygons, but outside the VMEs closed areas. Since some polygons are superposed and each haul is considered only once for the total, the total may not represent the sum of each VME indicator species. Figure 5 presents the percentage of cod catches and effort of the hauls directed to cod by year and gear made in the different polygons of each VME indicator and Figure 6 shows the maps with the positions of the cod directed hauls by year and gear that have been made in the different VME polygons of Flemish Cap.

In general, the percentage of catches and effort in the VME polygons of the longliners are much lower than those observed in the trawl fishery. This lower percentage of catches and effort in the VME polygons of the longline with respect to the trawl fishery is distributed among more VME indicator species. Since the technical measures are in force, a sharp decline of effort and catches was observed inside the VME polygons for the directed fishery with both gears. In the case of the longline sets, it falls to 1% of catch and effort in 2022, being negligible in 2021 and in the 2023-2024 period. In the previous period, the effort and catches made in the VME polygons were between 5-10%, with the polygons related to sea pens being the most affected. Regarding the trawl directed fishery, effort and catches decreases to less than 5% in the period 2021-2024, with the small gorgonian polygons in 2024 being the most affected (3.2%). In the period prior to the establishment of the technical measures, trawl catches in the VME polygons were around 20-30% and effort 15-25%, being the polygons related to the large gorgonians the most affected. This polygon, related with the closed area 13, coincides in part with the area of the southwest of the Flemish Cap in which Garrido *et al.* (2020b) located areas of large concentrations of spawning individuals during the first quarter of the year.

2.) Monitoring the cod caught as bycatch in other fisheries in Div. 3M

Catches and bycatch analysis

According to Table 3, almost 100% of the cod catches made with longline gear have been made in hauls targeting cod before and after the technical measures were implemented. Therefore, the analysis of cod bycatch in other fisheries will focus on trawl fisheries, although some information about the longline fishery is shown. The bycatch of cod in trawl fisheries directed to species other than cod in the period 2016-2020 oscillates in percentage between 6%, in 2020, and 3%, in 2017 and 2019. This percentage of cod bycatch increased to around 25% per year in the period 2021-2022 and around 15% in the period 2023-2024. In absolute numbers, this means that the catches of Atlantic cod in Div. 3M made by other trawl fisheries in the analyzed data account for between 190 and 375 tons annually in the period 2016-2020, and between 80 and 1055 tons annually in 2021-2024.

Bycatch levels of cod 3M in fisheries targeting other species

Table 8 shows the cod catches and effort of the trawl hauls targeting other species by year. The annual percentage of the different fisheries relative to the annual total cod caught as bycatch in other fisheries is also presented in this table and in Figure 7.

the directed redfish trawl fishery is the one that catches the highest percentage of cod as bycatch. In the period 2016-2020 the annual percentage is above 94% in all the years while in 2021 that percentage is 55% and almost 100% in 2022-2024 period. The second fishery catching cod as bycatch is the witch flounder fishery with much lower percentages, around 4%, during the period 2016-2020 and with a much higher percentage (45%) in 2021. In the period 2022-2024 the second fishery is the Greenland halibut but with a very small amount (less than 1%).

It is important to highlight the large increase of the number of sets in 2022-2024, when cod was caught as bycatch mainly in the redfish fishery. In that period more than twice hauls were observed with cod bycatch than the average number of sets observed in 2016-2020. A similar effect can be observed in the cod catch as bycatch, with 555 tons caught in 2022 and 1055 in 2024, which are much more than the average observed in the 2016-2020 period (275 tons). This clear increase in the absolute level of cod catch and hauls as bycatch in 2022 and 2024 period could be explained partly by the implementation of technical measures and partly by the increase in the TAC of redfish.

Fishing pattern

Table 9 and Figure 8 presents the annual cod catches and effort of the trawl hauls targeting other species by year and the catch and effort percentage by quarter relative to the annual total. Figure 9 shows the maps distribution of hauls catching cod as bycatch by year and fishery for the periods 2016-2020 and 2021-2024.

In both periods, the sets of longlines with cod catches as bycatch are very few. In the trawl fisheries targeting other species, the quarters with the highest percentages of cod bycatch are the first and third quarters in the 2016-2020 period. These are the quarters with the greatest effort in the redfish fishery in Flemish Cap. In the 2021-2024 period it is much more variable and with more effort and catch spread over more quarters.

Figure 9 does not show great changes in the spatial distribution of cod bycatch sets before and after the implementation of the technical measures, that more or less coincide with the spatial distribution of the redfish fishery. What can be seen in 2022-2024 is an increase in cod bycatch sets in the southwest of Flemish Cap that was not observed in previous years.

Impact of the fishing activity on VMEs.

Table 10 shows, for the hauls catching cod as bycatch, the annual cod bycatch and effort and their proportion by gear, year and VME indicator for the period 2016-2024. As happens in the fisheries targeting cod, it is important to point out that the different polygons that delimit the VME of the different indicator species overlap in some cases, so the same haul information can appear in the estimates of several VME at the same time. Therefore, the total effort and catches do not have to coincide with the sum of the hauls of the different VMEs. Moreover, there are not hauls inside the closed areas.

Figure 10 presents the percentage of the cod bycatch and effort (number of hauls), by year, gear and VME indicator, over the total of the hauls targeting other species with bycatch of cod. And Figure 11 shows the map with the positions of hauls made by other fisheries with bycatch of cod in the VMEs polygons for the period 2016-2024.

In the case of the longline fisheries with bycatch of cod in the period 2016-2020, it has already been commented that the annual cod bycatch is minimal. Of this minimal part, the percentages caught within the VME is cero except in 2018 where 74% of that small catch was made within the VME polygon of large gorgonians. In the period 2021-2024, there was no longliners cod bycatch within the VME polygons.

In the case of trawl fisheries targeting other species, the percentage of effort of the trawl hauls targeting other species with bycatch of cod in the VME polygons in the period 2016-2020 oscillates between 14% in 2019 and 25% in 2016, almost all corresponding to effort made inside the VME polygons of large gorgonians and

sponges. In 2021-2024, this percentage increased, mainly in 2022 where 45% of the sets with cod bycatch were made within the VME polygons of sponges and large gorgonians.

Regarding the catches in the period 2016-2020, the annual percentage of cod bycatch within VME is highly variable, between 7% in 2016 and 28% in 2018. Most of these annual percentages occur in the VME polygons of large gorgonians and sponges. In the period 2021-2024, this percentage was between 15% in 2023 and 25% in 2022 and most of these annual percentages also occur in the VME polygons of large gorgonians and sponges.

3.) Analyses of the cod catch composition in lengths and ages

Trawl and longline catches length distributions for the total fishery (directed and bycatch) are available for several countries, used for getting the total length distribution of the total catch of 3M cod (Garrido *et al.*, 2025). Figure 12 shows, for the period 2016-2024, the cod catches length distribution by year for the longliners, trawlers and total catches. In this figure it can be seen that the 2016 length distribution is quite different from those observed later, especially for the trawl and total length distributions. The average percentages by length observed in each period were calculated to obtain the average length distributions of the two periods (2016-2020 and 2021-2024) for the longliners, trawlers and total catches (Figure 13 and Table 11).

Figure 13 and Table 11 show no major changes in the size distributions of longliners and trawlers before and after implementing the technical measures. In the lengths of the trawler catches, a small decrease in the average number of individuals smaller than 41 cm (minimum landing size, fork length) was observed, from 5% to less than 1% after implementing the technical measures. The total length distribution of the two periods is more similar to the distribution observed in the trawlers, as expected due to their contribution to the total.

Figure 14 and Table 11 present the mean annual length observed in the cod catches of longliners, trawlers and total catches. A general decreasing trend can be observed in the longline catches through the entire period 2016-2020, being the mean length by period lower after the implementation of the technical measures (2021-2024). In trawlers the changes are not so clear, with similar values in both periods except in 2021 when an increase occurred. As with the length distributions, the mean length of the total catches closely resembles those observed in trawlers due to the higher percentage of this gear in the total catches.

Figure 15 shows the age composition in percentage of the annual catches of longliners, trawlers and total for the period 2016-2024. These compositions by age are quite variable between the years for both the longline and the trawl before implementing the technical measures. In the 2016-2019 period, catches in the trawl fishery were clearly influenced by the 2011 cohort; in the longline fishery, the influence of this cohort on catches was not as clear. After the implementation of technical measures, the age composition of catches is more stable and does not show significant annual changes in both trawl and longline fisheries, although it can be observed that in general the longline catches older individuals in higher percentages.

In the case of the longliners, the percentage of young ages (1-3 years) in the catches is small and similar before (2016-2020) and after (2021-2024) the implementation of the technical measures, 2.2% and 1.0% respectively. The intermediate ages (4-5 years) increased considerably after implementing the technical measures from 10% to 21%, while for older ages decreased from 87% to 77%. The pattern in trawl catches is similar for intermediate and older ages, however, in this case a decrease in the percentage of young ages is observed after implementing the technical measures (2021-2024) from 8% to 2.3%. As expected, the pattern of total catches is more similar to that observed in trawl catches.

Figure 16 presents the mean age observed in the cod catches of longliners, trawlers and total catches for both periods. It can be observed that the longliners catch older fish than the trawlers in both periods. The ages caught in the post-period are slightly younger than those caught before the implementation of the technical measures. However, in the case of the trawlers, a decrease in catches of younger ages (1-3) is observed after the implementation of the measures.

Conclusions

It should be noted that, apart from the technical measures implemented since 2021 (the closure of the directed fishery of the 3M cod during the first quarter, as well as the mandatory use of sorting grids in the cod trawl directed fishery), in the 2021-2023 period the TAC of 3M cod suffered a large reduction due to the stock situation. This large reduction in the TAC may interfere in the interpretation of this analysis, erroneously attributing some of the observed changes in the fishery to the implementation of technical measures.

Cod directed fisheries in Div. 3M

Catches and bycatch analysis: Almost 100% of the cod catches made with longline gear have been made in hauls targeting cod before and after the technical measures were implemented. In the case of cod catches made in trawl hauls targeting cod that percentage dropped from over 94% in the 2016-2020 period to around 75% in the 2021-2022 period and to around 85% in the 2023-2024 period. The differences in the percentage between the period 2021-2022 and 2023-2024 may be due to the low levels of TACs approved in the first period, but what seems clear is that after the introduction of the technical measures the percentage of annual cod caught as bycatch in trawl fisheries targeting other species has increased.

Bycatch levels of other species in the 3M cod directed fisheries: No significant change has been observed after the implementation of the technical measures in the catch composition and bycatch levels of the hauls directed to cod by longline. In the case of trawl, an increase in the bycatch percentage has been observed in sets targeting cod after the implementation of the measures, and this increase is more evident in the 2023-2024 period and especially in the percentage of redfish caught.

Fishing pattern (e.g. spatial and temporal distribution of catch and effort):

Prior to 2021, most of the cod catches from the directed fisheries were taken in the first quarter and in the east and southwest of the bank for the longliners and in the southwest for the trawlers. Since 2021, the longliners catches are mainly taken in the second quarter and they are concentrated in the central part of Flemish Cap while the trawler catches are more evenly distributed between the second, third and fourth quarters in the southwest of Flemish Cap. What has been observed is that in the 2021-2023 period the sets are in a much smaller area in the south and center of Flemish Cap than in the 2016-2020 period and in 2024, especially in the trawl fishery. This spatial concentration may be influenced by declining TACs in the 2021-2023 period rather than being exclusively the consequence of the implementation of sorting grids or temporary closure.

Impact of the fishing activity on VMEs: In both directed fisheries, longliners and trawlers, the percentage of catches and effort inside the VME polygons (outside the closed areas) in 2021-2024 is much lower than in 2016-2020. This could mean that the conservation measures for 3M cod have a favorable impact in the conservation of the VMEs.

Cod caught as bycatch in other fisheries in Div. 3M

Catches and bycatch analysis: The bycatch of cod when operating with longline gears is negligible in the whole period 2016-2024. Cod bycatch in trawl hauls targeting other species increased significantly after the technical measures were implemented, mainly in 2021-2022.

The redfish fishery catches practically all the cod that has been caught as bycatch before and after implementing the technical measures. To highlight, the increase in total cod catches in this fishery observed in 2022 and mainly in 2024. Part but not all of this increase in 2024 could be explained by the increase in the redfish TAC.

Fishing pattern (e.g. spatial and temporal distribution of catch and effort): Small changes have been observed in the spatial-temporal pattern of sets catching cod as bycatch before and after the implementation of the technical measures, mainly in the trawl fishery. In both periods, the sets of longliners with cod catches as bycatch are very few. In the trawl fisheries targeting other species, the quarters with the highest percentages of cod bycatch are the first and third quarters in the 2016-2020 period and are much more evenly distributed in the second, third and fourth quarters after the technical measures have been

implemented. What has been observed is an increase in the number of cod bycatch sets in the southwestern part of the Flemish Cap in the 2022-2024 period.

Impact of the fishing activity on VMEs: The impact on vulnerable marine ecosystems of longline sets catching cod as bycatch is minimal in both periods. Regarding the trawl hauls catching cod as bycatch, it should be noted the increase in effort carried out within the VME polygons, mainly of sponges and large gorgonians polygons, in the southwestern part of the Flemish Cap after implementing the technical measures.

Analyses of the cod catch composition in lengths and ages.

The analysis of the catches length distributions shows no major changes in the size distributions of longliners and trawlers before and after implementing the technical measures. In the lengths of the trawl catches, a small decrease in the average number of individuals smaller than 41 cm (minimum landing size, fork length) was observed.

The catches age compositions are quite variable between the years for both the longline and the trawl before implementing the technical measures. In the 2016-2019 period, catches in the trawl fishery were clearly influenced by the 2011 cohort; in the longline fishery, the influence of this cohort on catches was not as clear. After the implementation of technical measures, the age composition of catches is more stable and does not show significant annual changes in both trawl and longline fisheries.

Acknowledges

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Tables

Table 1. Original haul by haul Division 3M cod information (number of hauls and cod catches) and the information used in the analyses after the debug process (number of hauls, cod catches and their percentage relative to the original information).

	Total hauls (n)	Total Catch (t)	Kept hauls (n)	Kept Catch (t)	Kept hauls (%)	Kept Catch (%)
2016	1 903	11 198	1 885	11 146	99%	100%
2017	1 462	9 956	1 327	7 326	91%	74%
2018	2 595	10 526	2 486	9 717	96%	92%
2019	3 638	15 991	3 247	15 002	89%	94%
2020	1 314	7 684	1 291	7 619	98%	99%
2021	760	1 365	328	671	43%	49%
2022	2 069	3 937	1 911	3 712	92%	94%
2023	1494	4 383	1195	3303	80%	75%
2024	2 960	10 082	2 871	9 864	97%	98%

Table 2. Division 3M cod catches (tons) by year and gear and their annual percentage by gear from the haul by haul analyzed data.

Year	OTB	%	LL	%	Total
2016	7505	67%	3642	33%	11147
2017	6718	92%	608	8%	7326
2018	6431	66%	3286	34%	9717
2019	10806	72%	4196	28%	15002
2020	4648	61%	2971	39%	7619
2021	340	51%	331	49%	671
2022	2243	60%	1469	40%	3712
2023	2002	61%	1302	39%	3304
2024	6397	65%	3467	35%	9864

Table 3. Division 3M cod total catches (tons), directed catches (tons) and bycatch (tons) by year and gear and the annual percentage of the directed catches relative to the annual total catches by year and gear of the haul by haul analyzed data.

	Gear	Total Catch (t)	Directed Catch (t)	Bycatch (t)	Directed Catch (%)
2016	LL	3642	3641	0	100%
2017		608	608	0	100%
2018		3286	3284	2	100%
2019		4196	4196	0	100%
2020		2971	2971	0	100%
2021		331	331	0	100%
2022		1469	1469	0	100%
2023		1302	1302	0	100%
2024		3467	3467	0	100%
2016	OTB	7505	7197	308	96%
2017		6718	6528	190	97%
2018		6431	6057	375	94%
2019		10806	10530	276	97%
2020		4648	4374	273	94%
2021		340	260	80	76%
2022		2243	1687	556	75%
2023		2002	1726	276	86%
2024		6397	5341	1055	84%
2016	Total	11147	10838	308	97%
2017		7326	7136	190	97%
2018		9717	9340	377	96%
2019		15002	14726	276	98%
2020		7619	7345	273	96%
2021		671	590	80	88%
2022		3712	3156	556	85%
2023		3304	3028	276	92%
2024		9864	8808	1055	89%

Table 4. Catch composition by species and year (total and percentage) and annual effort (number of hauls) of the longline cod directed hauls in Division 3M of the analyzed data.

		Species	Catch (t)	Catch (%)	Effort (n Hauls)
LL	2016	COD	3641	99.3%	214
		HAL	20	0.6%	
		Others	6	0.2%	
	2017	COD	608	99.3%	30
		HAL	4	0.7%	
		Others	0	0.0%	
	2018	COD	3284	99.5%	167
		HAL	11	0.3%	
		Others	7	0.2%	
	2019	COD	4196	98.5%	239
		HAL	28	0.7%	
		Others	35	0.8%	
	2020	COD	2971	97.3%	207
		HAL	27	0.9%	
		Others	56	1.8%	
	2021	COD	331	96.4%	17
		HAL	10	2.8%	
		Others	3	0.8%	
	2022	COD	1469	97.2%	93
		HAL	29	1.9%	
		Others	14	0.9%	
	2023	COD	1302	95.0%	65
		HAL	42	3.1%	
		Others	27	2.0%	
	2024	COD	3467	94.4%	196
		HAL	150	4.1%	
		Others	58	1.6%	

Table 5. Catch composition by species and year (total and percentage) and annual effort (number of hauls and hours) of the trawl cod directed hauls in Division 3M of the analyzed data.

		Species	Catch (t)	Catch (%)	Effort (h)	Effort (n Hauls)
OTB	2016	COD	7192	96%	4123	961
		RED	140	2%		
		PLA	70	1%		
		WIT	44	1%		
		HAL	25	0%		
		Others	20	0%		
	2017	COD	6522	95%	3746	931
		RED	209	3%		
		PLA	48	1%		
		WIT	16	0%		
		HAL	30	0%		
		Others	18	0%		
	2018	COD	6057	91%	5777	1423
		RED	440	7%		
		PLA	75	1%		
		WIT	40	1%		
		HAL	52	1%		
		Others	20	0%		
	2019	COD	10530	94%	11142	2216
		RED	315	3%		
		PLA	170	2%		
		WIT	43	0%		
		HAL	92	1%		
		Others	46	0%		
	2020	COD	4374	92%	3119	756
		RED	196	4%		
		PLA	104	2%		
		WIT	44	1%		
		HAL	34	1%		
		Others	12	0%		
	2021	COD	260	93%	223	51
		WIT	6	2%		
		RED	5	2%		
		HAL	2	1%		
		PLA	1	0%		
		Others	6	2%		

	2022	COD	1687	90%	1098	247
		RED	151	8%		
		HAL	5	0%		
		PLA	4	0%		
		WIT	2	0%		
		Others	36	2%		
	2023	COD	1726	86%	1116	228
		RED	218	11%		
		HAL	9	0%		
		PLA	28	1%		
		WIT	0	0%		
		Others	24	1%		
	2024	COD	5341	82%	6391	1126
		RED	882	14%		
		HAL	67	1%		
		PLA	80	1%		
		WIT	17	0%		
		Others	112	2%		

Table 6. Percentage of cod catches and effort relative to annual catch and effort of the hauls targeting cod by year, gear and quarter.

		LL				OTB					
	Quarter	Y Catch	Q Catch (%)	Y Effort (n Hauls)	Q Effort (% n Hauls)	Y Catch	Q Catch (%)	Y Effort (h)	Q Effort (% h)	Y Effort (n Hauls)	Q Effort (% n Hauls)
2016	1st	3641	87.3%	214	76.6%	7192	59%	4123	28%	961	39%
	2nd		12.1%		14.5%		19%		38%		33%
	3rd		0.6%		8.9%		19%		28%		23%
	4th						3%		7%		6%
2017	1st	608	100.0%	30	100.0%	6522	59%	3746	39%	931	46%
	2nd						24%		33%		32%
	3rd						11%		21%		15%
	4th						7%		8%		6%
2018	1st	3284	71.8%	167	60.5%	6057	45%	5777	34%	1423	36%
	2nd		28.2%		39.5%		27%		30%		28%
	3rd						16%		21%		19%
	4th						13%		15%		17%
2019	1st	4196	59.1%	239	47.3%	10530	31%	11142	24%	2216	26%
	2nd		14.4%		16.3%		32%		27%		27%
	3rd		26.0%		36.0%		9%		24%		20%
	4th		0.5%		0.4%		29%		26%		27%
2020	1st	2971	54.1%	207	36.7%	4374	58%	3119	44%	756	51%
	2nd		41.9%		53.1%		21%		18%		17%
	3rd		4.1%		10.1%		17%		30%		24%
	4th						5%		8%		7%
2021	1st	331		17		260		223		51	
	2nd		100.0%		100.0%		63%		56%		69%
	3rd						12%		5%		4%
	4th						25%		40%		28%
2022	1st	1469		93		1687		1098		247	
	2nd		100.0%		100.0%		50%		36%		43%
	3rd						27%		33%		32%
	4th						23%		32%		24%
2023	1st	1302		65		1726		1116		228	
	2nd		99.5%		98.5%		55%		38%		
	3rd		0.5%		1.5%		26%		34%		
	4th						19%		28%		
2024	1st	3467		196		5341		6391		1126	
	2nd		71.1%		73.5%		57%		47%		49%
	3rd		11.5%		12.8%		18%		21%		21%
	4th		17.4%		13.8%		25%		32%		30%

Table 7. Cod catch and effort (both in absolute numbers and percentage over the total of each year and gear) of hauls directed to cod in VME polygons by year and gear.

		LL				OTB					
	VME	Catch (t)	Catch (%)	Effort (n Hauls)	Effort (% n Hauls)	Catch (t)	Catch (%)	Effort (h)	Effort (% h)	Effort (n Hauls)	Effort (% n Hauls)
2016	Black Corals	0	0.0%	0	0.0%	9	0.1%	5	0.1%	1	0.1%
	L. Gorgonians	91	2.5%	5	2.3%	1888	26.2%	381	9.2%	142	14.8%
	Sea Pens	101	2.8%	4	1.9%	5	0.1%	1	0.0%	1	0.1%
	S. Gorgonians	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	Sponges	1	0.0%	1	0.5%	363	5.0%	94	2.3%	27	2.8%
	TOTAL	**193**	**5.3%**	**10**	**4.7%**	**2264**	**31.5%**	**481**	**11.7%**	**171**	**17.8%**
2017	Black Corals	22	3.7%	2	6.7%	5	0.1%	12	0.3%	2	0.2%
	L. Gorgonians	0	0.0%	0	0.0%	2262	34.7%	730	19.5%	222	23.8%
	Sea Pens	8	1.4%	1	3.3%	5	0.1%	6	0.2%	2	0.2%
	S. Gorgonians	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	Sponges	0	0.0%	0	0.0%	61	0.9%	42	1.1%	11	1.2%
	TOTAL	**31**	**5.0%**	**3**	**10.0%**	**2334**	**35.8%**	**789**	**21.0%**	**237**	**25.4%**
2018	Black Corals	14	0.4%	1	0.6%	1	0.0%	2	0.0%	1	0.1%
	L. Gorgonians	86	2.6%	14	8.4%	1134	18.7%	744	12.9%	216	15.2%
	Sea Pens	147	4.5%	10	6.0%	2	0.0%	5	0.1%	1	0.1%
	S. Gorgonians	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	Sponges	0	0.0%	0	0.0%	19	0.3%	14	0.2%	4	0.3%
	TOTAL	**247**	**7.5%**	**25**	**15.0%**	**1155**	**19.1%**	**765**	**13.2%**	**222**	**15.6%**
2019	Black Corals	46	1.1%	2	0.8%	1	0.0%	2	0.0%	1	0.1%
	L. Gorgonians	75	1.8%	4	1.7%	1828	17.4%	1229	11.0%	266	12.0%
	Sea Pens	160	3.8%	7	2.9%	0	0.0%	0	0.0%	0	0.0%
	S. Gorgonians	0	0.0%	0	0.0%	2	0.0%	9	0.1%	4	0.2%
	Sponges	24	0.6%	1	0.4%	52	0.5%	55	0.5%	12	0.5%
	TOTAL	**305**	**7.3%**	**14**	**5.9%**	**1882**	**17.9%**	**1295**	**11.6%**	**283**	**12.8%**
2020	Black Corals	111	3.8%	3	1.5%	0	0.0%	0	0.0%	0	0.0%
	L. Gorgonians	7	0.2%	3	1.5%	1216	27.8%	605	19.4%	163	21.6%
	Sea Pens	157	5.3%	9	4.4%	21	0.5%	12	0.4%	2	0.3%
	S. Gorgonians	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	Sponges	0	0.0%	0	0.0%	71	1.6%	52	1.7%	10	1.3%
	TOTAL	**275**	**9.3%**	**15**	**7.3%**	**1308**	**29.9%**	**669**	**21.5%**	**175**	**23.2%**
2021	Black Corals	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	L. Gorgonians	0	0.0%	0	0.0%	12	4.6%	4	1.8%	1	2.0%
	Sea Pens	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	S. Gorgonians	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	Sponges	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	TOTAL	**0**	**0.0%**	**0**	**0.0%**	**12**	**4.6%**	**4**	**1.8%**	**1**	**2.0%**
2022	Black Corals	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	L. Gorgonians	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	Sea Pens	18	1.2%	1	1.1%	0	0.0%	0	0.0%	0	0.0%
	S. Gorgonians	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	Sponges	0	0.0%	0	0.0%	5	0.3%	5	0.5%	1	0.4%
	TOTAL	**18**	**1.2%**	**1**	**1.1%**	**5**	**0.3%**	**5**	**0.5%**	**1**	**0.4%**
2023	Black Corals	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	L. Gorgonians	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	Sea Pens	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	S. Gorgonians	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	Sponges	0	0.0%	0	0.0%	5	0.3%	5	0.5%	1	0.4%
	TOTAL	**0**	**0.0%**	**0**	**0.0%**	**5**	**0.3%**	**5**	**0.5%**	**1**	**0.4%**
2024	Black Corals	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	L. Gorgonians	0	0.0%	0	0.0%	8	0.2%	25	0.4%	5	0.4%
	Sea Pens	0	0.0%	0	0.0%	21	0.4%	32	0.5%	5	0.4%
	S. Gorgonians	0	0.0%	0	0.0%	245	4.6%	205	3.2%	36	3.2%
	Sponges	0	0.0%	0	0.0%	7	0.1%	12	0.2%	3	0.3%
	TOTAL	**0**	**0.0%**	**0**	**0.0%**	**282**	**5.3%**	**274**	**4.3%**	**49**	**4.4%**

Table 8. Cod bycatch and effort of the trawl hauls targeting other species by year. The annual percentage of the different fisheries relative to the annual total cod caught as bycatch in other fisheries is also presented.

	Fishery	Catch_Tn	Effort_hrs	Effort_nHauls	Catch_Perc
2016	RED	289	3009	695	94%
	HAD	12	10	3	4%
	WIT	6	31	9	2%
2017	RED	185	1543	345	98%
	WIT	5	24	9	2%
	HAL	0	7	1	0%
2018	RED	366	3674	889	98%
	WIT	9	22	5	2%
2019	RED	275	3964	784	100%
	WIT	1	18	5	0%
	HAL	0	19	3	0%
2020	RED	262	1360	320	96%
	WIT	11	19	8	4%
2021	RED	45	1047	243	56%
	WIT	36	31	17	44%
2022	RED	555	5076	1566	100%
	GHL	1	16	5	0%
2023	RED	275	3385	882	100%
	GHL	1	168	20	0%
2024	RED	1055	6295	1547	100%
	GHL	0	8	2	0%

Table 9. Annual cod bycatch and effort of the trawl hauls targeting other species by year and the bycatch and effort percentage by quarter relative to the total annual.

	Quarter	CodCatch	ByCatch_Perc	CodEffort_hrs	Effort_hrsPerc	CodEffort_nHauls	Effort_nHaulsPerc
2016	1st	308	43%	3050	48%	707	52%
	2nd		2%		1%		1%
	3rd		55%		51%		47%
	4th		0%		0%		0%
2017	1st	190	47%	1575	44%	355	47%
	2nd		1%		2%		3%
	3rd		52%		54%		50%
	4th						
2018	1st	375	68%	3696	41%	894	41%
	2nd		2%		1%		1%
	3rd		30%		58%		59%
	4th						
2019	1st	276	57%	4001	23%	792	30%
	2nd		5%		2%		3%
	3rd		38%		75%		66%
	4th						
2020	1st	273	59%	1379	41%	328	48%
	2nd		4%		1%		2%
	3rd		37%		57%		49%
	4th		0%		1%		1%
2021	1st	80	32%	1078	44%	260	54%
	2nd		45%		3%		7%
	3rd		24%		53%		40%
	4th						
2022	1st	556	32%	5092	52%	1571	60%
	2nd						
	3rd		68%		47%		39%
	4th		1%		1%		1%
2023	1st	276	25%	3553	41%	902	42%
	2nd		5%		8%		7%
	3rd		55%		47%		46%
	4th		15%		4%		4%
2024	1st	1055	8%	6303	23%	1549	26%
	2nd		45%		32%		35%
	3rd		30%		29%		25%
	4th		19%		17%		14%

Table 10. Cod bycatch and effort (both in absolute numbers and percentage over the total of each year and gear) of hauls directed to other species in VME polygons by year and gear.

		LL				OTB					
	VME	Catch_Tn	Catch_Perc	Effort_nHauls	Effort_nHaulsPerc	Catch_Tn	Catch_Perc	Effort_hrs	Effort_hrsPerc	Effort_nHauls	Effort_nHaulsPerc
2016	Black Corals	0	0%	0	0	5	2%	250	8%	47	7%
	Large Gorgonians	0	0%	0	0	2	1%	10	0%	3	0%
	Sea Pens	0	0%	0	0	12	4%	483	16%	100	14%
	Small Gorgonians	0	0%	0	0	2	1%	87	3%	19	3%
	Sponges	0	0%	0	0	1	0%	26	1%	7	1%
	TOTAL	0	0%	0	0	22	7%	857	28%	176	25%
2017	Black Corals	0	0%	0	0	3	1%	30	2%	6	2%
	Large Gorgonians	0	0%	0	0	5	3%	52	3%	13	4%
	Sea Pens	0	0%	0	0	9	5%	162	10%	31	9%
	Small Gorgonians	0	0%	0	0	6	3%	66	4%	16	5%
	Sponges	0	0%	0	0	17	9%	36	2%	10	3%
	TOTAL	0	0%	0	0	38	20%	345	22%	76	21%
2018	Black Corals	0	0%	0	0	1	0%	23	1%	5	1%
	Large Gorgonians	1	74%	1	50	84	22%	334	9%	92	10%
	Sea Pens	0	0%	0	0	10	3%	230	6%	46	5%
	Small Gorgonians	0	0%	0	0	2	1%	45	1%	10	1%
	Sponges	0	0%	0	0	6	2%	75	2%	15	2%
	TOTAL	1	74%	1	50	103	28%	706	19%	168	19%
2019	Black Corals	0	0%	0	0	1	0%	32	1%	5	1%
	Large Gorgonians	0	0%	0	0	31	11%	156	4%	37	5%
	Sea Pens	0	0%	0	0	3	1%	141	4%	23	3%
	Small Gorgonians	0	0%	0	0	1	0%	12	0%	5	1%
	Sponges	0	0%	0	0	6	2%	171	4%	39	5%
	TOTAL	0	0%	0		41	15%	512	13%	109	14%
2020	Black Corals	0	0%	0	0	1	0%	24	2%	3	1%
	Large Gorgonians	0	0%	0	0	23	8%	98	7%	31	9%
	Sea Pens	0	0%	0	0	1	0%	35	3%	7	2%
	Small Gorgonians	0	0%	0	0	0	0%	3	0%	1	0%
	Sponges	0	0%	0	0	12	4%	49	4%	14	4%
	TOTAL	0	0%	0	0	36	13%	209	15%	56	17%
2021	Black Corals	0	0%	0	0	1	1%	7	1%	2	1%
	Large Gorgonians	0	0%	0	0	9	11%	129	12%	34	13%
	Sea Pens	0	0%	0	0	1	1%	70	6%	11	4%
	Small Gorgonians	0	0%	0	0	0	1%	7	1%	2	1%
	Sponges	0	0%	0	0	3	4%	60	6%	14	5%
	TOTAL	0	0%	0	0	14	18%	272	25%	63	24%
2022	Black Corals	0	0%	0	0	2	0%	28	1%	10	1%
	Large Gorgonians	0	0%	0	0	76	14%	1002	20%	402	26%
	Sea Pens	0	0%	0	0	6	1%	110	2%	23	1%
	Small Gorgonians	0	0%	0	0	2	0%	43	1%	14	1%
	Sponges	0	0%	0	0	50	9%	688	14%	227	14%
	TOTAL	0	0%	0	0	136	25%	1870	37%	676	43%
2023	Black Corals	0	0%	0	0	2	1%	41	1%	9	1%
	Large Gorgonians	0	0%	0	0	22	8%	353	10%	102	11%
	Sea Pens	0	0%	0	0	8	3%	286	8%	50	6%
	Small Gorgonians	0	0%	0	0	2	1%	24	1%	6	1%
	Sponges	0	0%	0	0	8	3%	241	7%	51	6%
	TOTAL	0	0%	0	0	42	15%	944	27%	218	24%
2024	Black Corals	0	0%	0	0	24	2%	253	4%	57	4%
	Large Gorgonians	0	0%	0	0	45	4%	420	7%	115	7%
	Sea Pens	0	0%	0	0	55	5%	725	12%	160	10%
	Small Gorgonians	0	0%	0	0	73	7%	467	7%	131	8%
	Sponges	0	0%	0	0	14	1%	148	2%	44	3%
	TOTAL	0	0%	0	0	210	20%	2014	32%	507	33%

Table 11. Mean cod catches length distribution (percentage) by gear and total for the period 2016-2020 and 2021-2024.

	Abundance (2016-2020) (%)			Abundance (2021-2024) (%)		
Length (cm)	**OTB**	**LL**	**TOTAL**	**OTB**	**LL**	**TOTAL**
18	0	0	0	0	0	0
21	0	0	0	0	0	0
24	0.1	0	0	0	0	0
27	0.2	0	0.1	0	0	0
30	0.3	0	0.2	0	0	0
33	0.5	0	0.4	0.1	0	0.1
36	1.1	0.3	1.0	0.4	0.1	0.4
39	3.3	0.6	2.9	0.7	0.6	0.8
42	2.9	0.6	2.6	1.2	1.5	1.5
45	4.1	1.3	3.6	2.0	3.2	2.7
48	5.1	1.2	4.4	6.7	4.5	6.6
51	6.5	1.9	5.7	9.8	4.4	8.7
54	8.6	3.0	7.6	12.8	5.1	11.3
57	10.4	5.0	9.3	10.3	5.6	9.1
60	12.6	8.1	11.6	11.4	6.9	10.3
63	11.8	10.1	11.4	9.7	7.2	8.7
66	9.8	9.6	9.6	9.5	6.9	8.1
69	7.8	10.9	8.3	6.9	7.8	6.9
72	5.6	9.0	6.3	5.7	7.0	5.7
75	4.1	6.7	4.6	4.1	6.3	4.6
78	2.3	6.3	3.1	3.5	5.8	4.1
81	1.1	4.3	1.7	1.8	5.6	2.8
84	0.5	3.7	1.1	1.3	5.1	2.2
87	0.4	2.9	0.9	0.8	3.7	1.4
90	0.3	2.5	0.7	0.6	2.8	1.2
93	0.2	1.8	0.4	0.3	2.0	0.7
96	0.1	1.9	0.4	0.1	1.9	0.6
99	0.1	1.9	0.4	0.1	1.3	0.4
102	0.1	1.4	0.3	0.1	1.1	0.3
105	0.1	1.1	0.2	0	0.9	0.3
108	0.1	1.3	0.3	0	0.7	0.2
111	0	0.8	0.1	0	0.3	0.1
114	0	0.7	0.1	0	0.3	0.1
117	0	0.4	0.1	0	0.3	0.1
120	0	0.2	0.1	0	0.2	0.1
123	0	0.2	0	0	0.2	0
126	0	0.1	0.1	0	0.2	0
129	0	0	0	0	0.1	0
132	0	0.1	0	0	0.1	0
135	0	0	0	0	0	0
138	0	0	0	0	0	0
Mean length	**59.8**	**72.3**	**62.0**	**61.2**	**70.1**	**63.0**

Table 12. Mean cod catches age distribution (percentage) by gear and total for the period 2016-2020 and 2021-2024.

	Abundance (2016-2020) (%)			Abundance (2021-2024) (%)		
Age	**OTB**	**LL**	**TOTAL**	**OTB**	**LL**	**TOTAL**
1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.5	0.2	0.5	0.1	0.0	0.0
3	7.4	2.1	6.5	2.2	1.0	1.9
4	8.9	2.9	7.9	33.5	11.0	27.0
5	21.7	7.2	19.2	29.8	11.0	24.4
6	27.8	18.7	26.2	16.0	10.7	14.4
7	17.0	21.6	17.8	6.2	6.3	6.2
8	16.7	47.5	22.0	12.2	60.0	26.0

Figures

Figure 1. Species catch composition in percentage of the longline hauls targeting cod in the analyzed data.

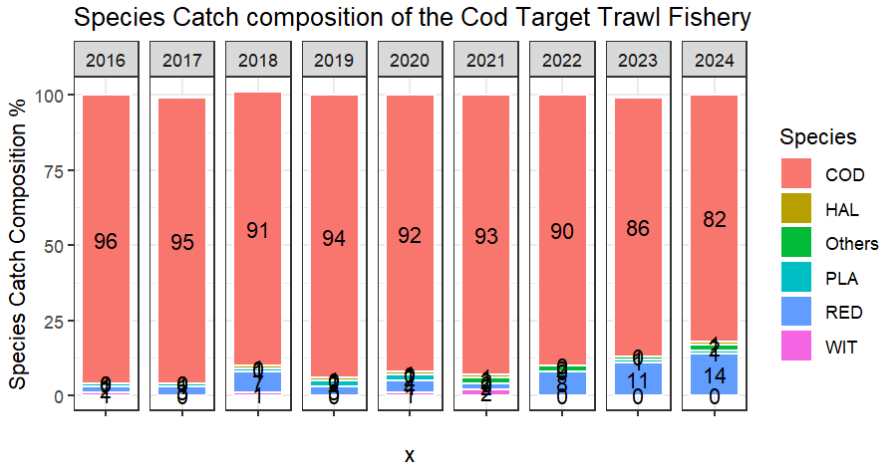

Figure 2. Species catch composition in percentage of the trawl hauls targeting cod in the analyzed data.

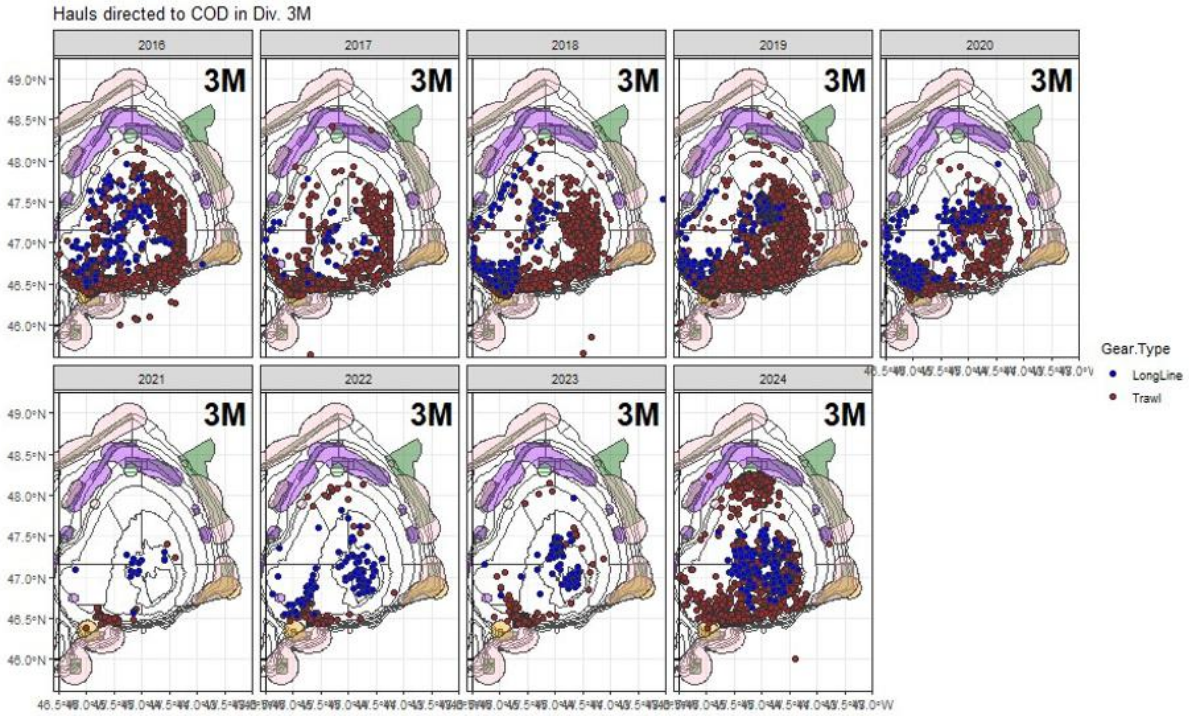

Figure 3. Position of the hauls targeting cod by year and gear in the period 2016-2024. Brown circles represent trawl hauls and blue circles represent longline sets. The polygons defined for each VME taxa have been drawn in different colours and the areas closed to bottom fishing to protect the different VMEs have been drawn in green and numbered.

Figure 4. Cod catches in percentage by year and quarter of the trawl and longline directed fishery in the analyzed data.

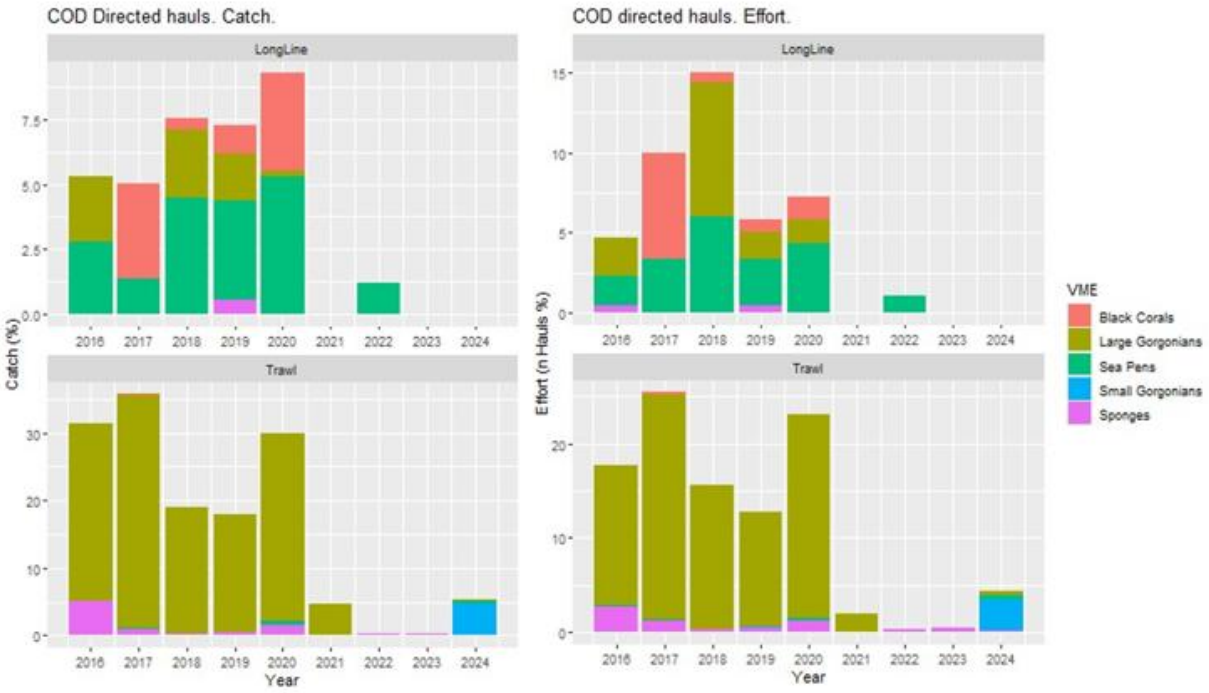

Figure 5. Percentage of cod catches and effort of the analyzed hauls targeting cod by year and gear made in the different polygons of each VME indicator. a) Catches. b) Effort in number of sets.

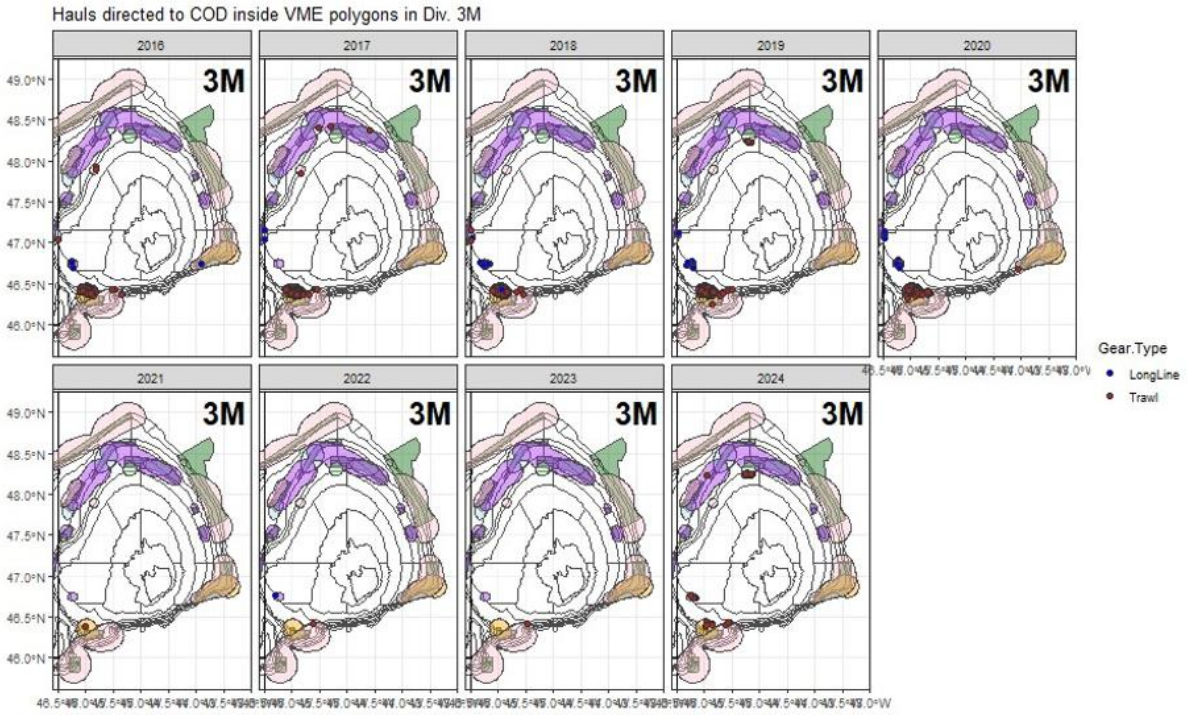

Figure 6. Map with the position of hauls targeting cod in VME polygons by year. The polygons defined for each VME taxa have been drawn in different colours and the areas closed to bottom fishing to protect the different VMEs have been drawn in green and numbered.

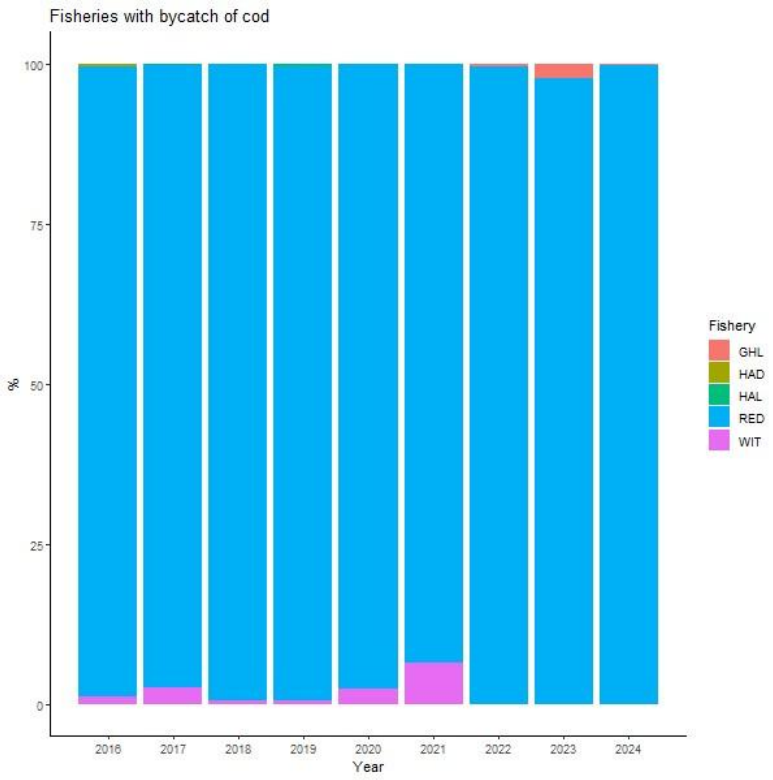

Figure 7. Percentage of cod catches caught as bycatch in the trawl fishery by year in the analyzed data.

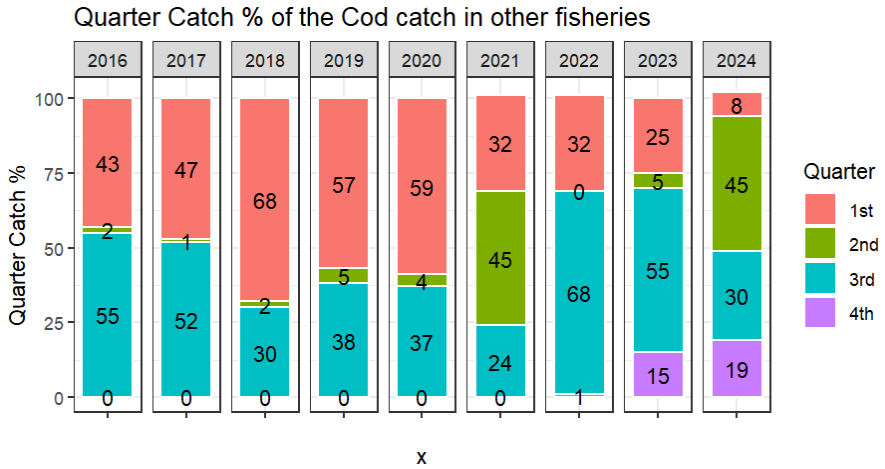

Figure 8. Percentage of cod catches caught as bycatch in the trawl fishery by quarter and year in the analyzed data.

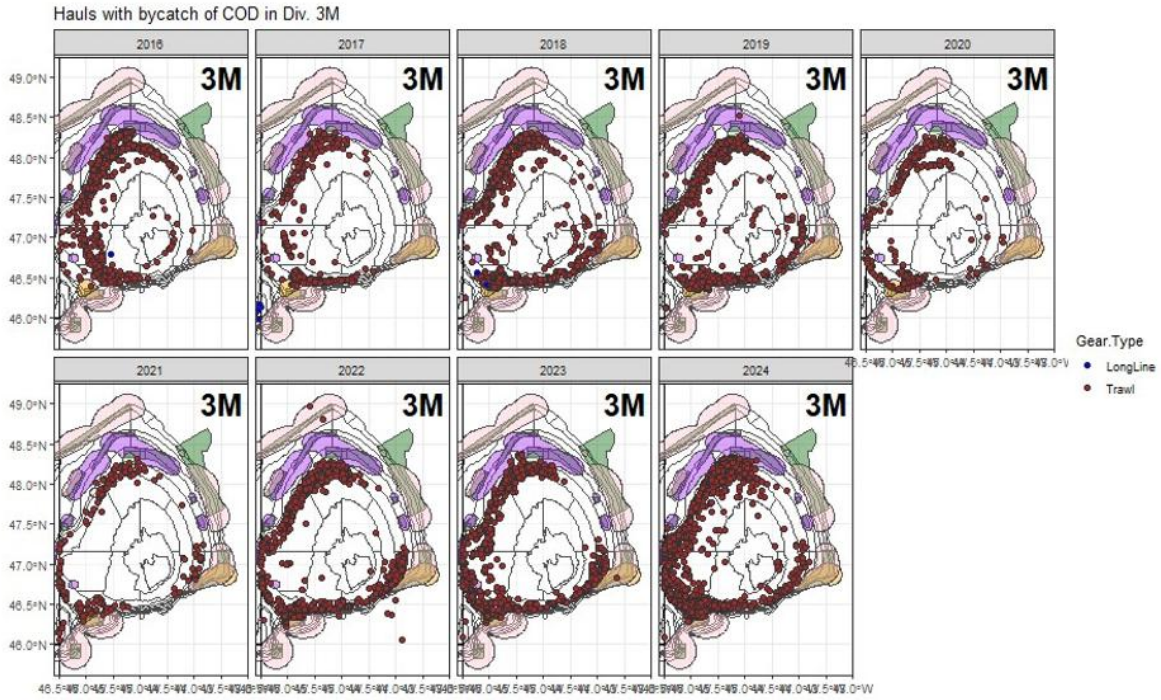

Figure 9. Position of the hauls catching cod as bycatch by year and gear for the periods 2016-2020 and 2021-2024. Brown circles represent trawl hauls and blue circles represent longline sets.

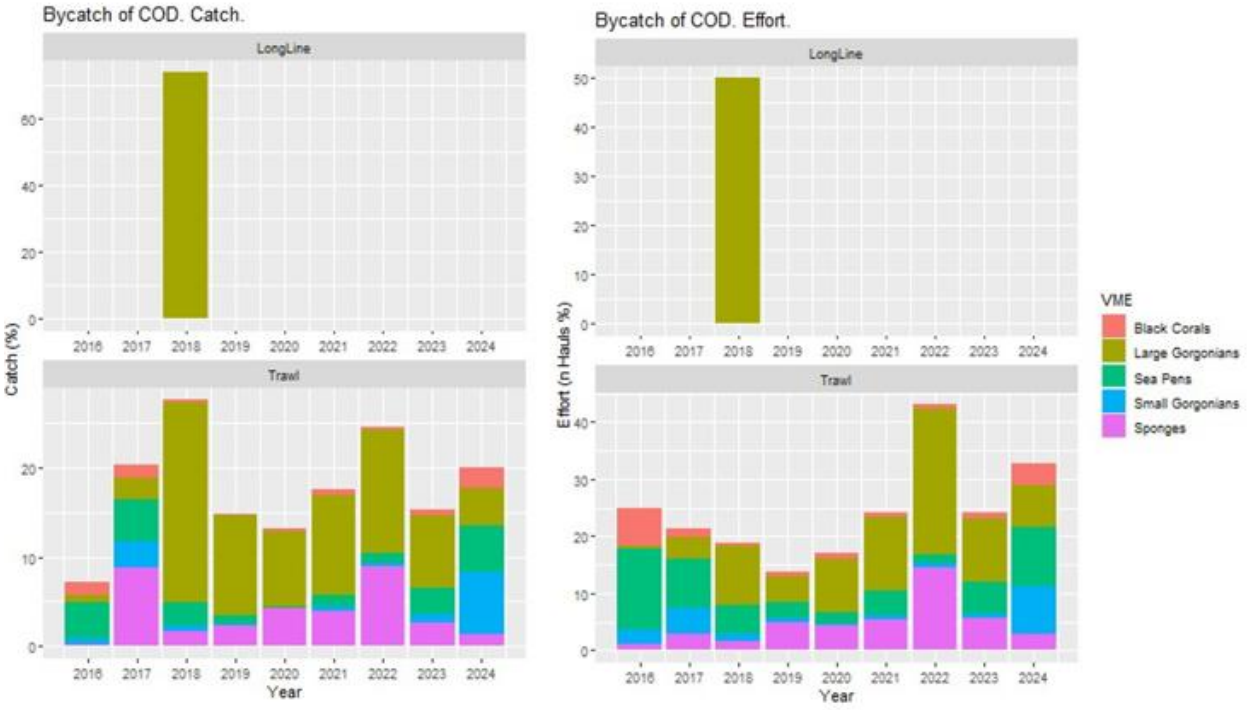

Figure 10. Percentage of cod bycatches and effort of hauls targeting other species by year and gear made in the different polygons of each VME indicator. a) Catches. b) Effort in number of sets.

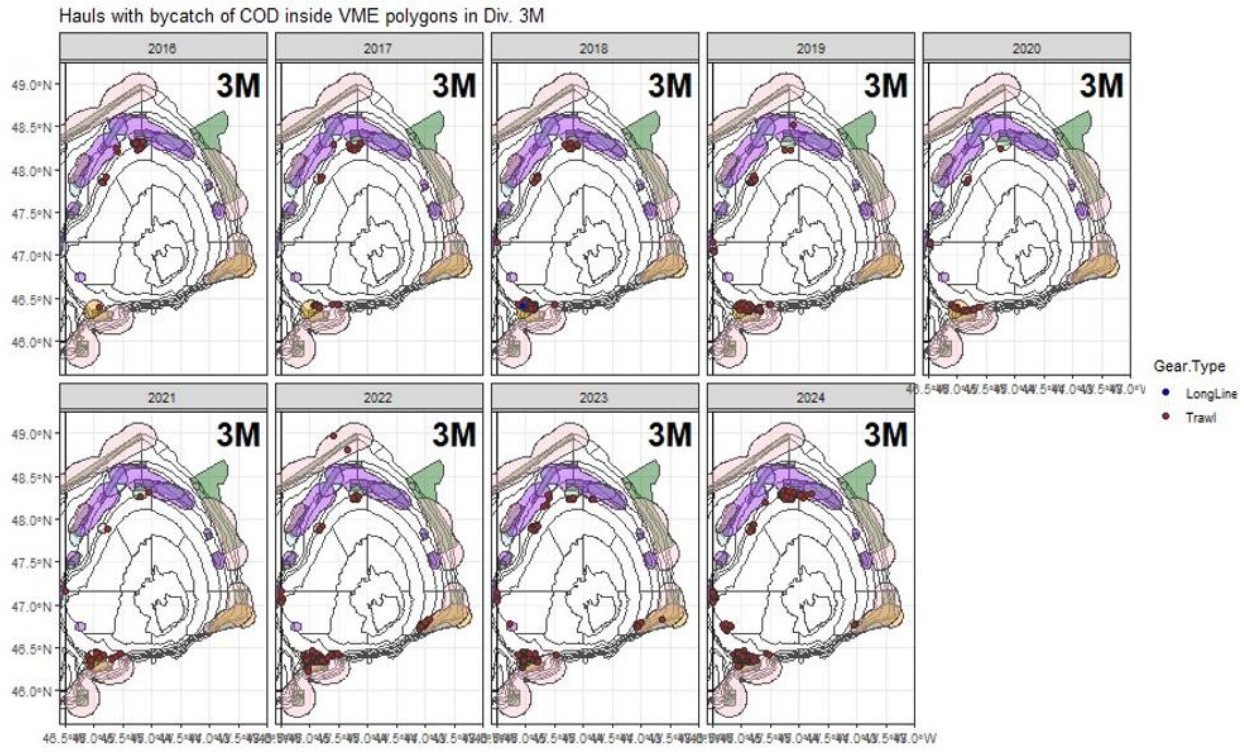

Figure 11. Position of the hauls catching cod as bycatch in the VME polygons by year for the periods 2016-2020 and 2021-2024.

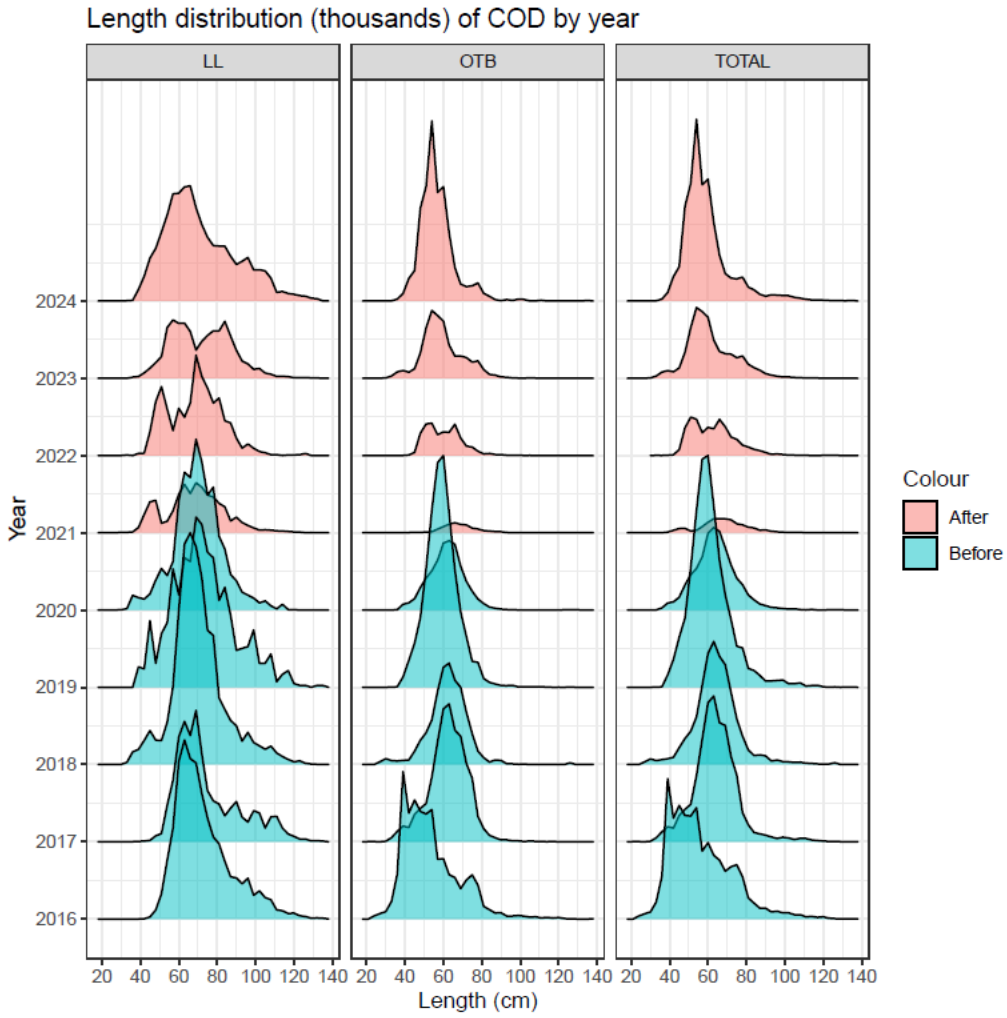

Figure 12. Cod catches length distribution by year for the longliners, trawlers and total catches for the period 2016-2022.

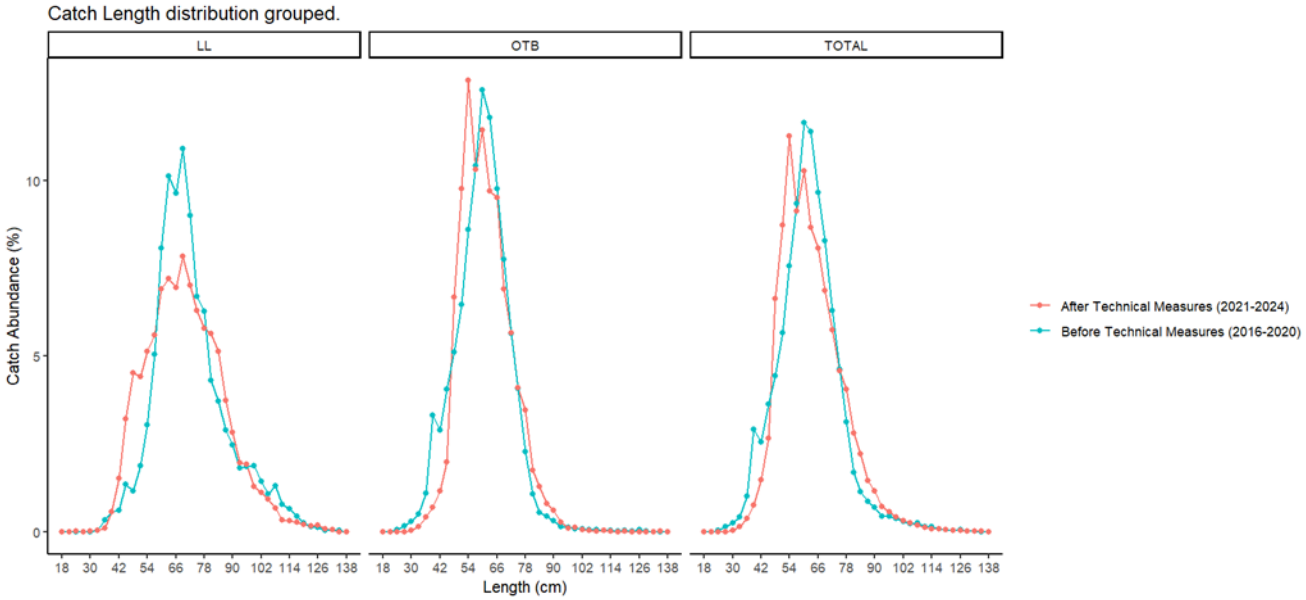

Figure 13. Mean cod catches length distribution (percentage) for the periods 2016-2020 and 2021-2024 for the longliners, trawlers and total.

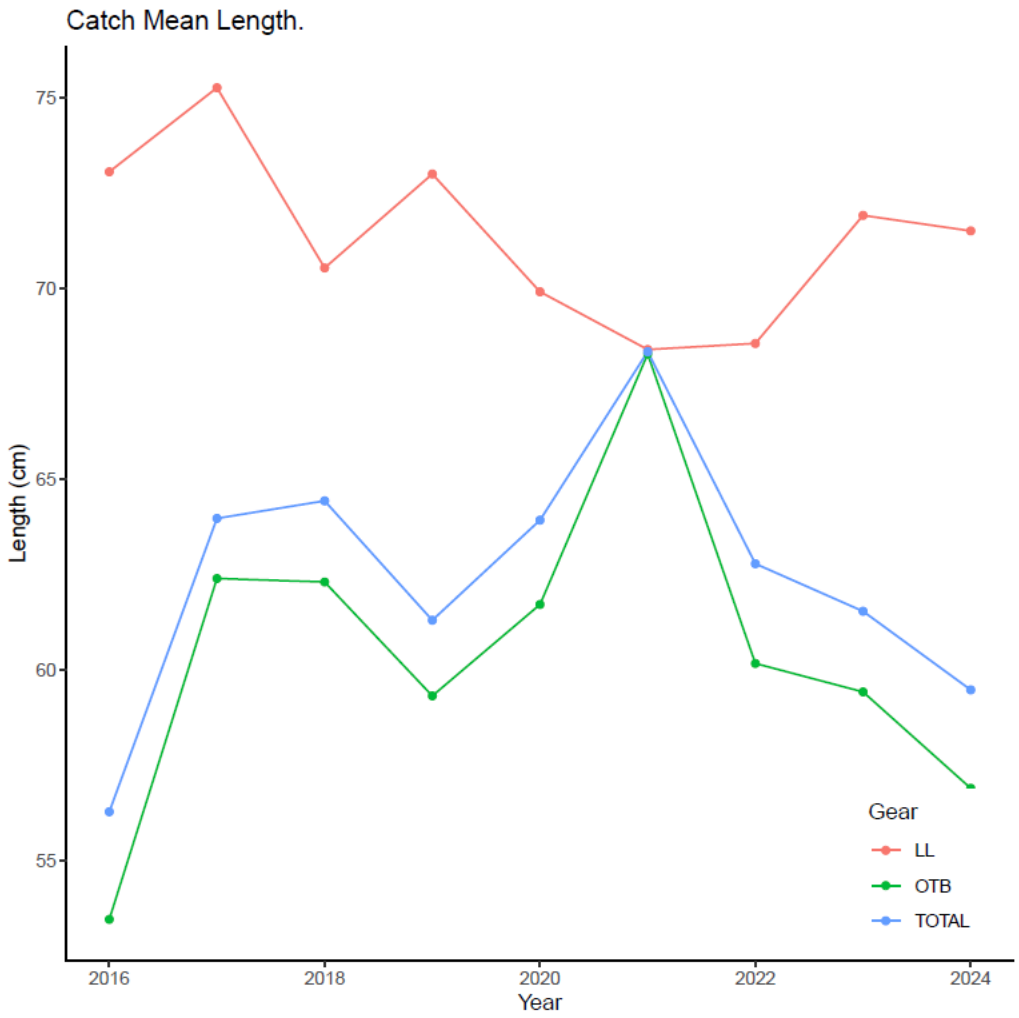

Figure 14. Mean annual length observed in the cod catches of longliners, trawlers and total catches by year in the 2016-2024 period.

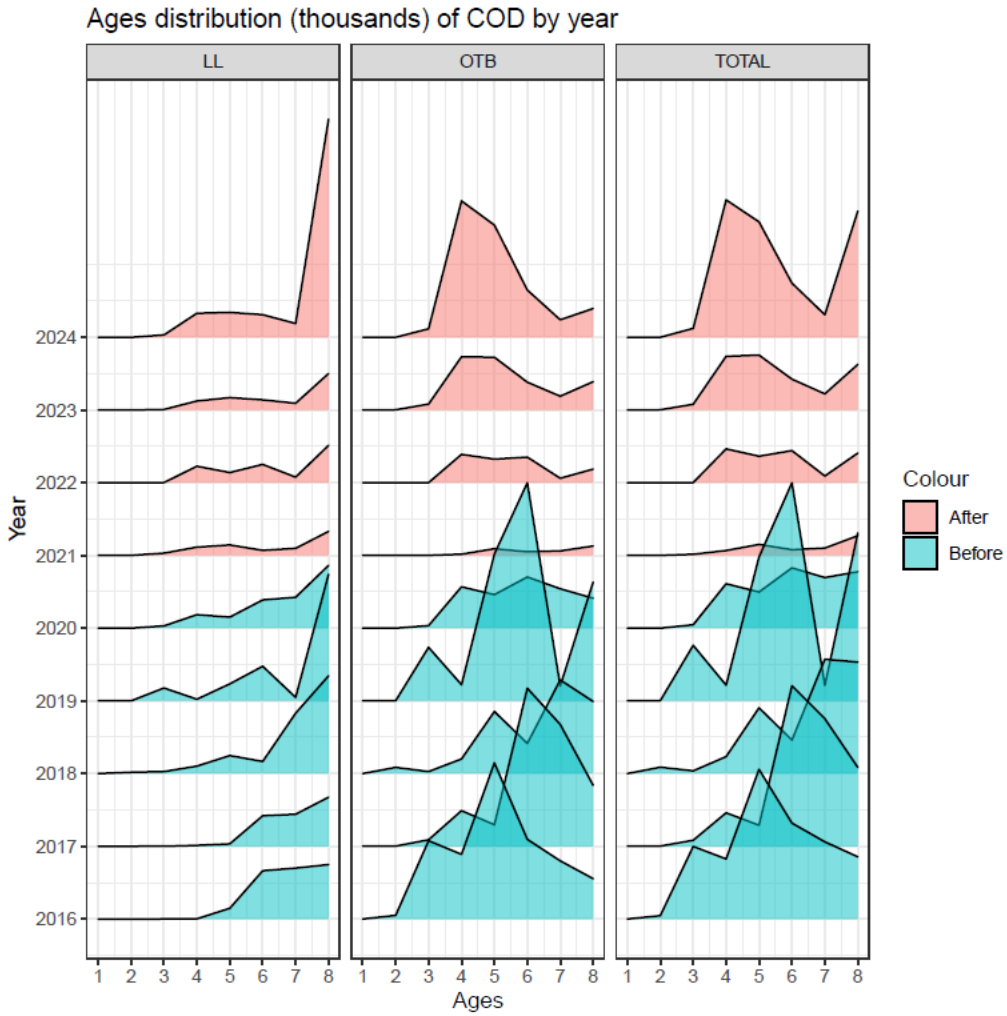

Figure 15. Age composition of the annual cod longliners, trawlers and total catches for the period 2016-2024.

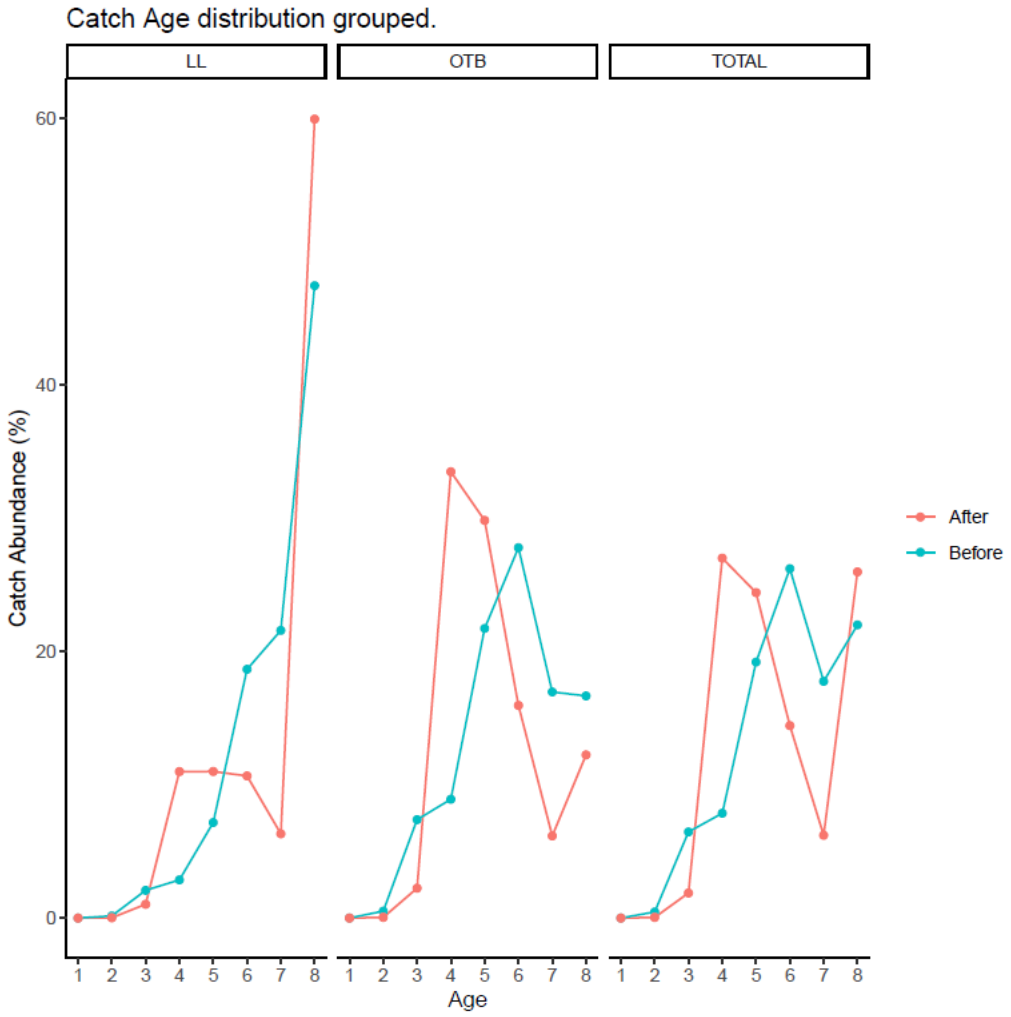

Figure 16. Mean age composition (percentage) of the cod longliners, trawlers and total catches for the periods 2016-2020 and 2021-2024.