

NEAFC and OSPAR joint request on the status and distribution of deep-water elasmobranchs

Advice summary

In response to a joint request from NEAFC and OSPAR, ICES reviewed existing information on deep-water sharks, skates and rays from surveys and the literature. Distribution maps were generated for 21 species, showing the location of catches from available survey data on deep-water sharks and elasmobranchs in the NEAFC and OSPAR areas of the Northeast Atlantic. Shapefiles of the species distribution areas are available as supporting documentation to this work.

This advice sheet presents a summary of ICES advice on the stock status of species for which an assessment is available, as well as current knowledge on the stock status of species for which ICES does not provide advice.

An overview of approaches which may be applied to mitigate bycatch and to improve stock status is also presented. ICES recognizes that, despite their limitations, prohibition, gear and depth limitations, and TAC are mechanisms currently available to managers to regulate outtake; therefore, ICES advises that these mechanisms should be maintained. Furthermore, ICES advises that additional measures, such as electromagnetic exclusion devices, acoustic or light-based deterrents, and spatio-temporal management could be explored.

Request

NEAFC and OSPAR requested ICES to produce:

- a. Maps and shapefiles of the distribution of the species, identifying, if possible, key areas used during particular periods/stages of the species' lifecycle in terms of distribution and relative abundance of the species, and expert interpretation of the data products;*
- b. Summary of ICES advice on status of those species for which an assessment is available in ICES. For stocks not assessed, literature review of studies of the status and any other relevant information, will be summarised and reported (e.g. Neat et al. 2015, previous WGEF reports on e.g. *C. granulosus* in Portugal, etc.).*
- c. Presentation of the potential options that can contribute to improving the status of the species and mitigate bycatch of deep sea sharks.*

Elaboration on the advice

Maps and shapefiles of species distribution

Maps of species distribution are presented in Annex 1. Shapefiles are available electronically¹. These maps show the best available information of the distribution of the main deep-water elasmobranch species. The maps do not cover the Azores or any of the Mid-Atlantic Ridge, because data for these areas were not available for this special request.

Summary of ICES advice on status

ICES has, upon the request of the European Commission, provided advice on only four species since 2005: the Portuguese dogfish (*Centroscymnus coelolepis*), leafscale gulper shark (*Centrophorus squamosus*), kitefin shark (*Dalatias licha*), and the blackmouthed dogfish (*Galeus melastomus*). The remaining species have never been advised upon by ICES. However, ICES (2018) has compiled and reviewed available preliminary information on their abundance trends, which are presented below.

For the species that ICES provides advice for (excepting *Galeus melastomus*), information was collected since the beginning of the commercial fisheries. In contrast, abundance trends presented for the remaining species do not cover the entire time span of their exploitation; hence it must be treated with caution. Most of the time-series began in the late 1990s or

¹ < <https://doi.org/10.17895/ices.data.7490>>.

early 2000s, but exploitation of deep-water species began in 1990 to the west of the British Isles, and earlier in Portuguese waters. It should be noted that the abundance trends for species that ICES has not provided advice for only cover parts of their distribution area.

Kitefin shark (*Dalatias licha*) in subareas 1–10, 12, and 14 (the Northeast Atlantic and adjacent waters)

The analysis using the Azorean data performed in 2002, showed that the stock was depleted and that it has undergone a marked decline in abundance from the mid-1970s to the late 1980s. Based on this assessment, advice for zero catch was given in 2005. This advice has been reiterated in all subsequent years since 2005, on the basis that there is no evidence to suggest a change in stock status. The stock is currently advised under ICES framework for category 6. For this category, the ICES framework specifies a precautionary reduction of catches unless there is ancillary information clearly indicating that the current level of exploitation is appropriate. The current advice for zero catches is already the lowest possible. Discarding is known to take place; however, ICES cannot quantify the corresponding catch. Discard survival, which is likely to be extremely low, has also not been estimated.

Leafscale gulper shark (*Centrophorus squamosus*) in subareas 1–10, 12, and 14 (the Northeast Atlantic and adjacent waters)

This stock has been subject to advice for zero catch since 2006. The basis of this advice has always been the precautionary approach, and the stock is currently advised under ICES framework for category 6. For this category, the ICES framework specifies a precautionary reduction of catches unless there is ancillary information clearly indicating that the current level of exploitation is appropriate. The current advice for zero catches is already the lowest possible. Discarding is known to take place; however, ICES cannot quantify the corresponding catch. Discard survival, which is likely to be extremely low, has also not been estimated.

Portuguese dogfish (*Centroscymnus coelolepis*) in subareas 1–10, 12, and 14 (the Northeast Atlantic and adjacent waters)

This stock has been subject to advice for zero catch since 2006. The basis of this advice has always been the precautionary approach, and the stock is currently advised under ICES framework for category 6. For this category, the ICES framework specifies a precautionary reduction of catches unless there is ancillary information clearly indicating that the current level of exploitation is appropriate. The current advice for zero catches is already the lowest possible. Discarding is known to take place; however, ICES cannot quantify the corresponding catch. Discard survival, which is likely to be extremely low, has also not been estimated.

Black-mouthed dogfish (*Galeus melastomus*) in Subarea 8 and Division 9.a (Bay of Biscay and Atlantic Iberian waters)

This stock, which is commercialized in this area, has been subject to catch advice since 2017. The first quantitative catch advice (156 tonnes of catch per annum) was provided on a biennial basis for 2018 and 2019. The basis of this advice has been ICES framework for category 3, based on survey abundance trends. ICES was not requested to provide advice on fishing opportunities for 2020 and 2021. Discarding is known to take place; however, ICES cannot quantify the corresponding catch. Discard survival, which is likely to occur, has also not been estimated.

Black-mouthed dogfish (*Galeus melastomus*) in subareas 6 and 7 (Celtic Seas and English Channel)

This stock has been subject to catch advice since 2017. The basis of this advice has been the precautionary approach, based on recent average catches. ICES advised in 2017 that catches in each of the years 2018 and 2019 could be increased by no more than 20% compared to the average catches in 2014–2016. ICES was not requested to provide advice on fishing opportunities for 2020 and 2021. Discarding is known to take place; however, ICES cannot quantify the corresponding catch. Discard survival, which is likely to occur, has also not been estimated.

Birdbeak dogfish (*Deania calcea*) and Arrowhead dogfish (*Deania profundorum*)

In the Spanish Porcupine Bank survey (SpPGFS-WIBTS-Q4), these two species were traditionally registered together, but have been better separated since 2012. *D. calcea* is the most abundant of the two species. The biomass and abundance of these species (mainly *D. calcea*) have been fluctuating without trend during the last decade (Figure 1).

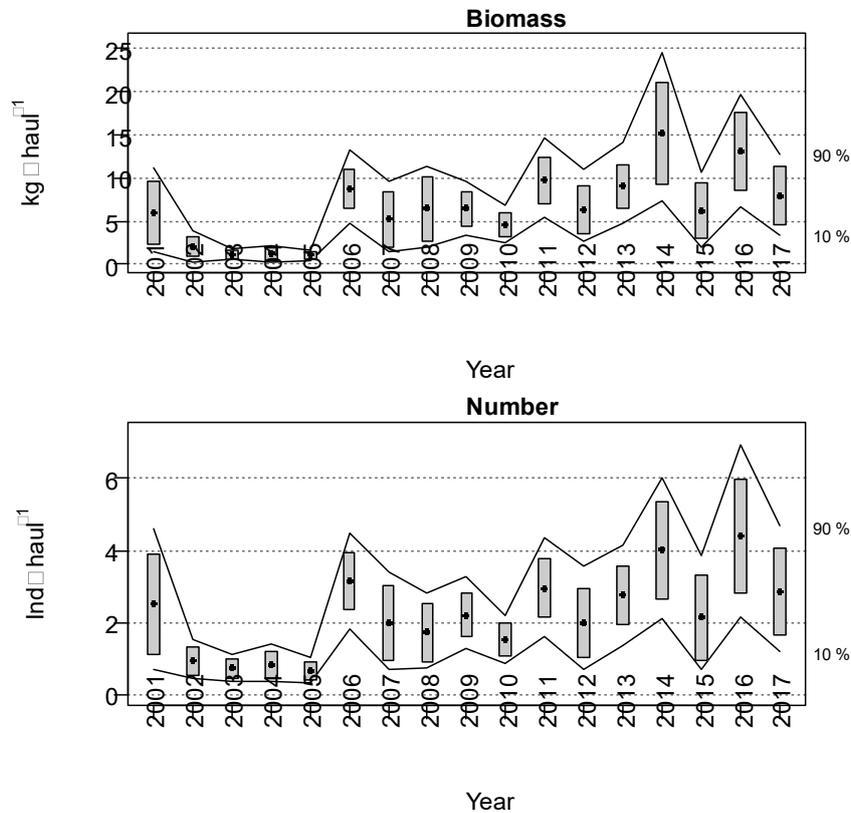


Figure 1 Birdbeak dogfish (*Deania calcea*) biomass index ($\text{kg} \times \text{haul}^{-1}$) from the Spanish Porcupine Bank survey (SpPGFS-WIBTS-Q4) time-series (2001–2016). Boxes show parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals ($\alpha = 0.80$, bootstrap iterations = 1000). From ICES Working Group on Elasmobranch Fishes (ICES, 2018) and references therein.

In the Spanish IEO Q4-IBTS survey in the Cantabrian Sea and Galician waters, *D. calcea* and *D. profundorum* were recorded together until 2009. The two species were first recorded separately in 2009. To avoid confounding effects between the two species, results prior to 2009 combine the two species and were referred to as *Deania spp.* (Figure 2). Both species are usually common in additional deeper survey hauls (> 500 m) and scarce or absent on the standard survey hauls (70–500 m). *Deania calcea*, which used to be commonly captured in additional deeper hauls, was absent in the 2017 survey for the first time since 2009. *Deania profundorum* biomass in 2017 declined to almost half of the 2016 value.

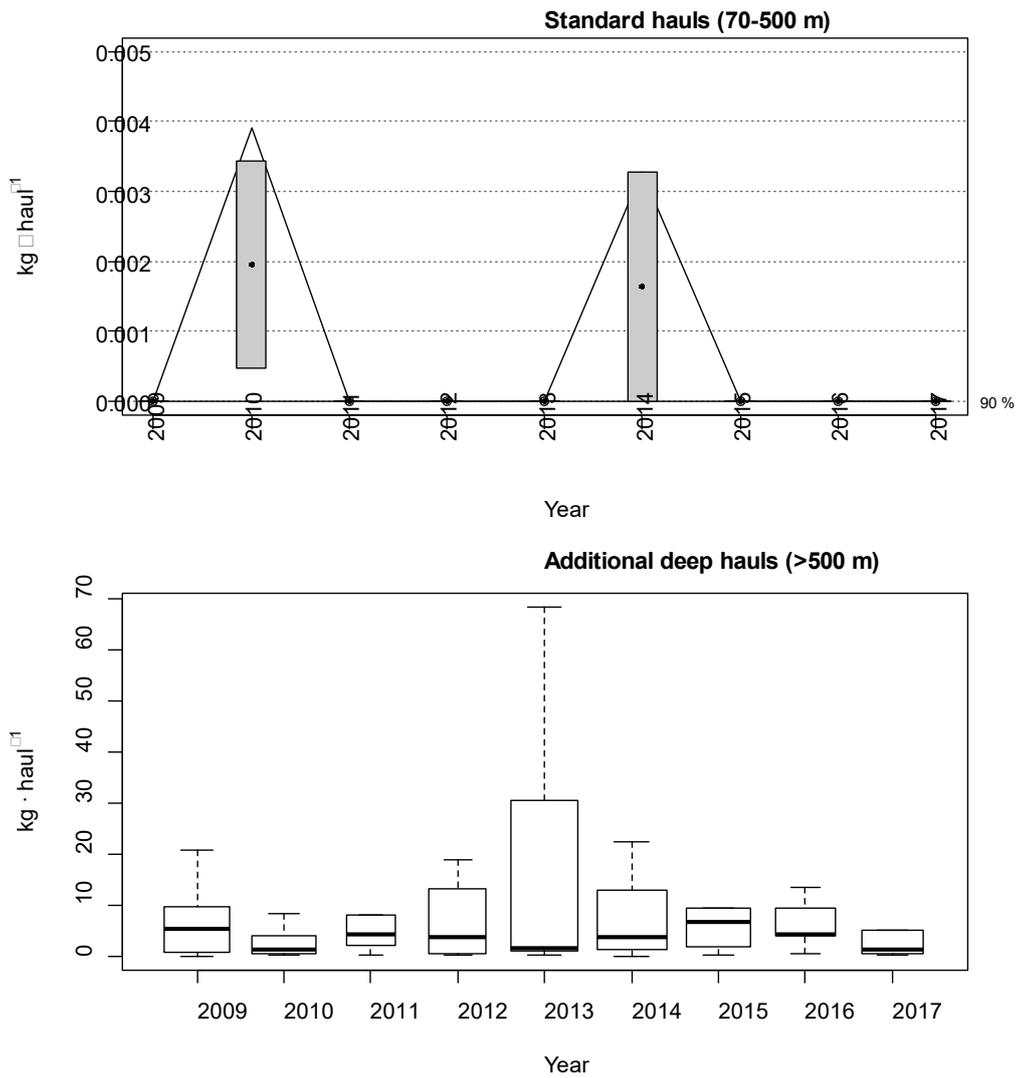


Figure 2 Evolution of *Deania calcea* and *Deania profundorum* stratified biomass index in standard hauls and in additional deep hauls during the North Spanish shelf bottom trawl survey time series. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals ($\alpha = 0.80$, bootstrap iterations = 1000).

An analysis by Neat *et al.* (2015) carried out using survey hauls collected in the core depth range of 400–1500 m on the Scottish slope showed a statistically significant positive trend over time (Figure 3). The results of this analysis are indicative only of recent trends, because the time-series does not extend back to the beginning of deep-water fisheries in the 1980s.

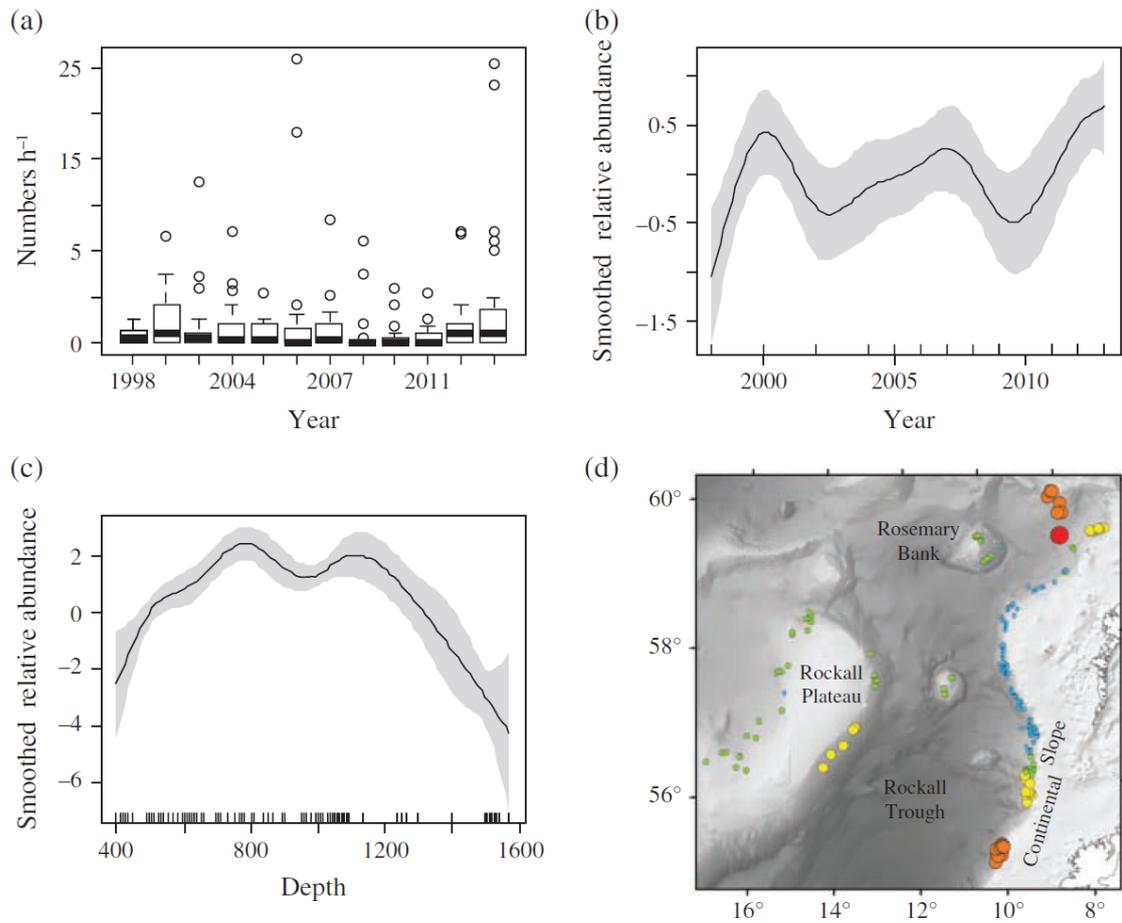


Figure 3 Results of GAM analysis of catches of birdbeak dogfish *Deania calcea* in the Scottish deep-water trawl survey from Neat *et al.* (2015), showing (a) a box-whisker plot of numbers per hour for each year; (b) a smoothed function of relative abundance across years; (c) a smoothed function of relative abundance across depths (short bars near the x axis indicate observations); and (d) distribution of abundance across the survey area. Large red dots indicate hauls of high abundance in close proximity to other hauls of high abundance, whereas small blue dots indicate hauls of low abundance in close proximity to other hauls of low abundance.

Knifetooth dogfish (*Scymnodon ringens*)

In the Spanish Porcupine Bank survey (SpPGFS-WIBTS-Q4), the biomass and abundance of *S. ringens* in 2017 decreased from the 2016 value, but remained among the average values of the time-series (Figure 4).

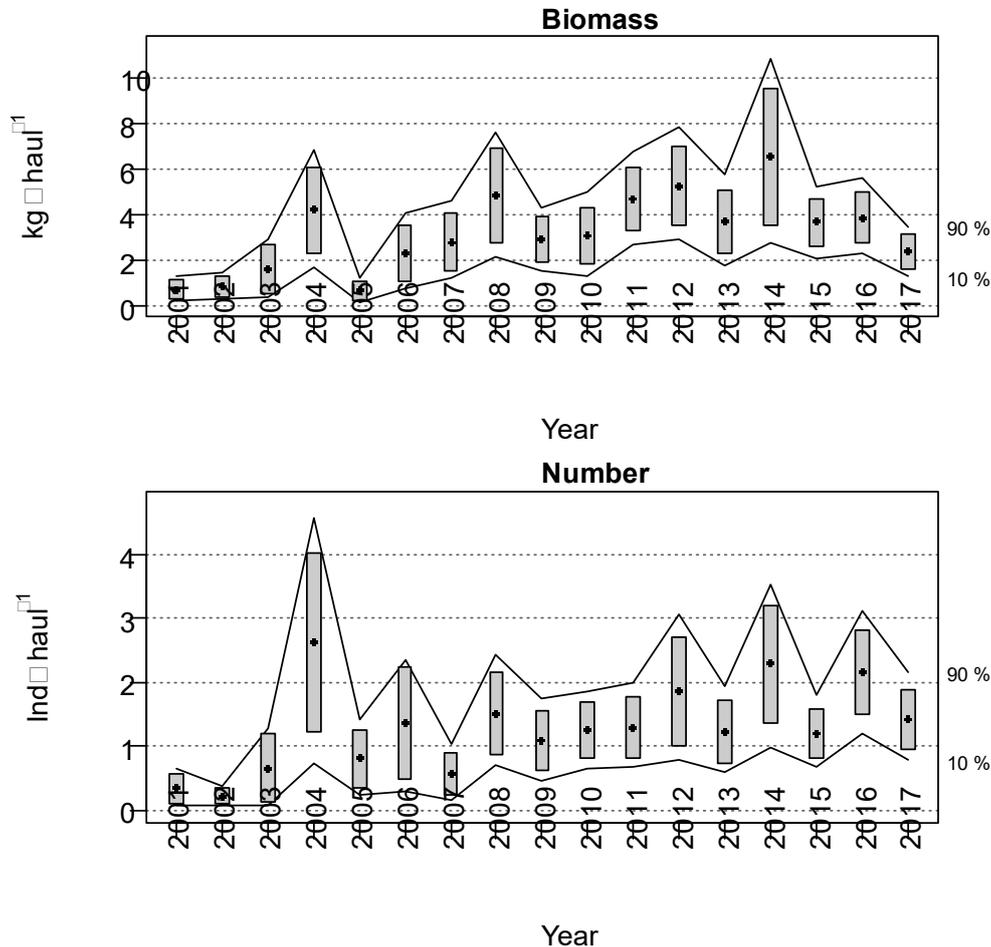


Figure 4 Knifetooth dogfish (*Scymnodon ringens*) biomass index (top, kg x haul⁻¹) and abundance index (bottom, numbers). Haul in the Spanish Porcupine Bank survey (SpPGFS-WIBTS-Q4) time-series (2001–2017). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals ($\alpha = 0.80$, bootstrap iterations = 1000). From ICES Working Group on Elasmobranch Fishes (ICES, 2018) and references therein.

Biomass values in the Spanish IEO Q4-IBTS survey in the Cantabrian Sea and Galician waters are very low. In 2017, the biomass of *S. ringens* decreased to nearly half of the 2016 value in additional deeper hauls and was not captured in standard hauls during the last four years. Biomass has fluctuated with no evident trend since 2004 (Figure 5).

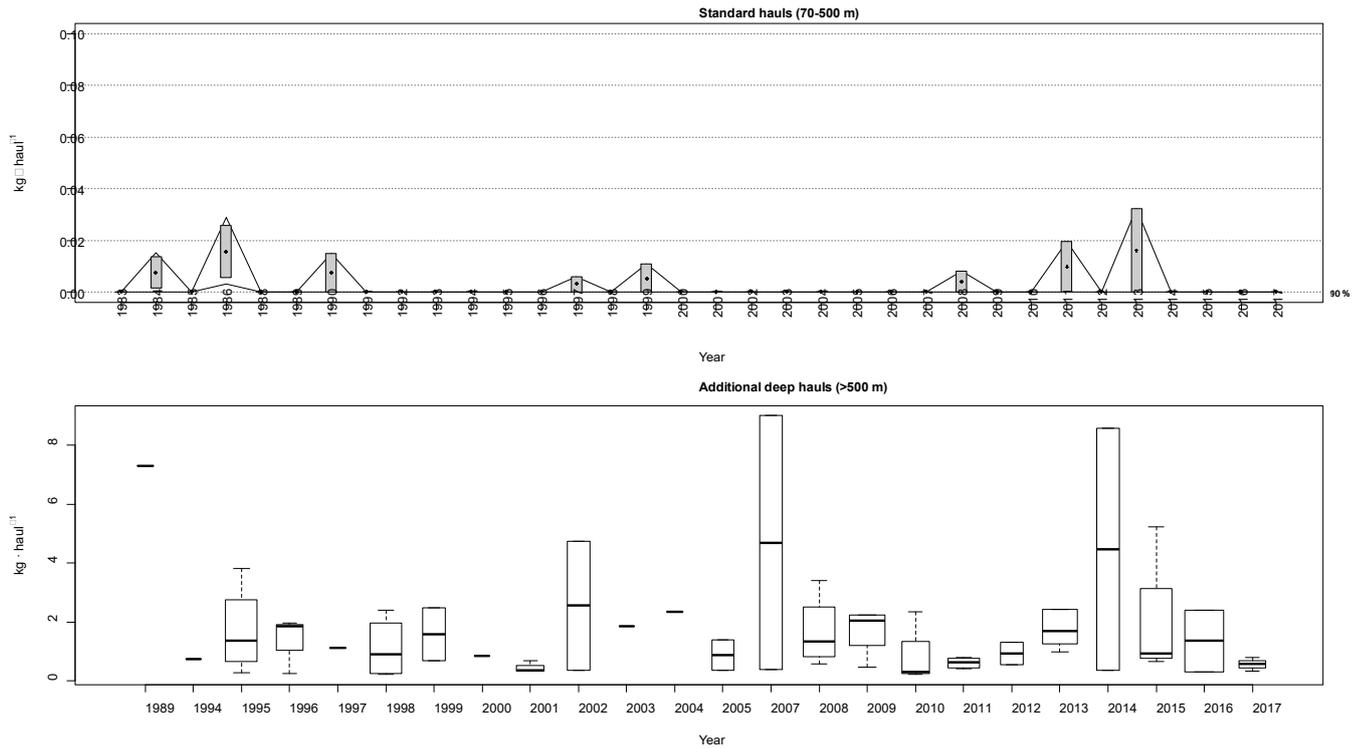


Figure 5 Evolution of *Scymnodom ringens* stratified biomass index in standard hauls and in additional deep hauls during the North Spanish shelf bottom-trawl survey time-series. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals ($\alpha = 0.80$, bootstrap iterations = 1000). From ICES Working Group on Elasmobranch Fishes (ICES, 2018) and references therein.

Velvet belly lanternshark (*Etmopterus spinax*)

Both the biomass and abundance indexes of *E. spinax* in the Spanish Porcupine Bank survey (SpPGFS-WIBTS-Q4) have fluctuated without a trend from 2001 to 2017 (Figure 6).

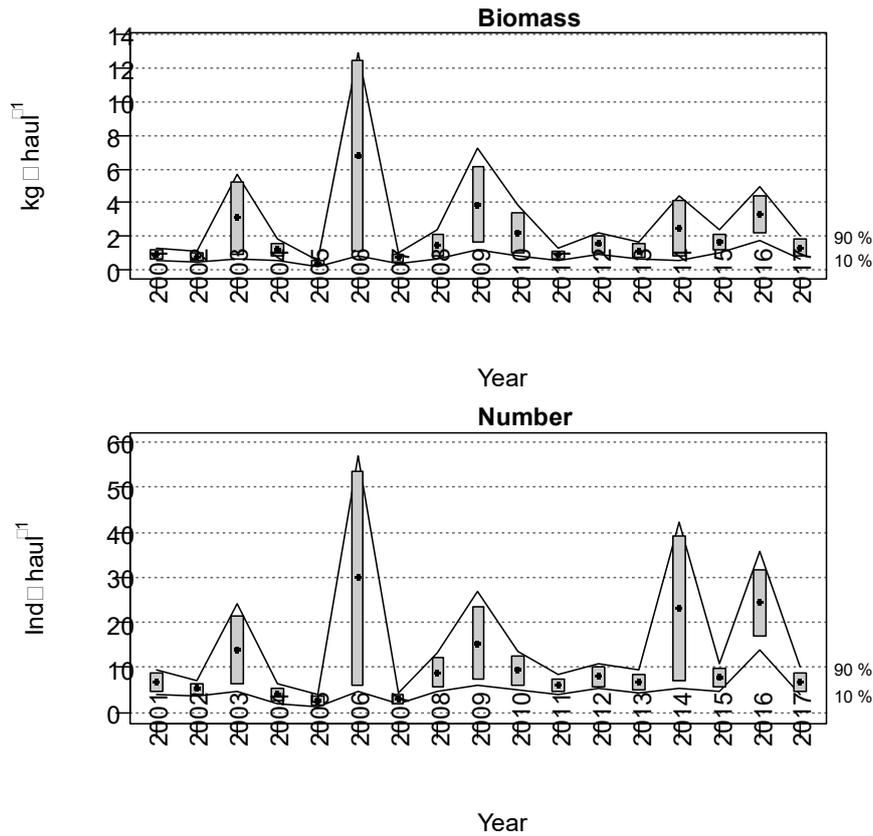


Figure 6 Velvet belly lanternshark (*Etmopterus spinax*) biomass index (top, kg × haul⁻¹) and abundance index (bottom, individuals × haul⁻¹) during the Porcupine Bank survey time-series (2001–2017). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals ($\alpha = 0.80$, bootstrap iterations = 1000). From ICES Working Group on Elasmobranch Fishes (ICES, 2018) and references therein.

In the Spanish IEO Q4-IBTS survey in the Cantabrian Sea and Galician waters, the biomass index shows an increasing trend since 1996. In 2017, about 70% of the biomass of this elasmobranch species was found in hauls deeper than 500 m. The biomass of this species in standardized hauls has been higher in the last two years (about twice the level of the previous 5 years). Biomass has generally been higher in the additional deep hauls since 2009 (Figure 7).

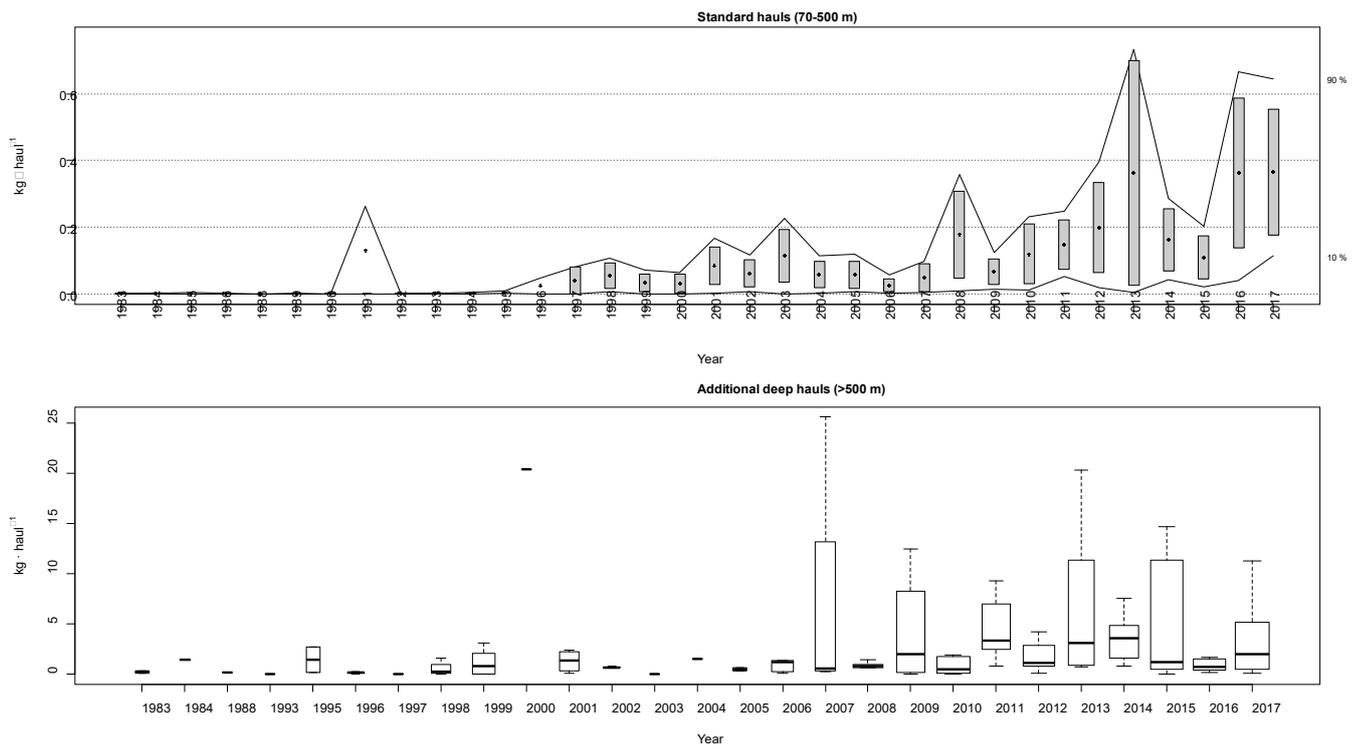


Figure 7 Evolution of *Etmopterus spinax* stratified biomass index in standard hauls and in additional deep hauls during the North Spanish shelf bottom-trawl survey time-series, covered by the survey. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals ($\alpha = 0.80$, bootstrap iterations = 1000). From ICES Working Group on Elasmobranch Fishes (ICES, 2018) and references therein.

The relative abundance of *Etmopterus spinax* derived from the Scottish deep-water survey at depths from 300 to 1100 m has varied with no overall trend since 1998 (Figure 8) (Neat *et al.*, 2015).

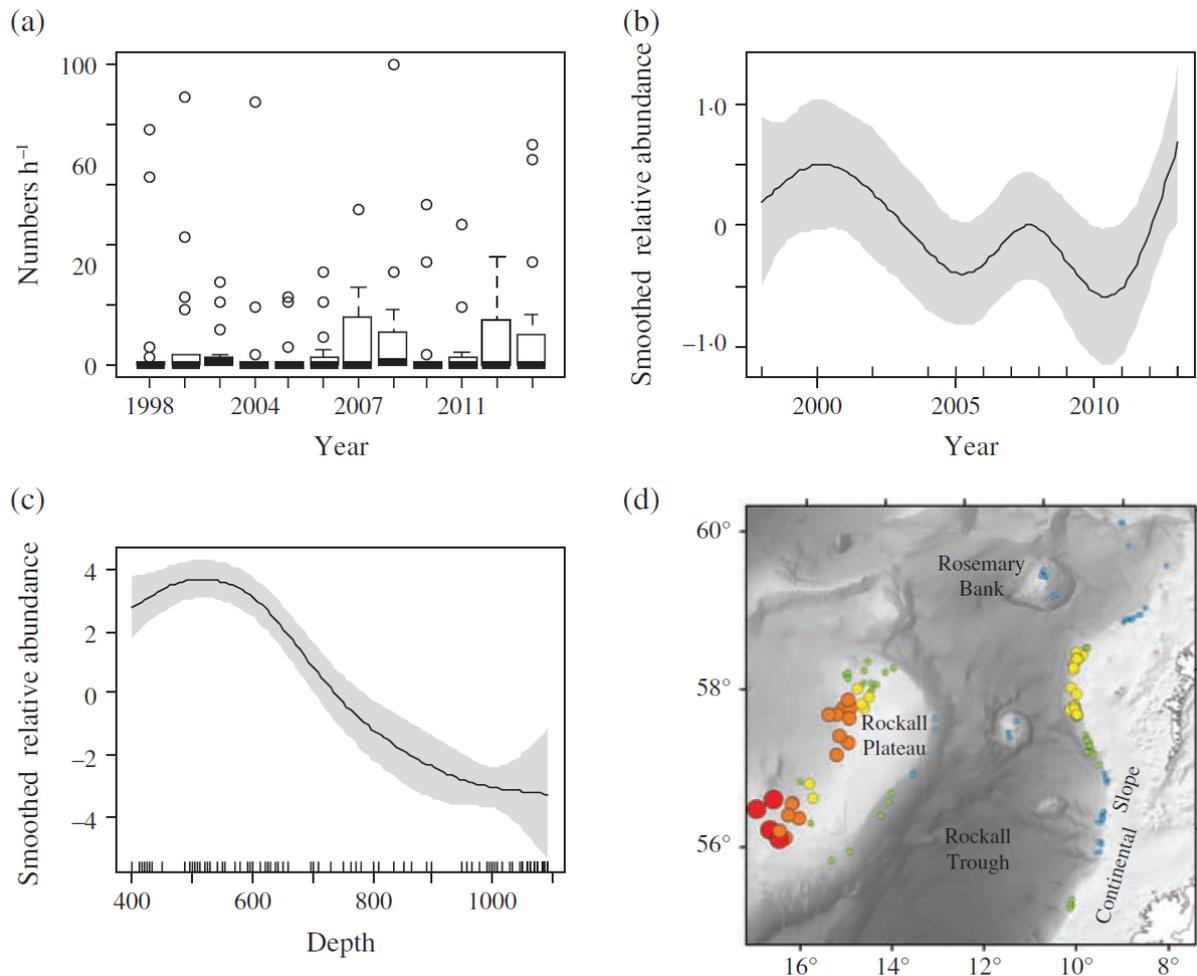


Figure 8 Results of GAM analysis of catches of velvet belly (*Etmopterus spinax*) in the Scottish deep-water trawl survey from Neat *et al.* (2015), showing (a) a box-whisker plot of numbers per hour for each year; (b) a smoothed function of relative abundance across years; (c) a smoothed function of relative abundance across depths (short bars near the x axis indicate observations); and (d) distribution of abundance across the survey area. Large red dots indicate hauls of high abundance in close proximity to other hauls of high abundance, whereas small blue dots indicate hauls of low abundance in close proximity to other hauls of low abundance

Greater lantern shark (*Etmopterus princeps*)

The relative abundance of this species between depths of 800 m and 1800 m from the Scottish deep-water survey has fluctuated without a trend for the past 14 years (Figure 9) (Neat *et al.*, 2015).

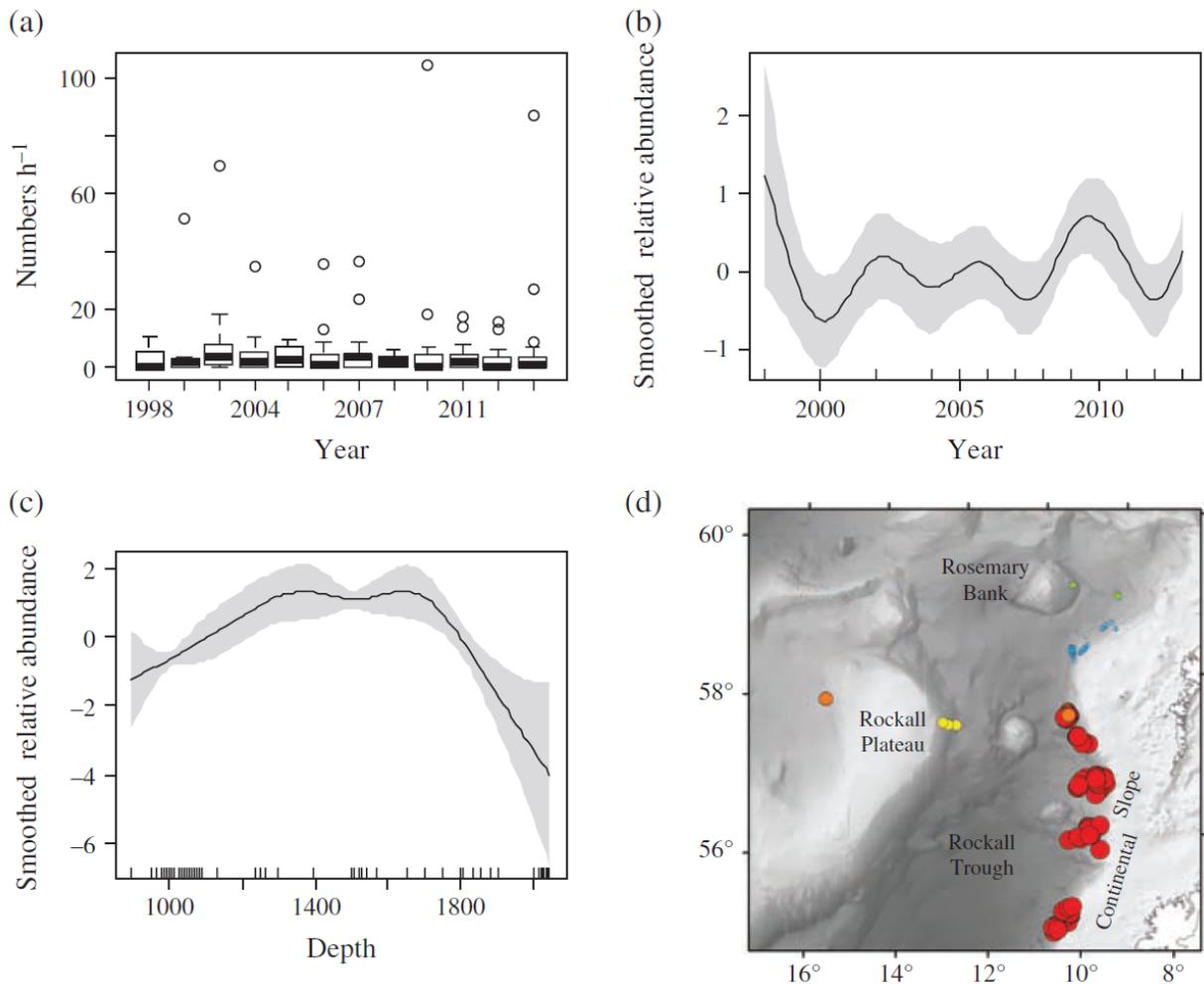


Figure 9 Results of GAM analysis of catches of greater lantern shark (*Etmopterus princeps*) in the Scottish deep-water trawl survey from Neat *et al.* (2015), showing (a) a box-whisker plot of numbers per hour for each year; (b) a smoothed function of relative abundance across years; (c) a smoothed function of relative abundance across depths (short bars near the x axis indicate observations); and (d) distribution of abundance across the survey area. Large red dots indicate hauls of high abundance in close proximity to other hauls of high abundance, whereas small blue dots indicate hauls of low abundance in close proximity to other hauls of low abundance.

Bluntnose six-gill shark (*Hexanchus griseus*)

Stratified biomass index of *H. griseus* in the Spanish Porcupine Bank survey (SpPGFS-WIBTS-Q4) has fluctuated without a trend between 2001 and 2017 (Figure 10).

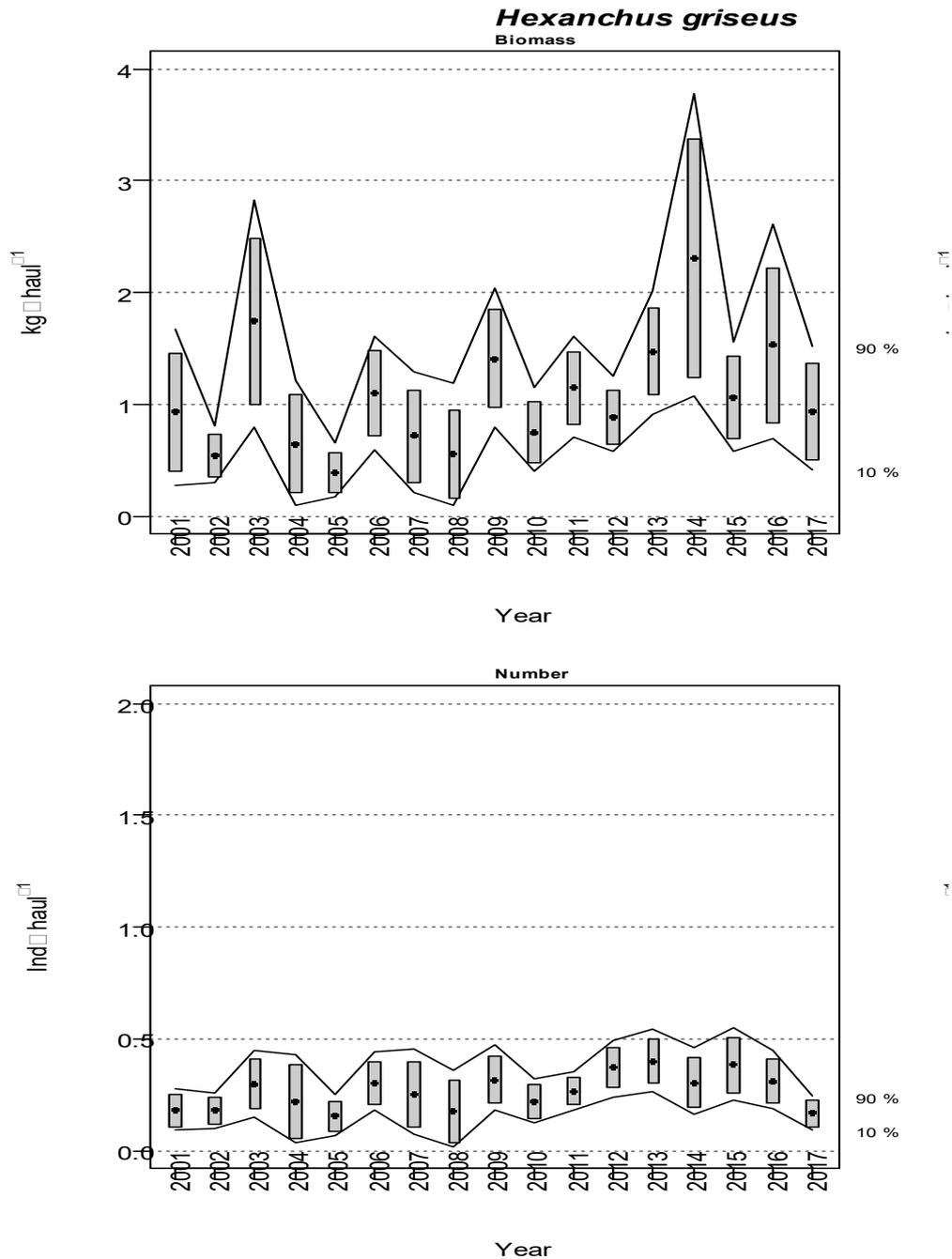


Figure 10 Changes in bluntnose six-gill shark (*Hexanchus griseus*) biomass index ($\text{kg} \times \text{haul}^{-1}$) during the Spanish Porcupine Bank survey (SpPGFS-WIBTS-Q4) time-series (2001–2017). Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals ($\alpha = 0.80$, bootstrap iterations = 1000). From ICES Working Group on Elasmobranch Fishes (ICES, 2018) and references therein.

In the Spanish IEO Q4-IBTS survey in the Cantabrian Sea and Galician waters, the biomass of *H. griseus* has fluctuated without a trend in standard hauls and the species was absent since 2015 in additional deeper hauls (Figure 11).

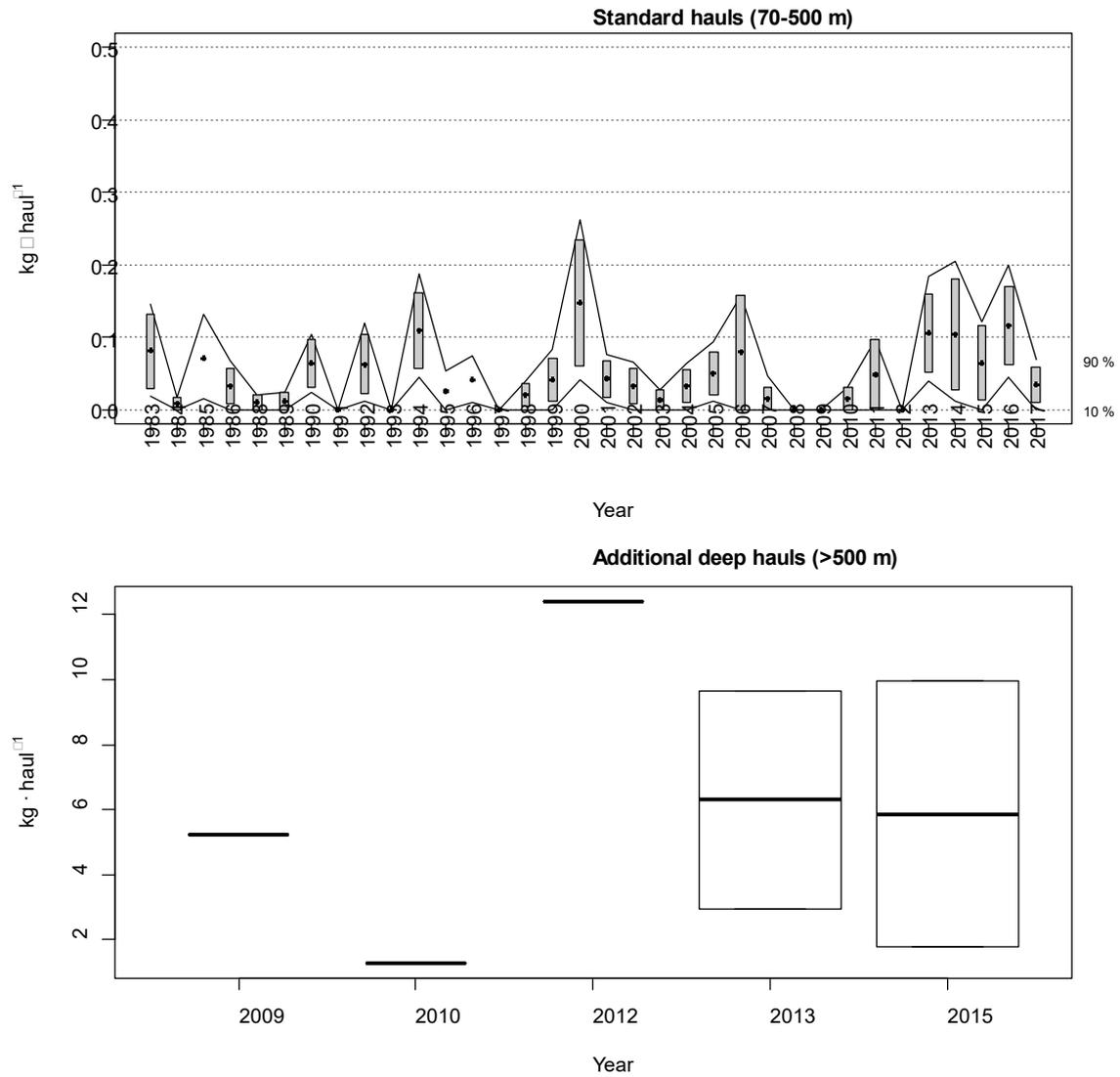


Figure 11 Evolution of *Hexanchus griseus* stratified biomass index in standard hauls and in additional deep hauls during the North Spanish shelf bottom-trawl survey time-series. Boxes mark parametric standard error of the stratified biomass index. Lines mark bootstrap confidence intervals ($\alpha = 0.80$, bootstrap iterations = 1000). From ICES Working Group on Elasmobranch Fishes (ICES, 2018) and references therein.

The relative abundance of *H. griseus* between depths of 300 m and 800 m from the Scottish deep-water survey averaged < 1 individuals \times h⁻¹ over the past 14 years (Table 1). There was an anomalously high catch of 15 individuals in 2008.

Table 1 Summary data for bluntnose six-gill shark (*Hexanchus griseus*) from the Scottish deep-water survey. (N_{hauls} = number of hauls; N_{fish} = number of fishes; Mean N_{pH} = mean number per hour). From ICES Working Group on Elasmobranch Fishes (ICES, 2018).

Year	N_{hauls}	N_{fish}	Mean N_{pH}	Proportion of positive hauls
1998	18	1	0.03	0.06
2000	16	0	0	0
2002	13	3	0.13	0.15
2004	14	0	0	0
2005	7	2	0.14	0.14
2006	11	1	0.05	0.09
2007	6	8	0.68	0.33
2008	8	15	1.09	0.25
2009	8	1	0.14	0.13
2011	8	0	0	0
2012	8	1	0.14	0.13
2013	11	3	0.31	0.18

Black dogfish (*Centroscyllium fabricii*)

The relative abundance of *C. fabricii* between depths of 800 m and 1800 m from the Scottish deep-water survey has fluctuated without a trend since 1998 but with higher numbers in recent years (Figure 12) (Neat *et al.*, 2015). Variability of the catch rates is high, with occasional large catches recorded.

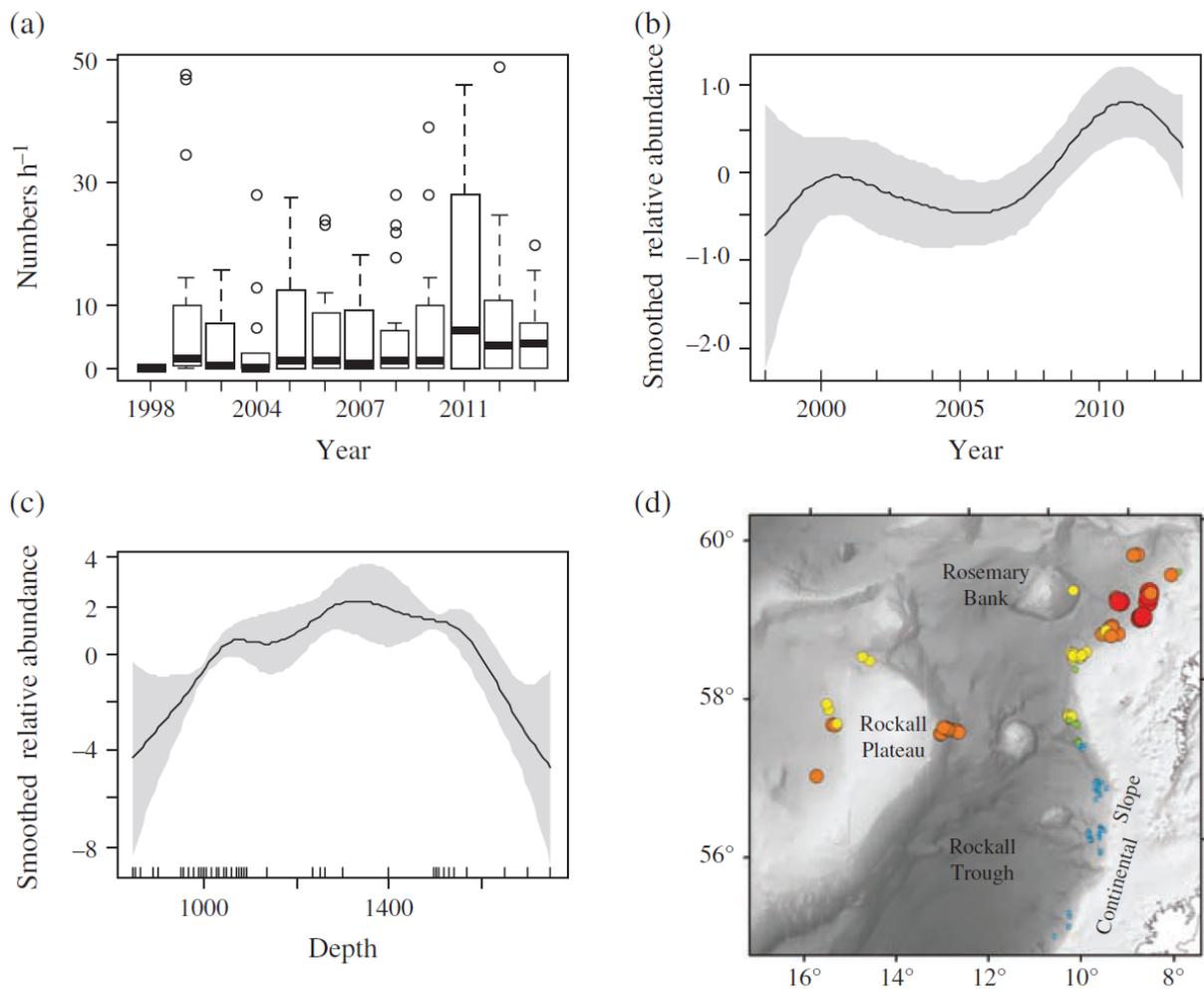


Figure 12 Results of GAM analysis of black dogfish (*Centroscymnus fabricii*) catches in the Scottish deep-water trawl survey from Neat *et al.* (2015), showing (a) a box-whisker plot of numbers per hour for each year; (b) a smoothed function of relative abundance across years; (c) a smoothed function of relative abundance across depths (short bars near the x axis indicate observations); and (d) distribution of abundance across the survey area. Large red dots indicate hauls of high abundance in close proximity to other hauls of high abundance, whereas small blue dots indicate hauls of low abundance in close proximity to other hauls of low abundance.

Longnose velvet dogfish (*Centroscymnus crepidater*)

The relative abundance of this species between depths of 500 m and 1800 m from the Scottish deep-water survey has fluctuated without a trend with mostly low numbers but with occasional very high catches for the past 14 years (Figure 13) (Neat *et al.*, 2015).

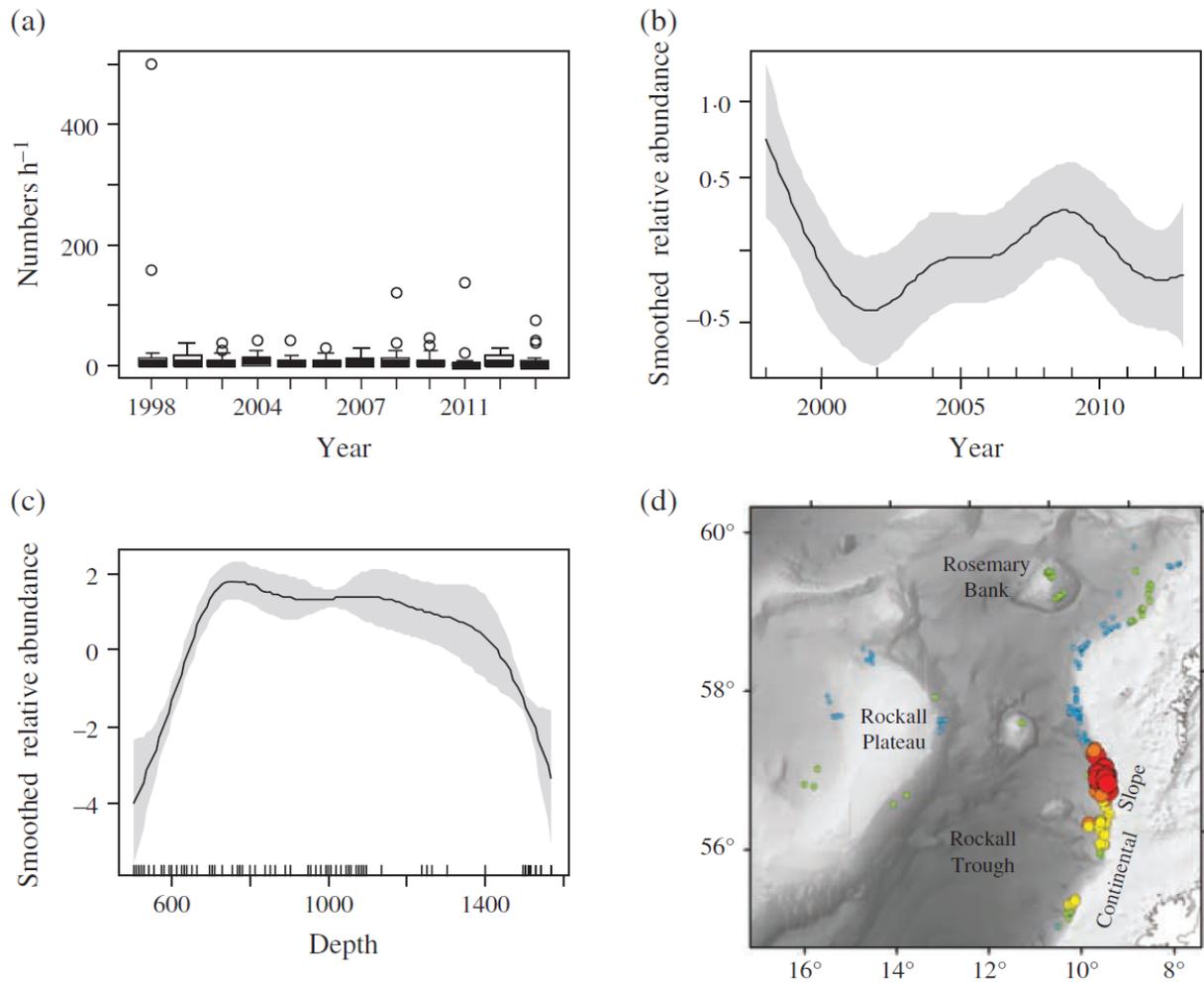


Figure 13 Results of GAM analysis of longnose velvet dogfish (*Centroscyrnus crepidater*) catches in the Scottish deep-water trawl survey from Neat *et al.* (2015), showing (a) a box-whisker plot of numbers per hour for each year; (b) a smoothed function of relative abundance across years; (c) a smoothed function of relative abundance across depths (short bars near the x axis indicate observations); and (d) distribution of abundance across the survey area. Large red dots indicate hauls of high abundance in close proximity to other hauls of high abundance, whereas small blue dots indicate hauls of low abundance in close proximity to other hauls of low abundance.

Small-eye catshark (*Apristurus microps*)

The relative abundance of this species at depths of 500 m and 1500 m from the Scottish deep-water survey was low on average over the past 14 years and analyses suggest an increasing trend over time (Figure 14) (Neat *et al.*, 2015).

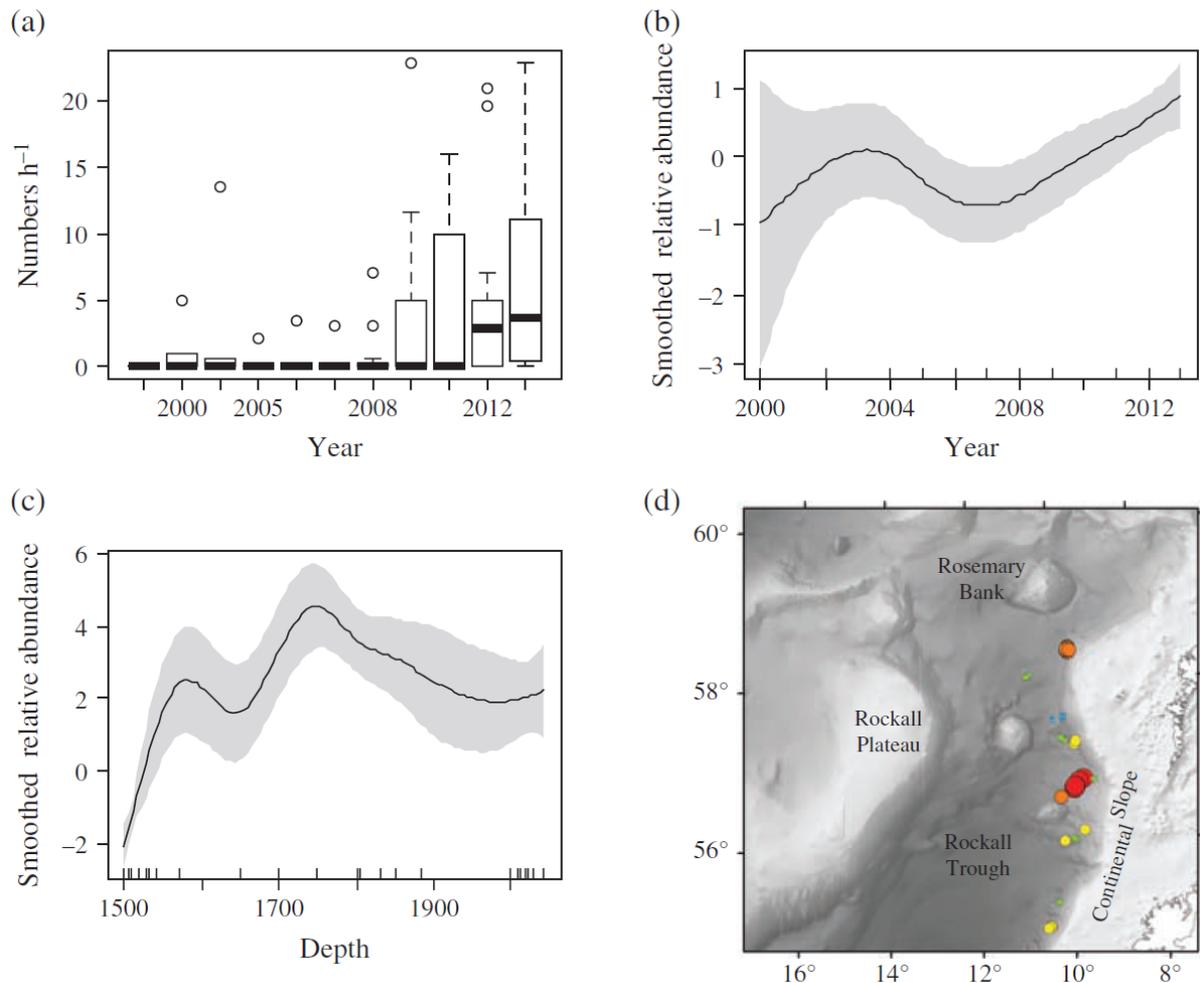


Figure 14 Results of GAM analysis of small-eye catshark (*Apristurus microps*) catches in the Scottish deep-water trawl survey from Neat *et al.* (2015), showing (a) a box-whisker plot of numbers per hour for each year; (b) a smoothed function of relative abundance across years; (c) a smoothed function of relative abundance across depths (short bars near the x axis indicate observations); and (d) distribution of abundance across the survey area. Large red dots indicate hauls of high abundance in close proximity to other hauls of high abundance, whereas small blue dots indicate hauls of low abundance in close proximity to other hauls of low abundance.

Pale catshark (*Apristurus aphyodes*)

The relative abundance of this species between depths of 800 m and 2030 m from the Scottish deep-water survey increased until 2006 and fluctuated without trend afterwards (Figure 15) (Neat *et al.*, 2015).

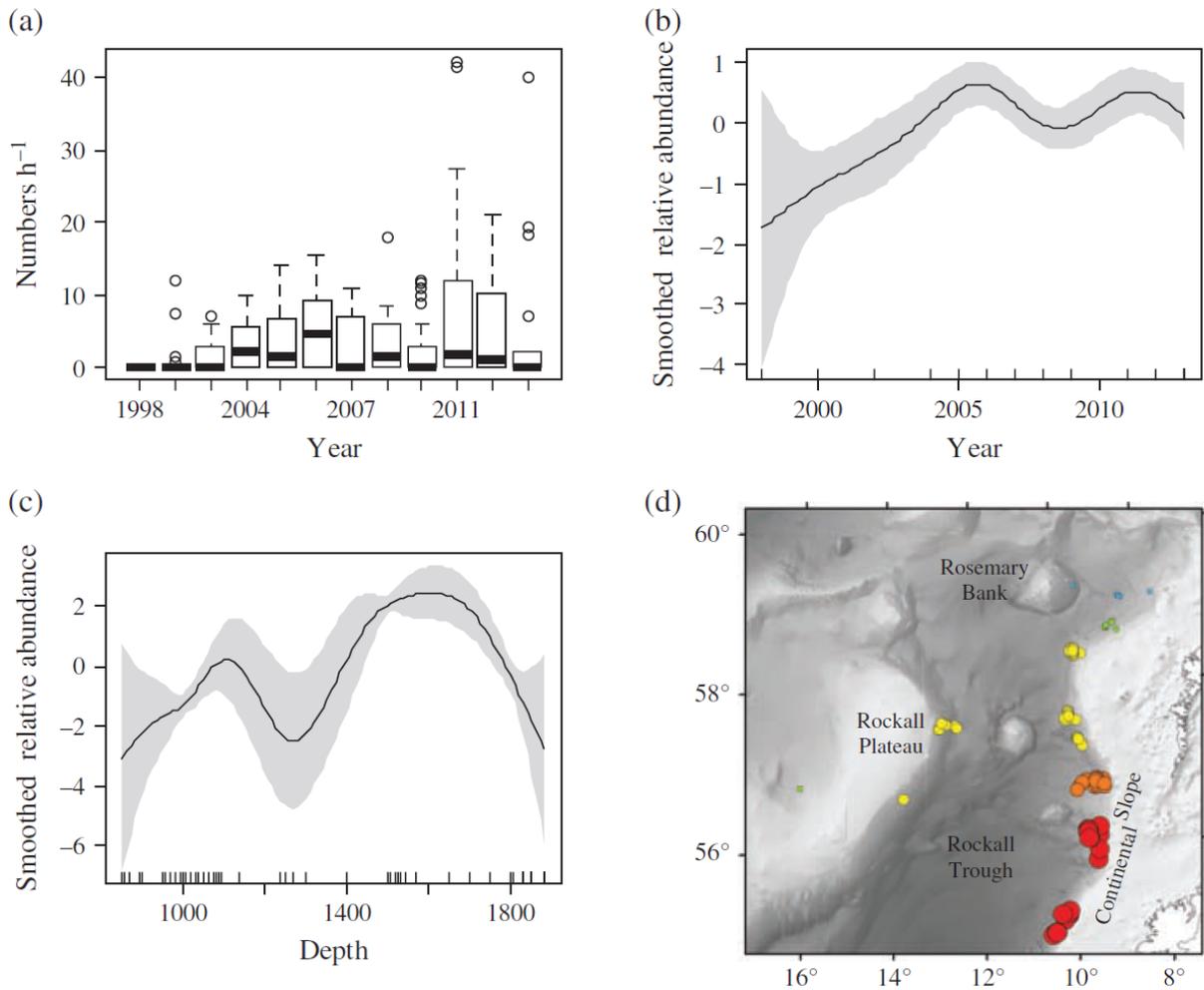


Figure 15 Results of GAM analysis of pale catshark (*Apristurus aphyodes*) catches in the Scottish deep-water trawl survey from Neat *et al.* (2015), showing (a) a box-whisker plot of numbers per hour for each year; (b) a smoothed function of relative abundance across years; (c) a smoothed function of relative abundance across depths (short bars near the x axis indicate observations); and (d) distribution of abundance across the survey area. Large red dots indicate hauls of high abundance in close proximity to other hauls of high abundance, whereas small blue dots indicate hauls of low abundance in close proximity to other hauls of low abundance.

Deep-water skates and rays

Skates are caught infrequently in the Scottish deep-water survey, and the total numbers of each species (blue pygmy skate *Neoraja caerulea*, Mid-Atlantic skate *Rajella kukujevi*, round skate *Rajella fyllae*, deep-water skate *Rajella bathyphila*, Bigelow's skate *Rajella bigelowi*, Richardson's skate *Bathyraja richardsoni*, Jensen's skate *Amblyraja jenseni*, and Krefft's skate *Malacoraja krefftii*) caught in respective years are shown in Table 2.

Table 2 Total number of deep-water skates caught in the Scottish deep-water survey across all depths by year (blue pygmy skate *Neoraja caerulea*, Mid-Atlantic skate *Rajella kukujevi*, round skate *Rajella fyllae*, deep-water skate *Rajella bathyphila*, Bigelow's skate *Rajella bigelowi*, Richardson's skate *Bathyraja richardsoni*, Jensen's skate *Amblyraja jenseni*, and Krefft's skate *Malacoraja krefftii*).

Year	<i>N. caerulea</i>	<i>R. kukujevi</i>	<i>R. fyllae</i>	<i>R. bathyphila</i>	<i>R. bigelowi</i>	<i>B. richardsoni</i>	<i>A. jenseni</i>	<i>M. krefftii</i>
1998	1	0	11	0	0	0	0	0
2000	1	0	6	2	2	0	0	0
2002	4	1	9	4	0	0	1	1
2004	0	1	7	1	0	0	0	0
2005	0	0	2	0	1	0	0	0
2006	0	0	7	2	1	0	0	0
2007	1	0	4	1	1	0	6	2
2008	0	0	6	0	0	0	3	0
2009	0	0	8	0	2	2	1	1
2011	0	4	4	0	1	0	1	0
2012	5	0	6	0	1	2	6	0
2013	0	0	1	0	3	10	6	2
Total	12	6	71	10	12	14	24	6

Potential options for mitigation of bycatch

Council Regulation (EU) 2018/2025 (EU, 2018) states that "It shall be prohibited for Union fishing vessels to fish for deep-sea sharks in ICES subareas 5 to 9, in Union and international waters of ICES subarea 10, in international waters of ICES subarea 12 and in Union waters of CECAF 34.1.1, 34.1.2 and 34.2 and to retain on board, tranship, relocate or land deep-sea sharks caught in those areas, with the exception of cases where TACs apply for bycatches in fisheries for black scabbardfish that use longlines". This limited bycatch TAC for deep-water sharks was allowed for each of the years from 2017 to 2020, on a trial basis, in the directed artisanal deep-sea longline fisheries for black scabbardfish (*Aphanopus carbo*; EU, 2016a, 2018). The TACs for bycatch amount to a total of 21 tonnes in ICES subareas 9 and 10 and in CECAF waters. This does not apply to *Galeus melastomus*, which is not one of the prohibited deep-sea sharks. For scientific purposes, limited bycatch is allowed in target fisheries for the black scabbardfish fishery (ICES, 2020). NEAFC has prohibited all the deep-water sharks from being fished.

These regulations imply that when caught, these species are discarded and do not survive because at such depths the likelihood of survival is very low. The existing legislation is not designed to mitigate bycatch, but to deter targeted catch and catch in areas where bycatch is high. Thus, TAC and prohibition management measures alone do not effectively regulate outtake of these species. Being subject to prohibition or equivalent, these species are not subject to the EU Landings Obligation. ICES recognizes that, despite their limitations, prohibition, gear and depth limitations (EU, 2016b), and TAC are mechanisms currently available to managers to regulate outtake; therefore, ICES advises that these mechanisms should be maintained.

Mitigation of bycatch of deep-water elasmobranchs can be considered across four broad gear types.

True deep-water fisheries in waters of greater than 400 m depth, and/or targeting deep-water species

1. Bottom trawls
2. Longlines
3. Gillnets and tanglenets

Non-deep-water fisheries with some interactions with deep-water species

4. Pelagic trawls when deployed at or near the bottom

Most of these deep-water sharks are only present in depths greater than 500 m. Hence, mitigation of bycatch is a concern only in dedicated deep-water fisheries or those operating in deep waters (e.g. some pelagic trawling). Various regulations restrict the use of the first three gear types above. Bottom trawling by EU vessels and in EU waters is banned in waters deeper than 800 m (EU, 2016b), while gillnet and tanglenet fisheries (by EU vessels and in EU waters) are banned at depths greater than 600 m (EU, 2007). A gillnet ban in waters deeper than 200 m is also in operation in the NEAFC Regulatory Area (all international waters of ICES Area).

Given these bans, the following gear types represent the main risk of bycatch:

- Longlines in all areas;
- Bottom trawls in waters shallower than 800 m;
- Bottom trawls at all depths in the NEAFC Regulatory Area (NEAFC-West only, because deep-water sharks are not widely distributed in NEAFC-Banana Hole and NEAFC-Doughnut Hole);
- Pelagic trawls operating in waters deeper than 600 m, especially those contacting the bottom.

Bycatch mitigation measures based on species selectivity (e.g. mesh sizes and sorting grids) are difficult to implement since many species occur in a similar size range as the target species in mixed fisheries (exceptions include the Greenland shark *Somniosus microcephalus*). However, there are other approaches that have been considered, such as electromagnetic exclusion devices, acoustic or light-based deterrents. None of these have been fully developed and are very much at the concept stage as of present.

For deep-water sharks, spatio-temporal management could be considered to minimize bycatch, for instance by avoidance of some fishing grounds or time of the year, where and when the spatial overlap between the target species of the fisheries and deep-water shark species could be considered.

Small-bodied and/or upper slope, cold water tolerant species such as *Galeus melastomus*, *Etmopterus spinax*, and *Chimaera monstrosa* may be taken in several fisheries in many areas, as for example in the Skagerrak (Subarea 3), Iceland (Subarea 5), Greenland (Subarea 14), the Porcupine Bank (Subarea 7), and the Bay of Biscay (Subarea 8). However, whether the species' populations can sustain the level of discarded bycatch needs to be evaluated in the context of a shark population assessment, providing estimates of fishing mortality in relation to sustainable exploitation rates.

Some pelagic trawl fisheries deploy their nets on or close to the bottom (to some extent), and a bycatch of deep-water sharks can be expected. This may be particularly relevant for blue whiting and redfish fisheries, both of which occur in deep waters. Further research is required to evaluate the full extent of interaction between pelagic trawls and bottom-dwelling sharks. Most blue whiting fishing takes place in waters shallower than 500 m; hence, it will have limited interaction with deep-water sharks. Although bycaught numbers may be expected to be low, midwater pelagic fisheries may interact with species which can be found in the water column above the bottom.

Suggestions

The maps generated for this advice are based on the data received from the dedicated data call² and show the best available information of the distribution of the main deep-water elasmobranch species. The maps do not cover the Azores, all of the Mid-Atlantic Ridge, and Faroese waters, because existing survey data were not available for this specific request. Future work could focus on collating all available data from these areas.

² <https://www.ices.dk/sites/pub/Publication%20Reports/Data%20calls/datacall.20190810-2.DeepSeaSharks.pdf>.

Basis of the advice

Background

The advice is produced in response to a joint request from NEAFC and OSPAR. The purpose of the request was for ICES to provide information on distribution, a summary of advice and stock trends, and possible mitigation measures to reduce bycatch on deep-sea elasmobranchs. The intent is that the same information could then be used by both organizations, each within their competence, in considering possible future measures to ensure healthy populations of these species.

Results and conclusions

Distribution maps

Distribution maps are provided both in PDF format (on Annex 1) and as shapefiles¹. For each of the species, maps were created for areas where the species were encountered in the surveys. If a species was not encountered in a particular area, then a map was not produced for the species in that area. As such, the maps show the distribution of individual species by depicting the location of the catches in the surveys within the depth range for the respective species (coloured depth contours).

The maps produced are based on national or international surveys. These surveys do not cover the entire Northeast Atlantic. Surveys may have geographic or depth restrictions, limiting the amount of data available. For example, the Mid-Atlantic Ridge has only been surveyed by two time-series: the Icelandic survey series and the Norwegian Mar-Eco project. This means that it has been less intensively surveyed than, for instance, the Porcupine Bank area. In addition, data from the Azores ecoregion were unavailable.

Due to gear limitations, most trawl surveys do not sample below 2000 m, and are rarely deployed below 1200 m. Areas primarily consisting of rough or rocky ground, or areas that have not previously been fished or surveyed using multibeam sonars, may not be sampled at all due to the risk of gear damage.

Differing gear types may produce different results. A good example is longlines vs. trawls. Longlines may not catch small elasmobranch specimens, as fish must be of a minimum size to be caught by the hook. Therefore, an area where a species has a juvenile or nursery area that is surveyed with this gear may show a different result if surveyed by trawl. In addition, differences in survey vessels and survey gear configuration (for a particular gear type) as well as seasonal differences in the timing of individual surveys vs species availability can also produce different results.

Taxonomy can be a confounding issue for some elasmobranch families, e.g. the Apristuridae. New species, such as *Apristurus melanoasper*, were described during the time-period of these surveys. Prior to 2005, this species did not appear in the records. Mis-identification of similar species can also occur. *A. microps* and *Galeus murinus*, in particular, can be difficult to tell apart. An unknown percentage of records of either of these two species may be incorrect. As a result, changes in taxonomic resolution over time may have introduced bias in relative abundance time series for some deepwater shark species.

The data available only represent the recorded catches of those sharks from survey stations where fishing occurred. The terrain of the deep sea is such that many areas cannot have survey gear deployed on them; hence, the distributions shown must be interpreted in that context.

Methods

Distribution maps

Distribution maps were produced, showing the main distributions of deep-water sharks in the NEAFC and OSPAR areas of the Northeast Atlantic. The data for the production of the maps originated from various national and international surveys conducted in deep waters. The data utilized were those submitted following a data call issued in 2019. Data were received from ten ICES Member Countries, covering a geographic area from ICES subareas 27.1 (Northeast Arctic) to 27.14 (Azores).

Data from surveys conducted in the Azores, the Mid-Atlantic Ridge, and Faroese waters were not available. Details of the data provided can be found in ICES (2020).

Maps were compiled showing depth ranges derived from the literature, available survey, and/or expert judgment. This was necessary as all deep-water sharks occupy a specific depth interval, which often varies from region to region, depending on the hydrographic conditions. As an example, Figure 16 illustrates the depth range of the more abundant species in the area west of Scotland. Further details are available in ICES (2020).

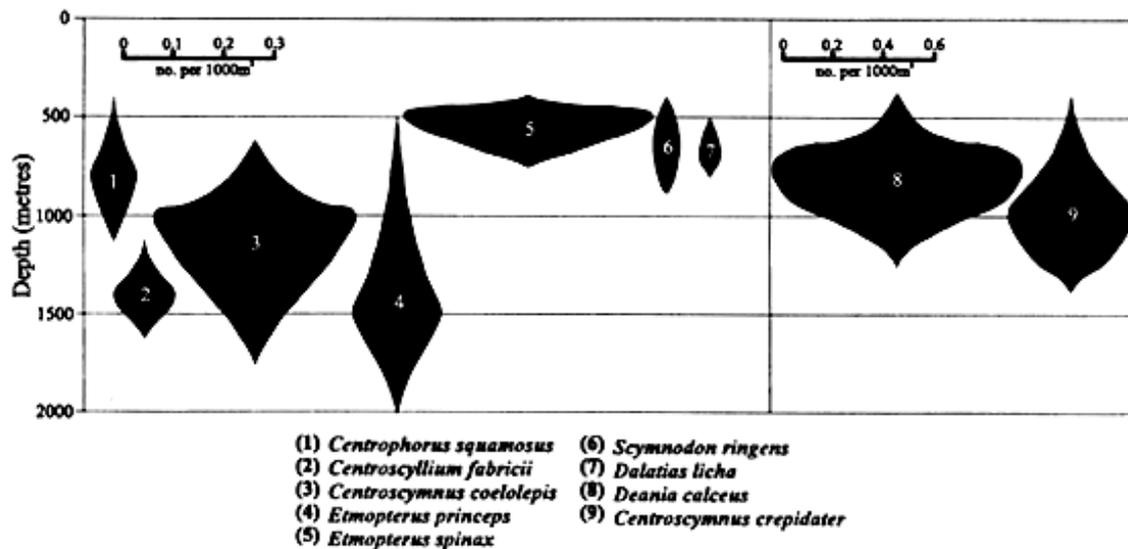


Figure 16 Distribution by depth of deep-water sharks in ICES Subarea 6. The figure illustrates that for most species, waters shallower than 500 m are not of importance. The exception is *Etmopterus spinax*. Reproduced from Gordon (1999).

The maps were generated by using GIS. The steps involved in the preparation of the individual maps were as follows:

- The shark species data from the joint OSPAR and NEAFC request for advice on deep-sea sharks, rays, and chimaeras were added to a layer in the GIS environment to create a shapefile. The shapefile was subsequently subdivided into relevant ICES areas: Area 27.10a1,2; Area 27.2-4; Area 27.5a,14ab; and Area 27.5b,9 for plotting, and saved as individual shapefiles.
- Bathymetry data was downloaded in relevant format (ESRI ASCII) in preparation for the plotting of depth range associated with the respective species, located in areas mentioned above. A specific depth range was constructed for all shark species associated within individual areas.
- Species depth range data were determined from literature review and expert judgement (Figure 16). Depth range analyses in the GIS model apply this information and map the corresponding ranges.
- Spatial area data to delineate species distribution was interpreted from expert judgement.
- For each species and area, the bathymetry of the depth interval occupied by the species was plotted as a coloured layer.

The resulting maps show the presence of the individual species on the bathymetric background of the species' spatial distribution.

Previous ICES advice and abundance time-series

ICES has previously provided advice for some of the species in the request and that advice was summarized. For other species, the information on abundance was derived from ICES (2018) and from Neat *et al.* (2015).

Mitigation measures

Potential mitigation measures for bycatch are provided and described in the “Elaboration on the advice”.

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Recommended citation: ICES. 2020. NEAFC and OSPAR joint request on the status and distribution of deep-water elasmobranchs. *In* Report of the ICES Advisory Committee, 2020. ICES Advice 2020, sr.2020.09. <https://doi.org/10.17895/ices.advice.7489>.

Annex 1 Species distribution maps

Data needed to electronically reproduce species distribution maps in this annex (shapefiles and associated datasets) are available at <https://doi.org/10.17895/ices.data.7490>

Amblyraja hyperborea

Amblyraja hyperborea, the Arctic skate, is a northern cold-water skate species. There are few records of the species from ICES subareas 27.6–27.12. The majority of records were documented in the Norwegian Sea, north to Svalbard (Figure A.1), around Iceland (Figure A.2), and north of the Wyville–Thomson Ridge (Figure A.3), south of which the species does not occur.

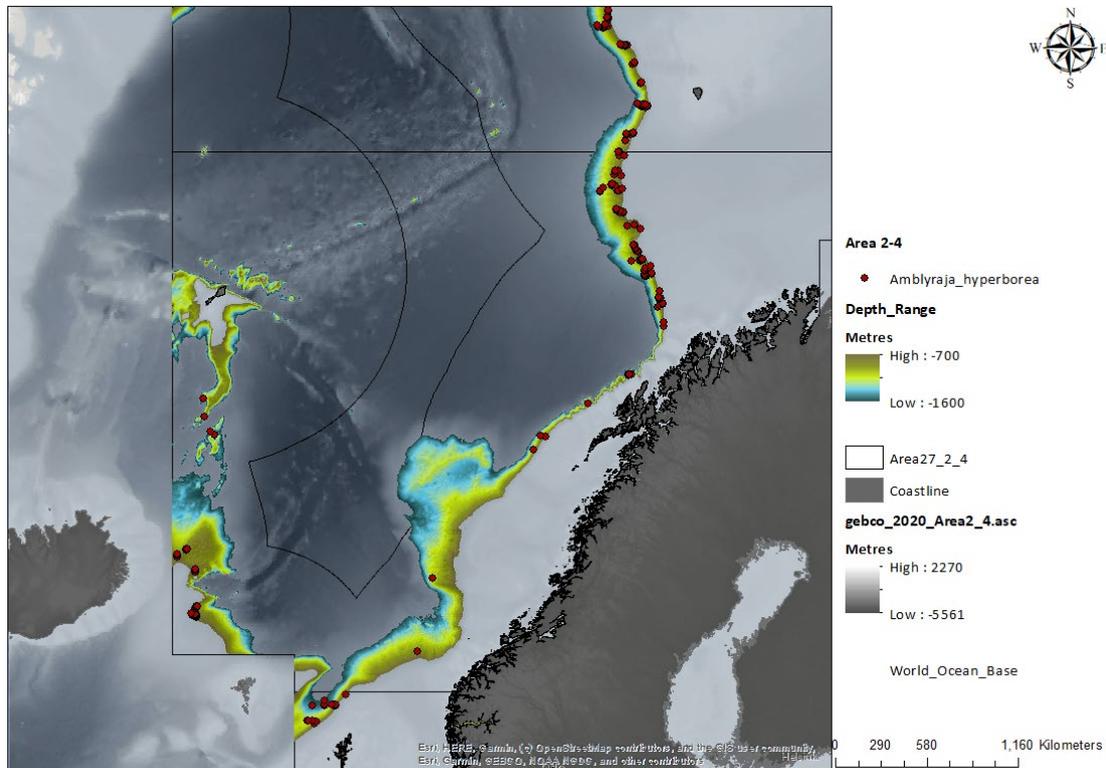


Figure A.1 Recorded distribution of survey catches (red dots) of *Amblyraja hyperborea* in ICES subareas 27.2–27.4.

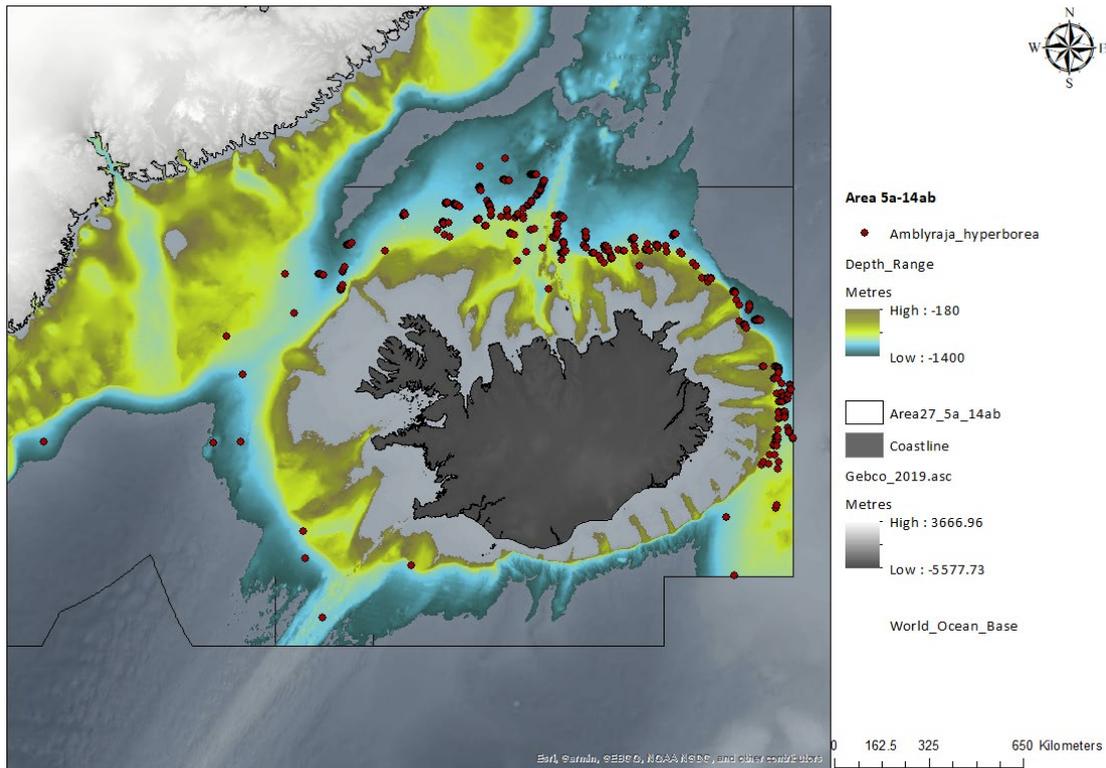


Figure A.2 Recorded distribution of survey catches (red dots) of *Amblyraja hyperborea* in ICES Division 27.5.a and Subarea 27.14.

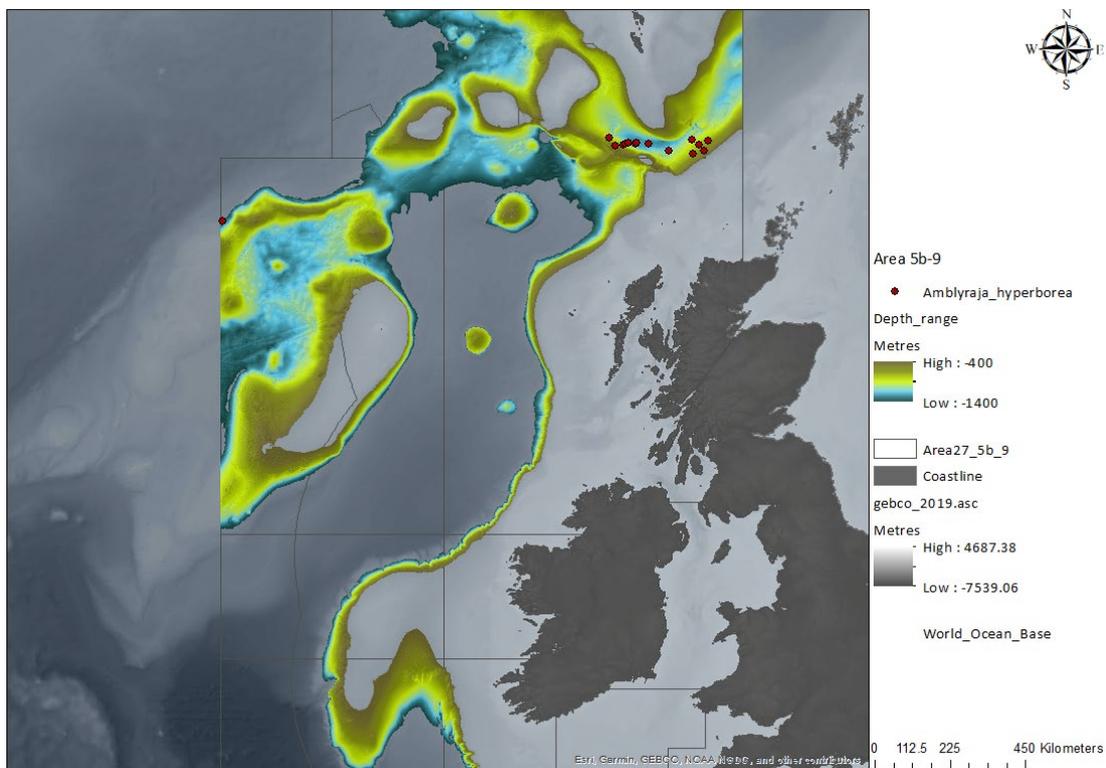


Figure A.3 Recorded distribution of survey catches (red dots) of *Amblyraja hyperborea* in ICES Division 27.5.b–Subarea 27.7.

Apristurus laurussonii

There is a clear northern component to the distribution of this species, with only two records from ICES Subarea 27.8. Around Iceland, the species is distributed to the south of the country, with no records from the northern coast (Figures A.4 and A.5). Records are also available from the western coast of Ireland, west of Scotland, with none reported from the Porcupine Bank area (Figure A.6). In Biscay and Iberia, there are records of the species south of Brittany, France.

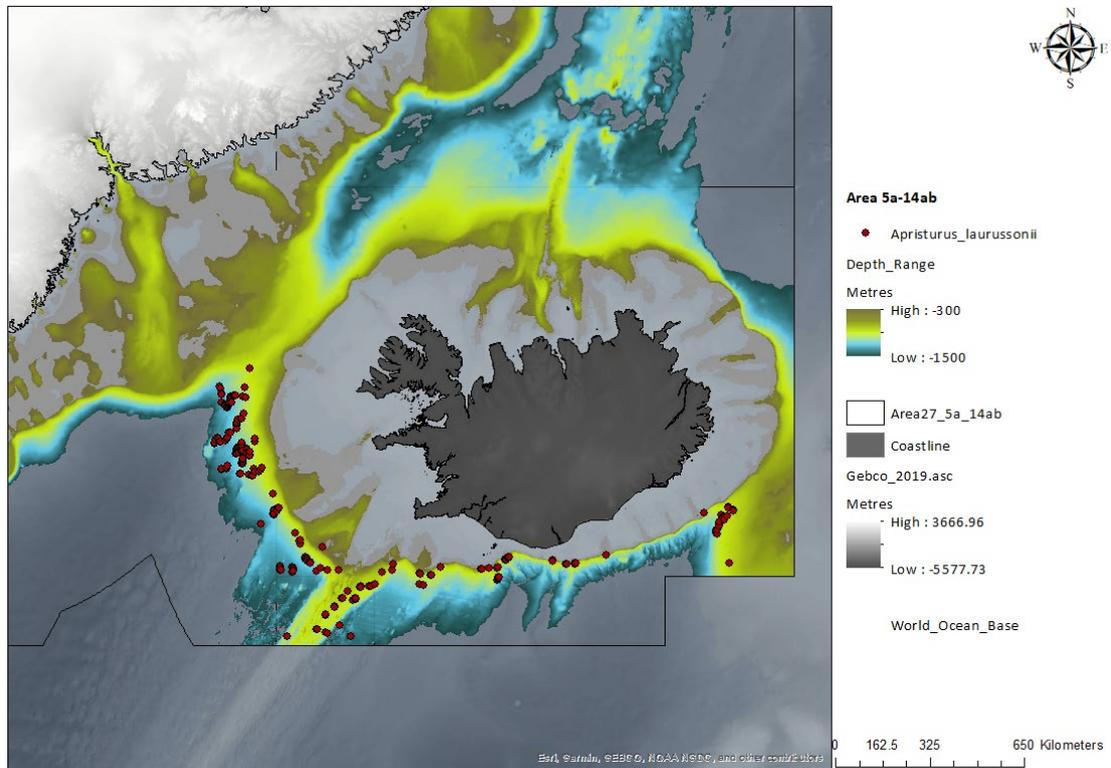


Figure A.4 Recorded distribution of survey catches (red dots) of *Apristurus laurussonii* in ICES Division 27.5.a and Subarea 27.14.

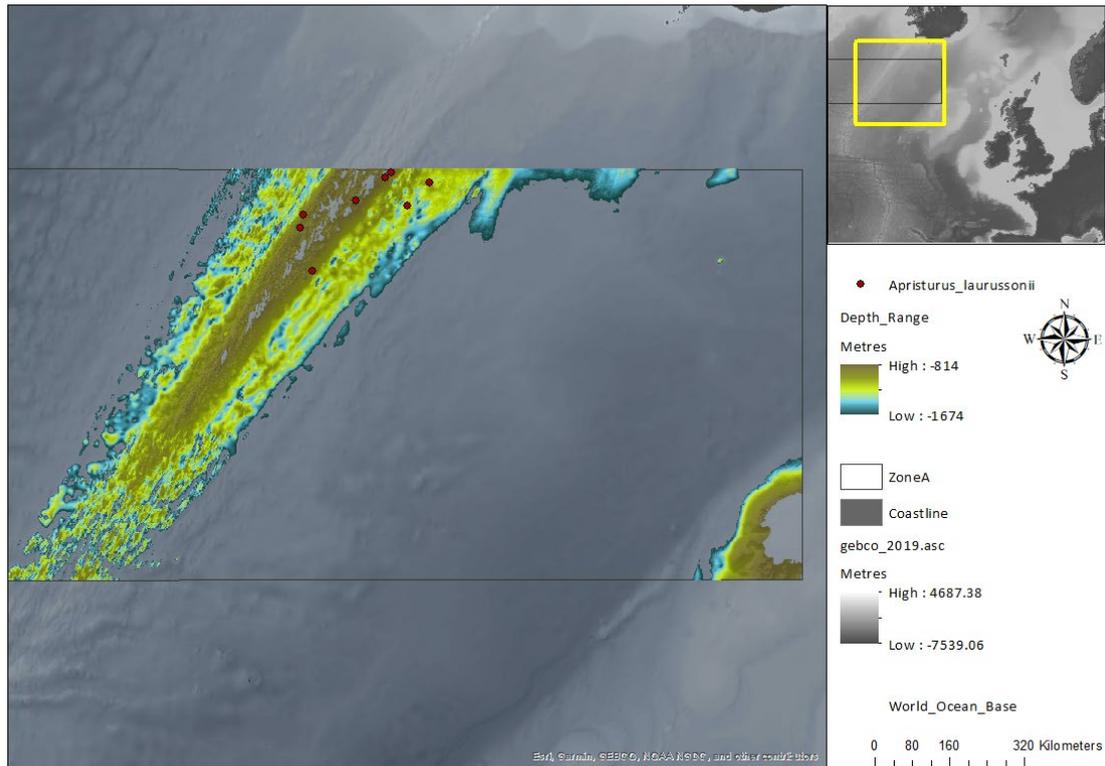


Figure A.5 Recorded distribution of survey catches (red dots) of *Apristurus laurussonii* in parts of ICES Divisions 27.12.ab.

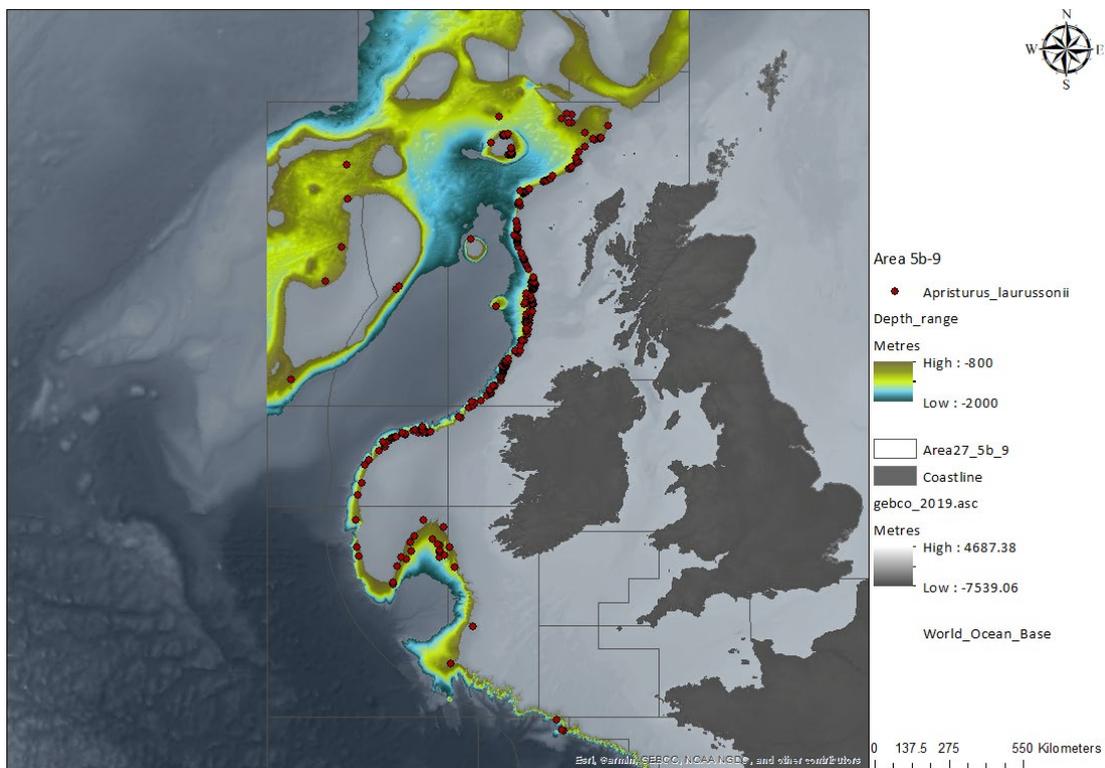


Figure A.6 Recorded distribution of survey catches (red dots) of *Apristurus laurussonii* in ICES Division 27.5.b–Subarea 27.8.

Centrophorus squamosus

Records of *C. squamosus* are from the south of Iceland (Figure A.7) and from the continental slopes and offshore banks south of the Wyville–Thomson Ridge (Figure A.8). The species is known to occur on the Mid-Atlantic Ridge south of Iceland (Figure A.9) and north of the Azores (Hareide and Garnes, 2001), though survey data are not available for that area in this analysis.

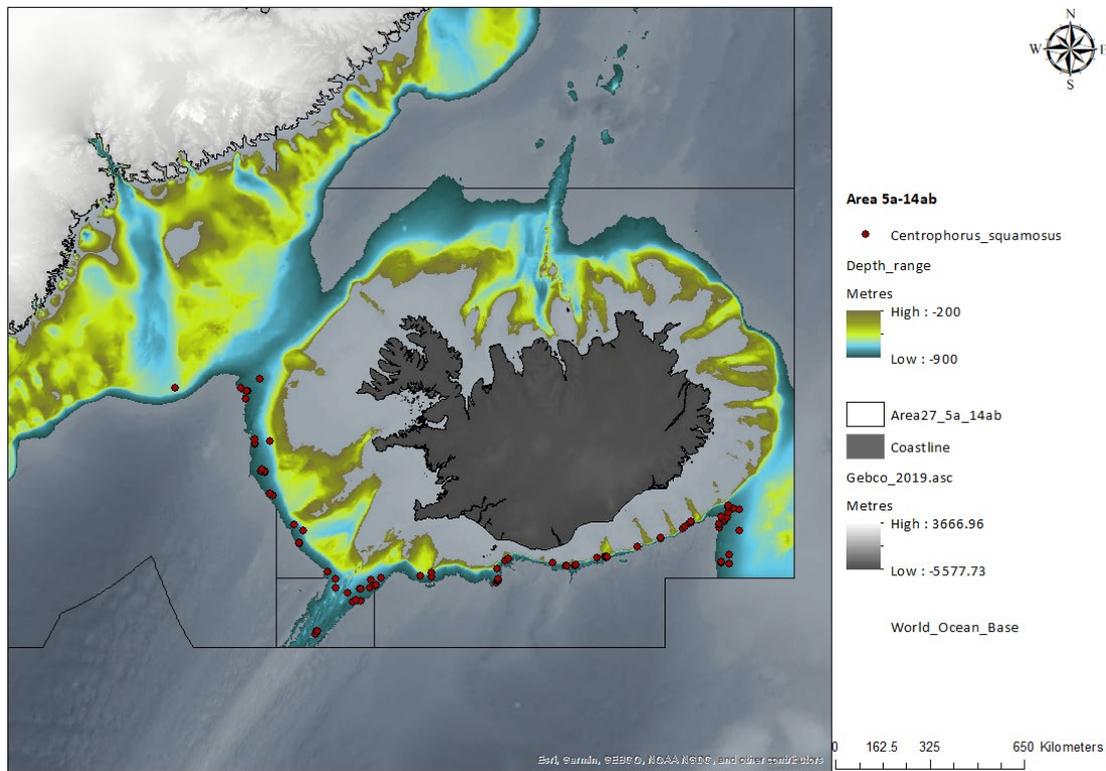


Figure A.7 Recorded distribution of survey catches (red dots) of *Centrophorus squamosus* in ICES Division 27.5.a and Subarea 27.14.

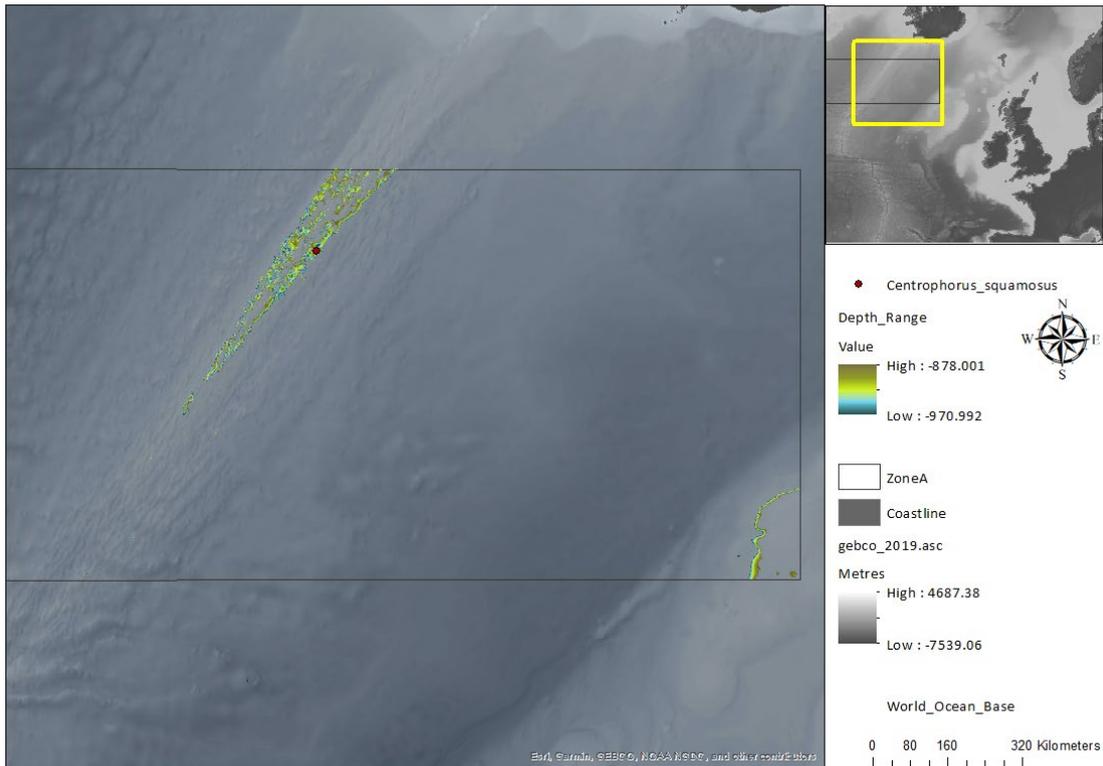


Figure A.8 Recorded distribution of survey catches (red dots) of *Centrophorus squamosus* in parts of ICES Divisions 27.12.ab.

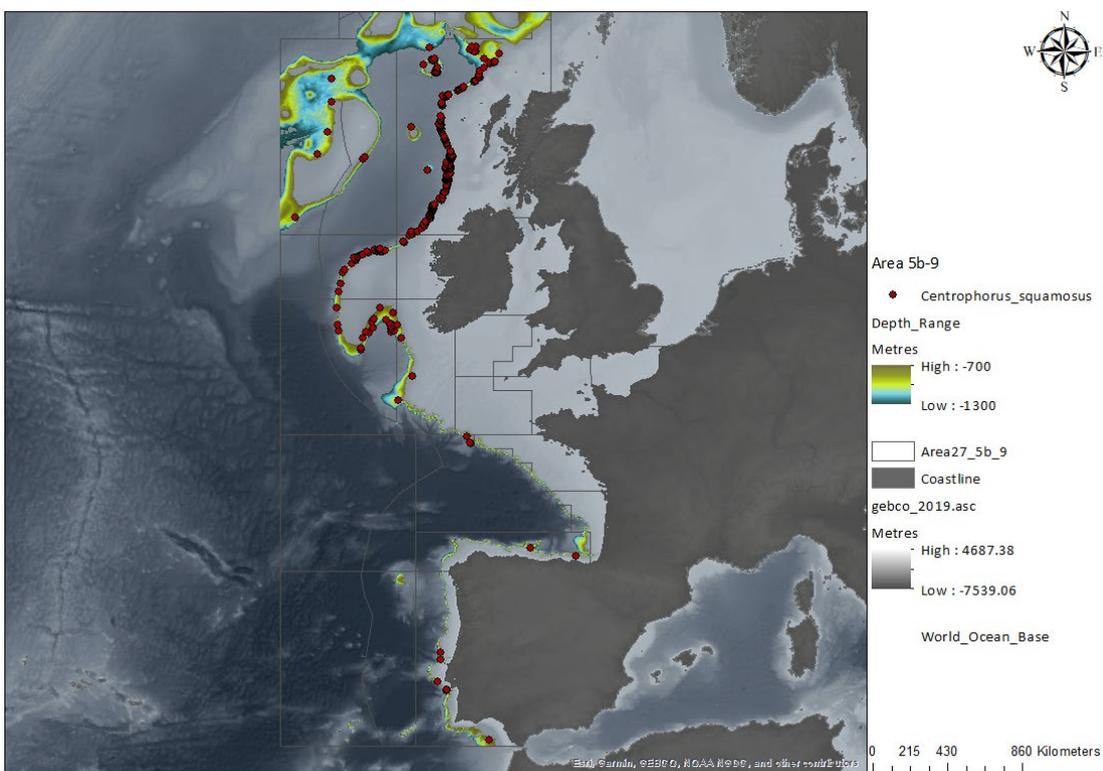


Figure A.9 Recorded distribution of survey catches (red dots) of *Centrophorus squamosus* in ICES Division 27.5.b-Subarea 27.9.

Centroscyllium fabricii

There is a northern trend in the distribution of *C. fabricii*, distributed south and west of Iceland (Figure A.10) and the Reykjanes Ridge (Figure A.11). In the eastern Atlantic, there are no records south of the Porcupine Bank (Figure A.12). Likewise, there are no reported records from the Mid-Atlantic Ridge.

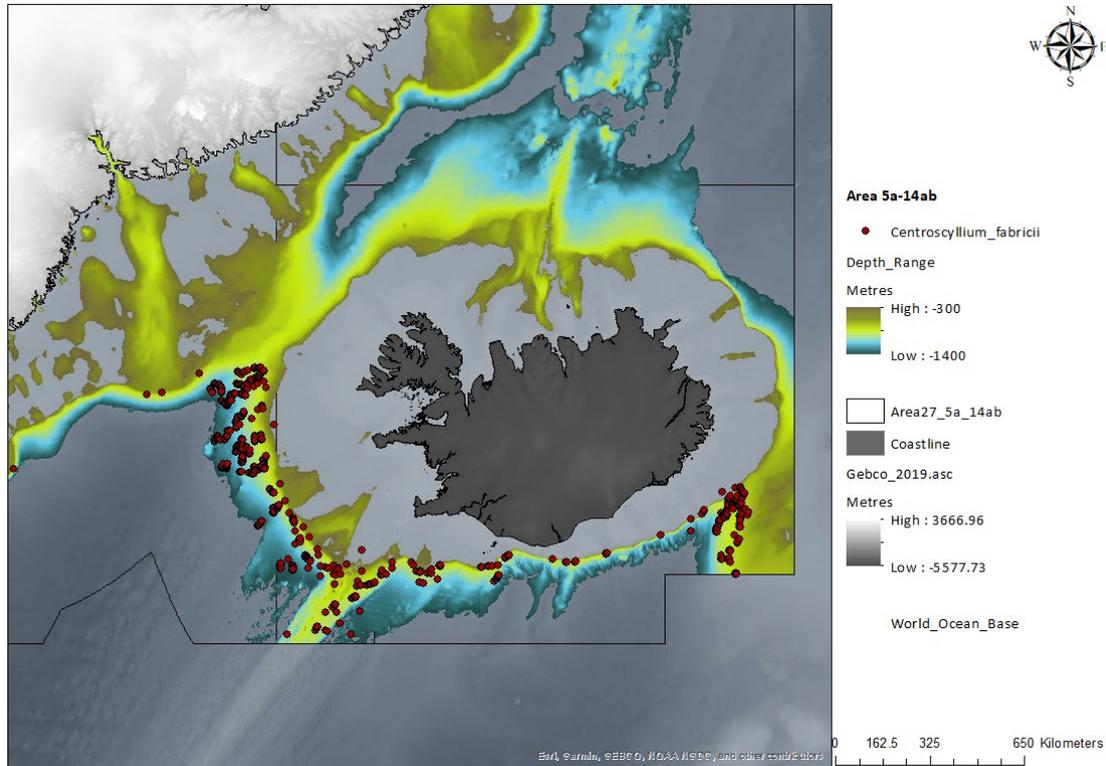


Figure A.10 Recorded distribution of survey catches (red dots) of *Centroscyllium fabricii* in ICES Division 27.5.a and Subarea 27.14.

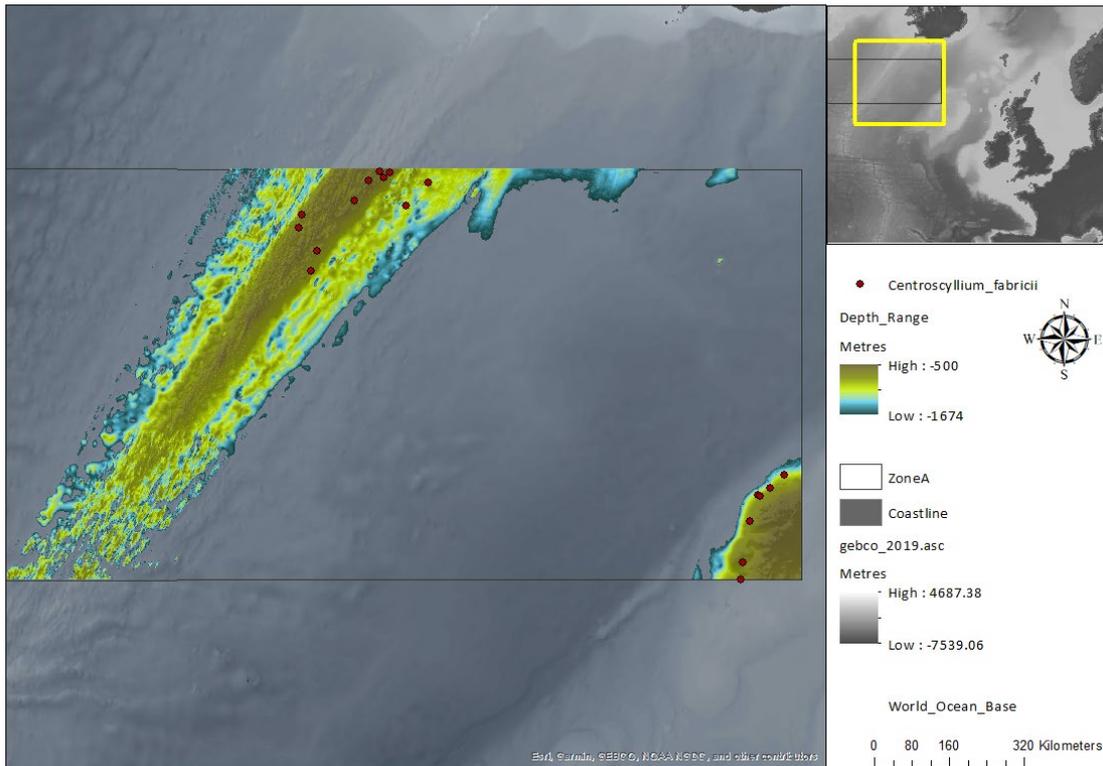


Figure A.11 Recorded distribution of survey catches (red dots) of *Centroscyllium fabricii* in parts of ICES Divisions 27.12.ab.

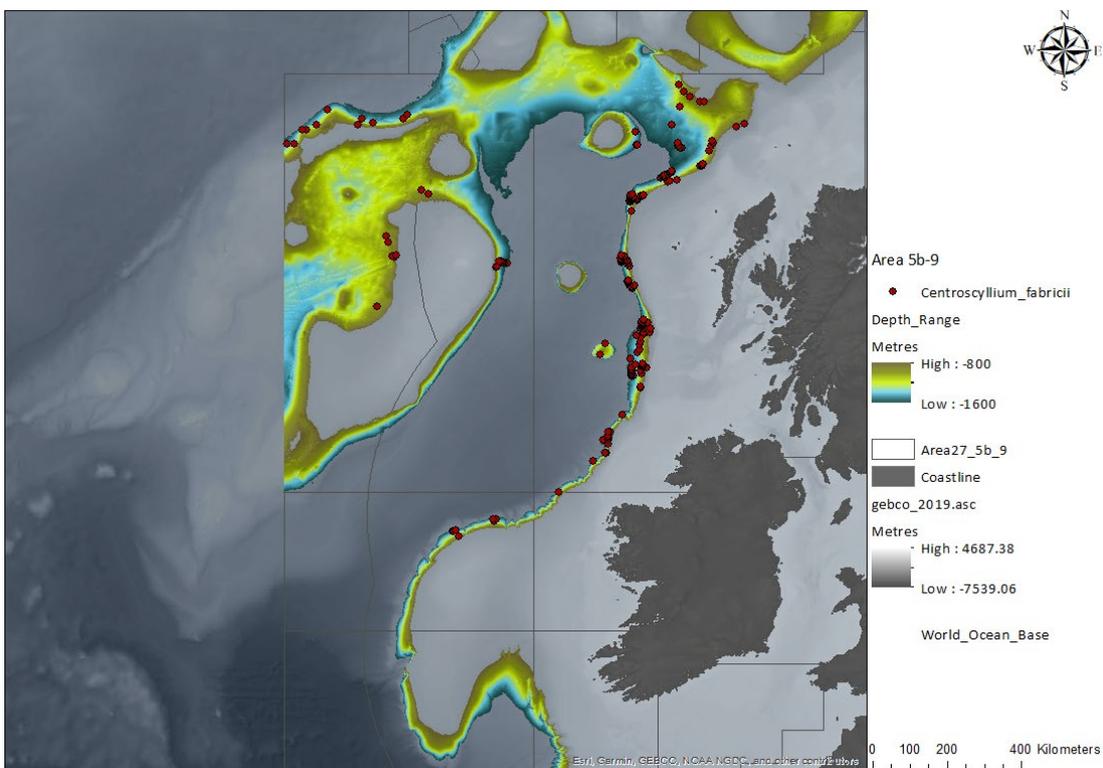


Figure A.12 Recorded distribution of survey catches (red dots) of *Centroscyllium fabricii* in ICES Division 27.5.b-Subarea 27.7.

Centroscymnus coelolepis

Centroscymnus coelolepis is found from south of Iceland to Portugal (Figures A.13–A.16). It is only absent from the Norwegian coast. Most records of *C. coelolepis* are from the northern part of its distribution. There are records from the north of Spain and the Portuguese coast. There are few records from the Bay of Biscay, but this is likely due to survey effort.

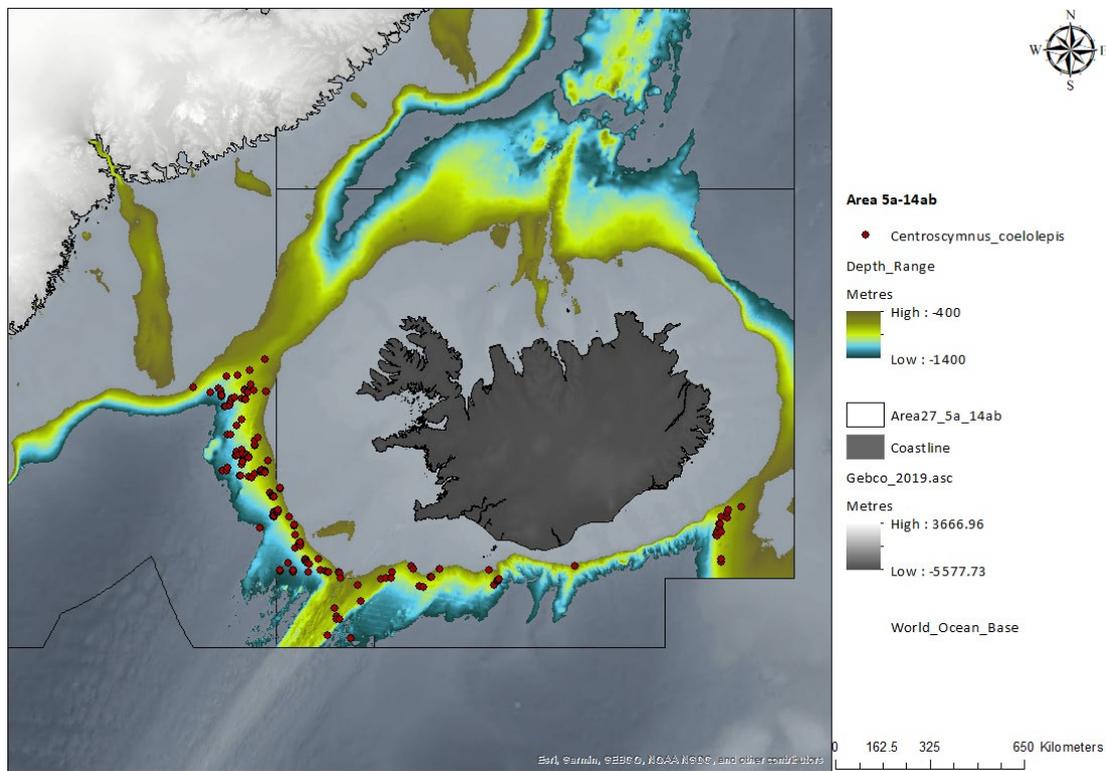


Figure A.13 Recorded distribution of survey catches (red dots) of *Centroscymnus coelolepis* in ICES Division 27.5.a and Subarea 27.14.

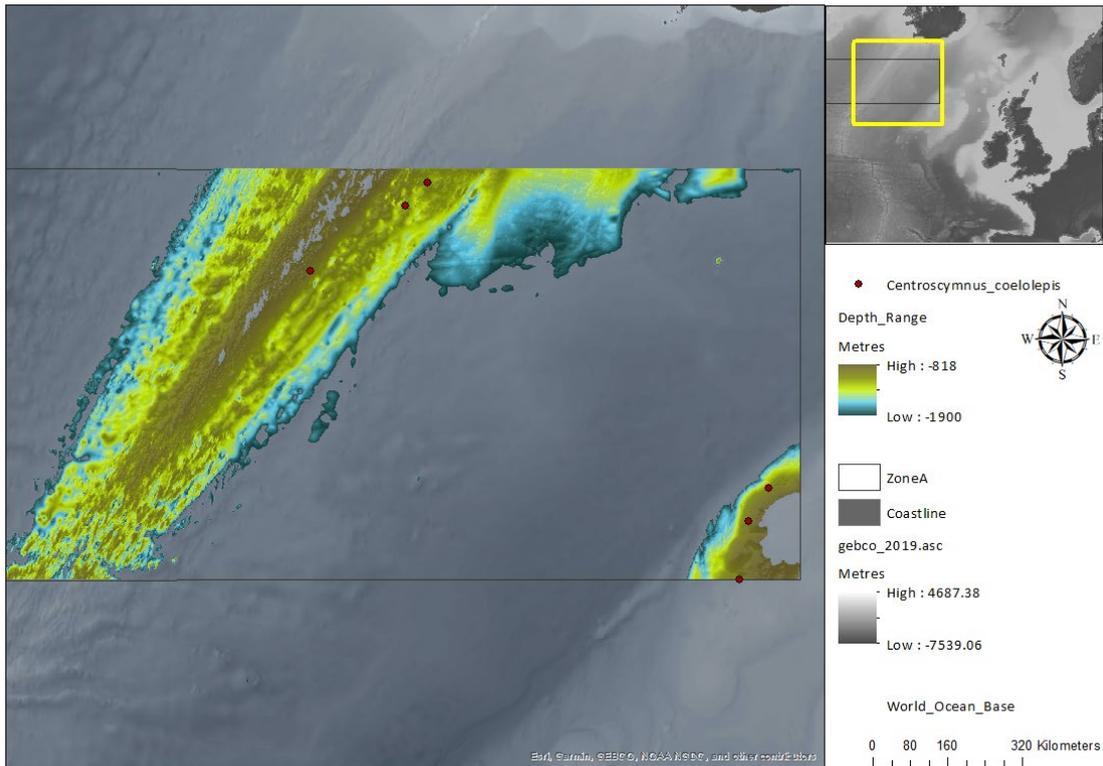


Figure A.14 Recorded distribution of survey catches (red dots) of *Centroscyrmnus coelolepis* in parts of ICES Divisions 27.12.ab.

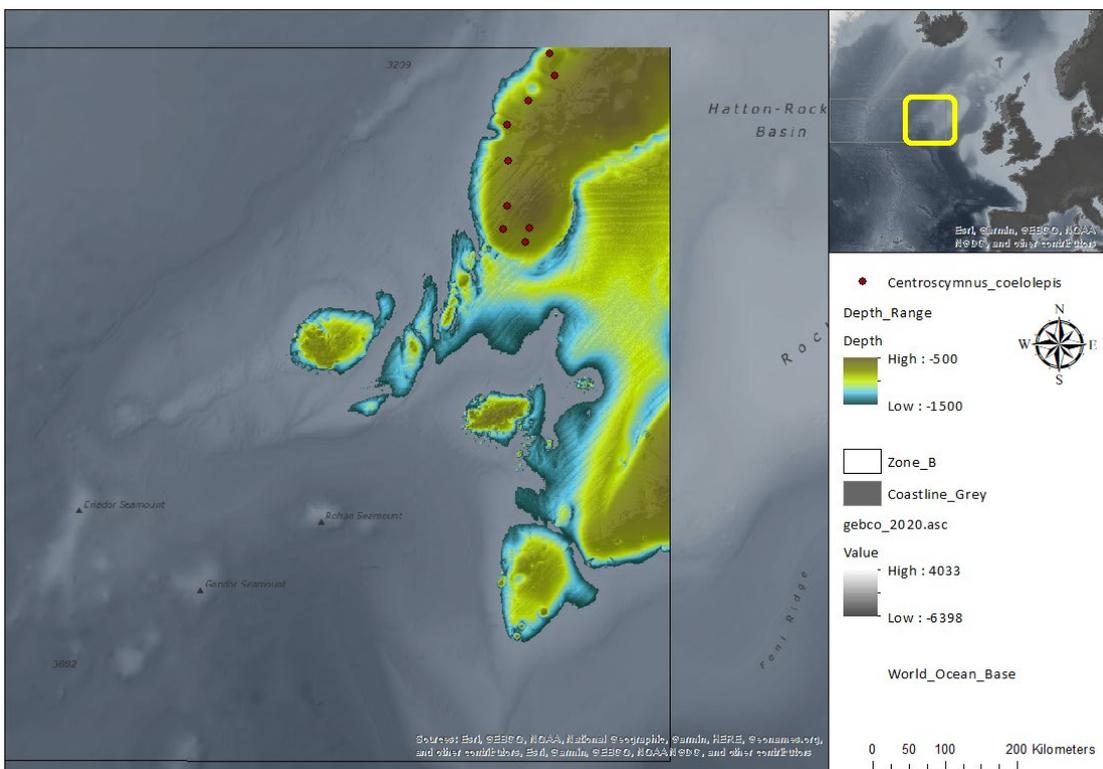


Figure A.15 Recorded distribution of survey catches (red dots) of *Centroscyrmnus coelolepis* in ICES Division 27.6.b.

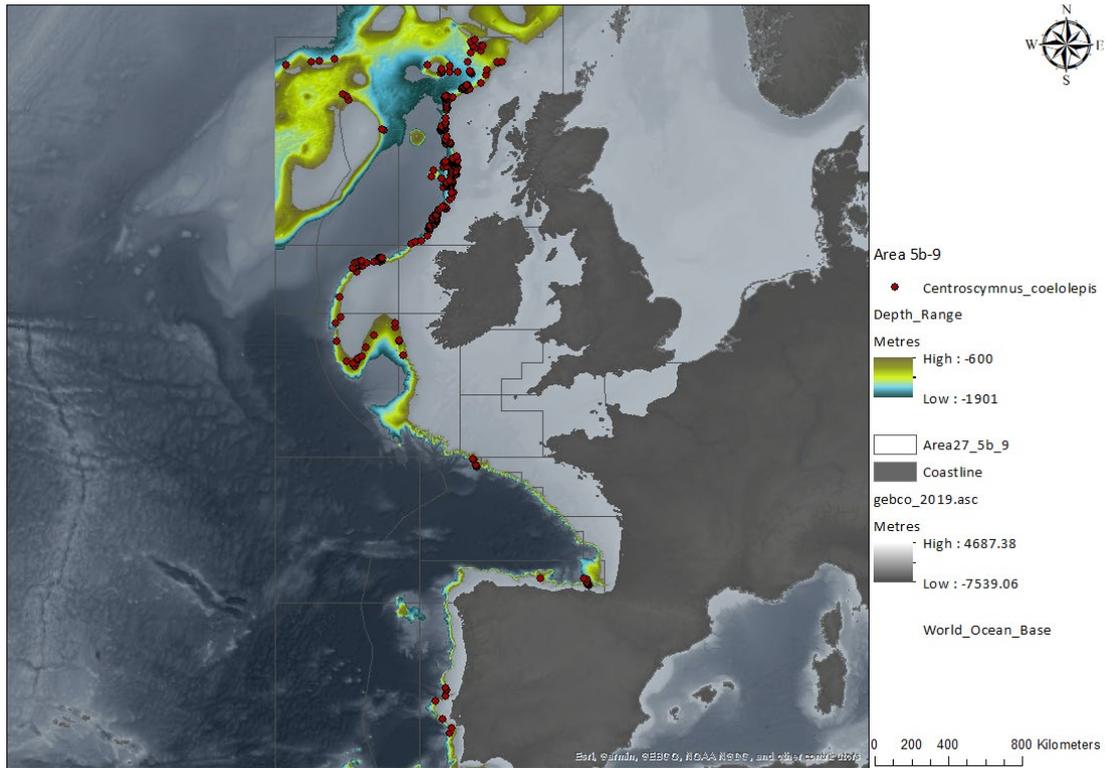


Figure A.16 Recorded distribution of survey catches (red dots) of *Centroscymnus coelolepis* in ICES Division 27.5.b–Subarea 27.9.

Centroscymnus crepidater

Centroscymnus crepidater is a widespread species, with records from a variety of depths. Around Iceland (Figures A.17 and A.18), it is mainly found west and south of the country. To the west of Ireland (Figure A.19), besides being present along the shelf edge, the species can also be found in deeper waters.

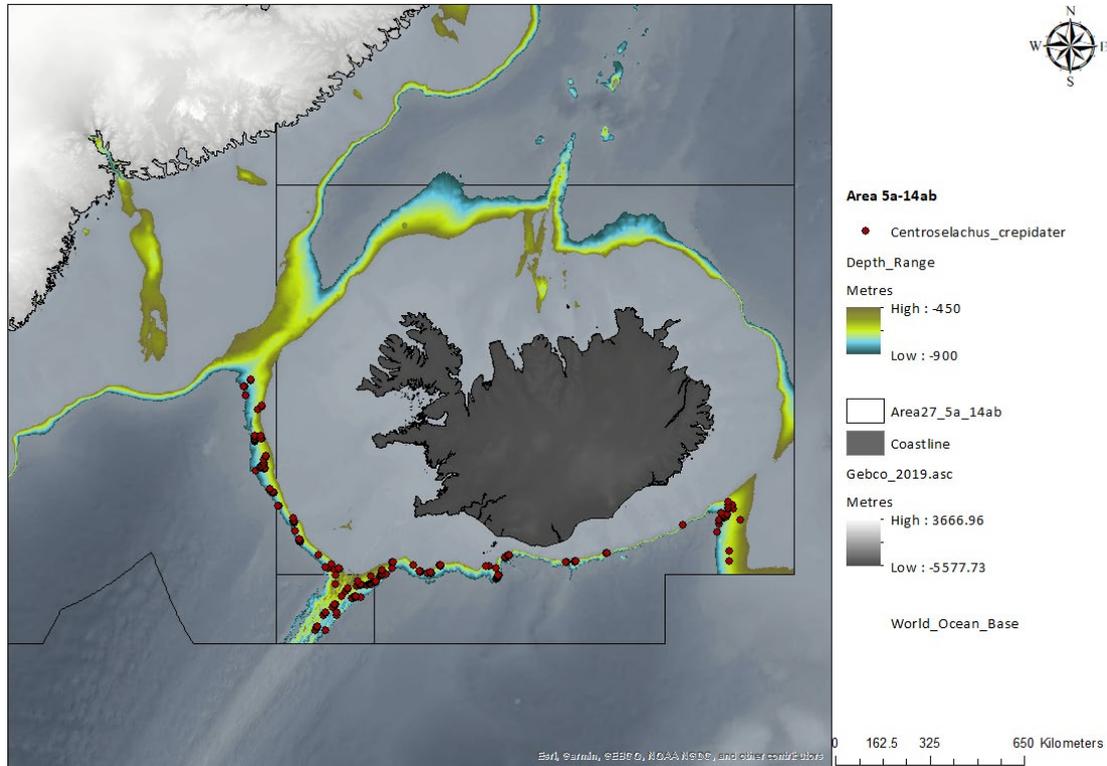


Figure A.17 Recorded distribution of survey catches (red dots) of *Centroscymnus crepidater* in ICES Division 27.5.a and Subarea 27.14.

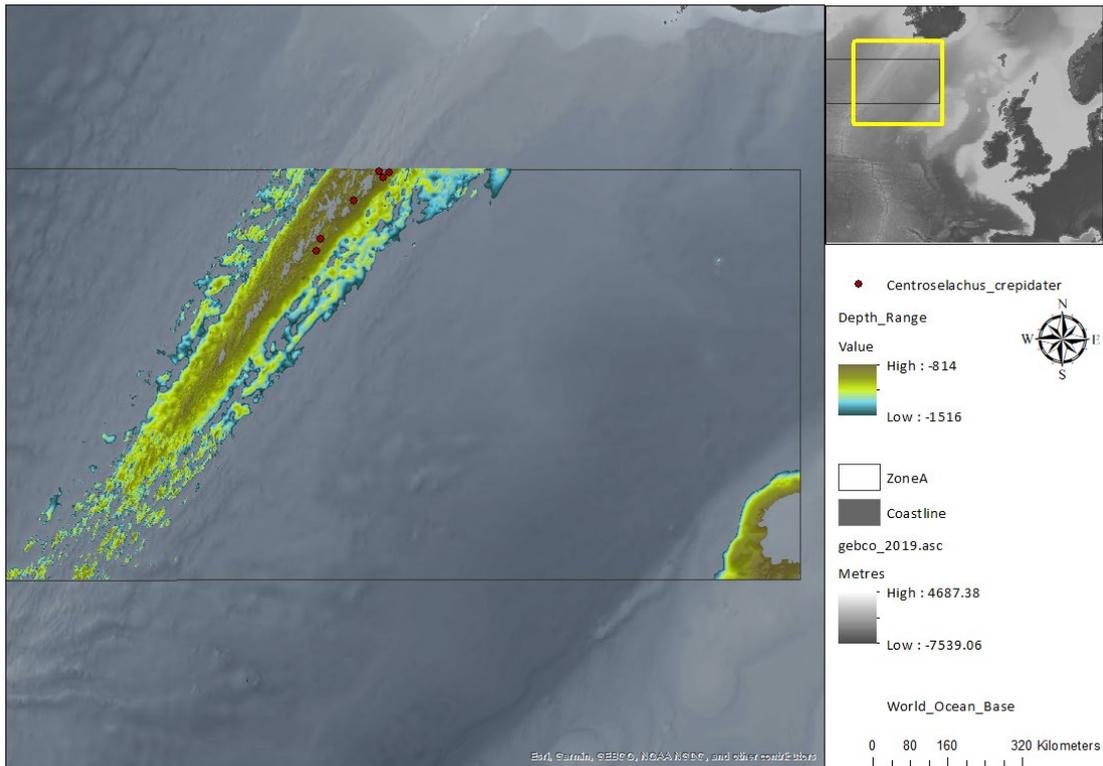


Figure A.18 Recorded distribution of survey catches (red dots) of *Centroselachus crepidater* in parts of ICES Divisions 27.12.ab.

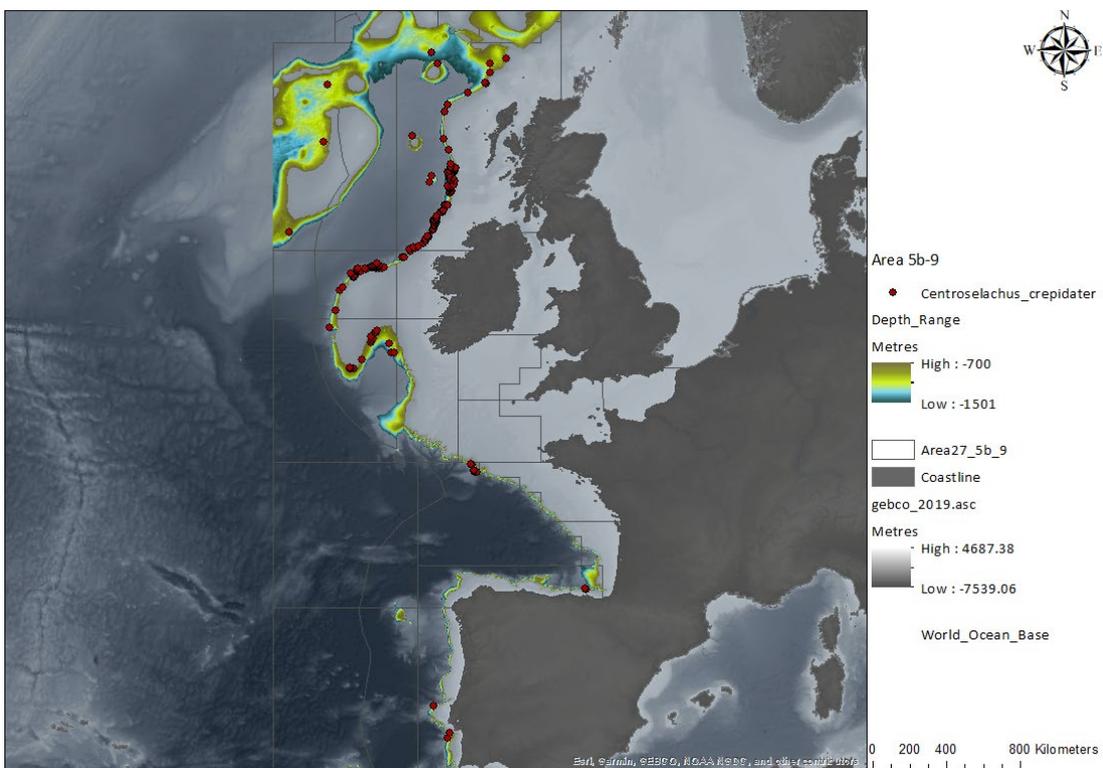


Figure A.19 Recorded distribution of survey catches (red dots) of *Centroselachus crepidater* in ICES Division 27.5.b-Subarea 27.9.

Chimaera monstrosa

Chimaera monstrosa is the most abundant of the chimaerids in European waters. It is distributed throughout the sampled range, with the exception of north of Iceland (Figure A.20) and Svalbard (Figures A.21 and A.22). Abundance hotspots appear to be around the Porcupine Seabight and the Algarve coast of Portugal (Figure A.23). There is also a hotspot in the deep water in the Skagerrak and to the south of Norway. It should be noted that *Chimaera opalescens* was only recently described (Luchetti *et al.*, 2011). Records of *C. monstrosa* prior to this may also include *C. opalescens*.

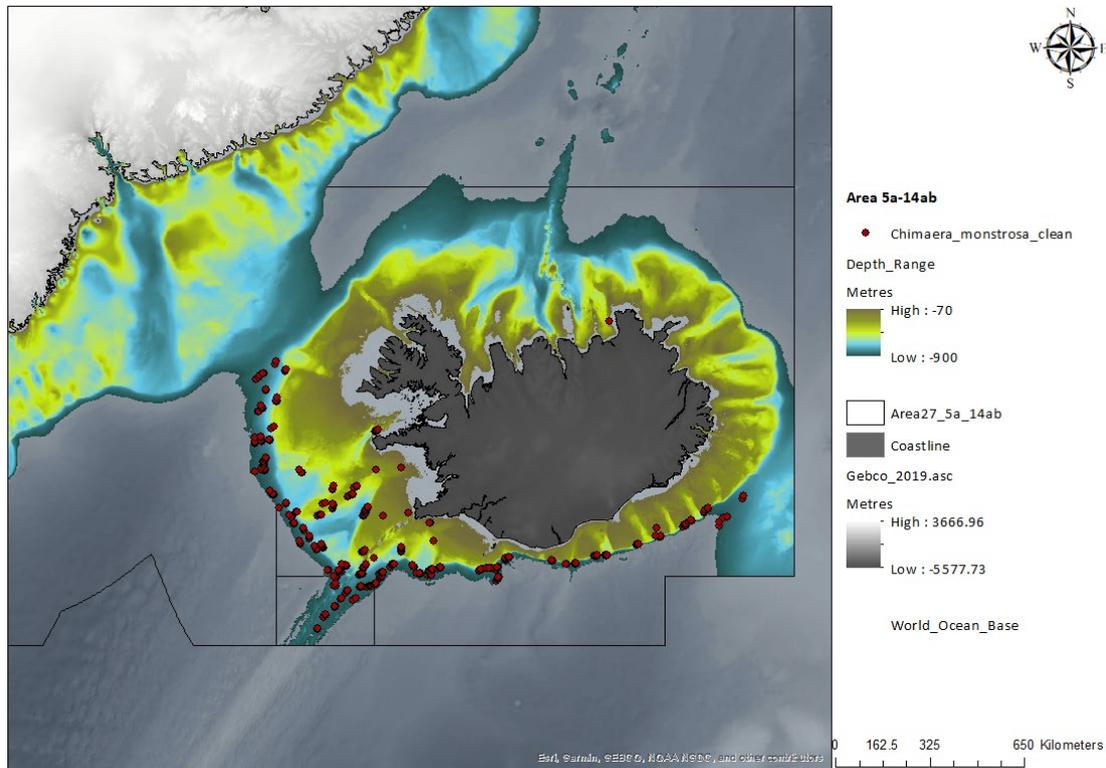


Figure A.20 Recorded distribution of survey catches (red dots) of *Chimaera monstrosa* in ICES Division 27.5.a and Subarea 27.14.

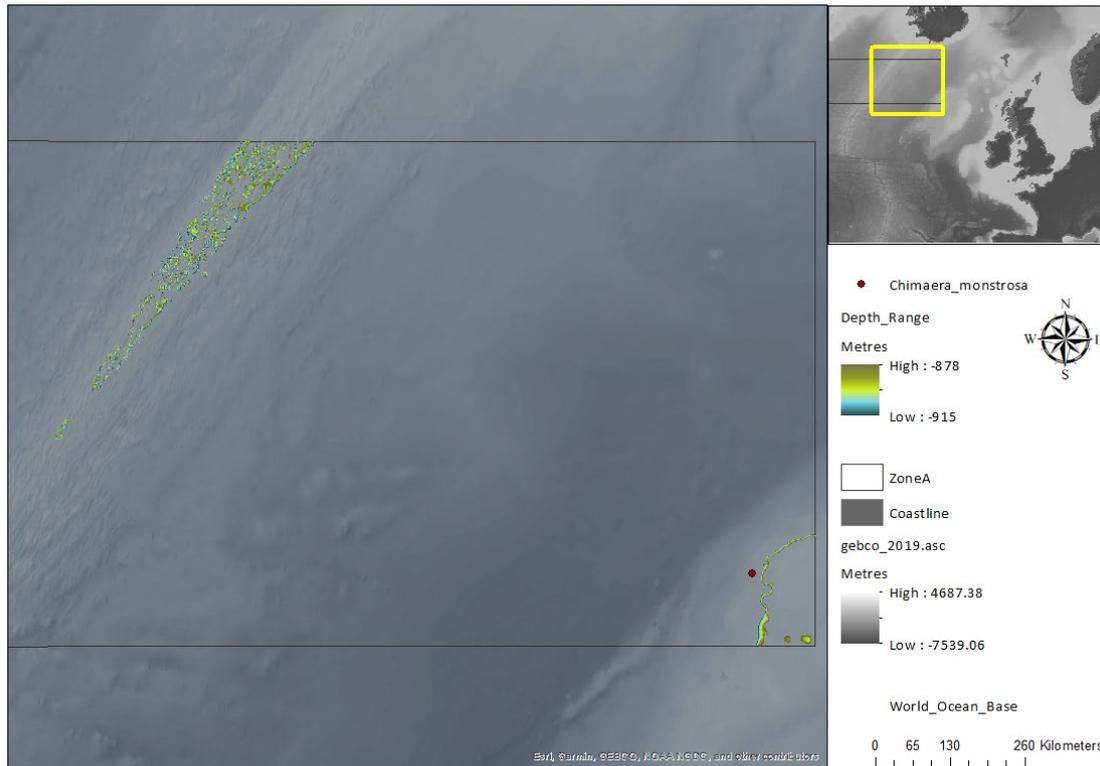


Figure A.21 Recorded distribution of survey catches (red dots) of *Chimaera monstrosa* in parts of ICES Divisions 27.12.ab. 0

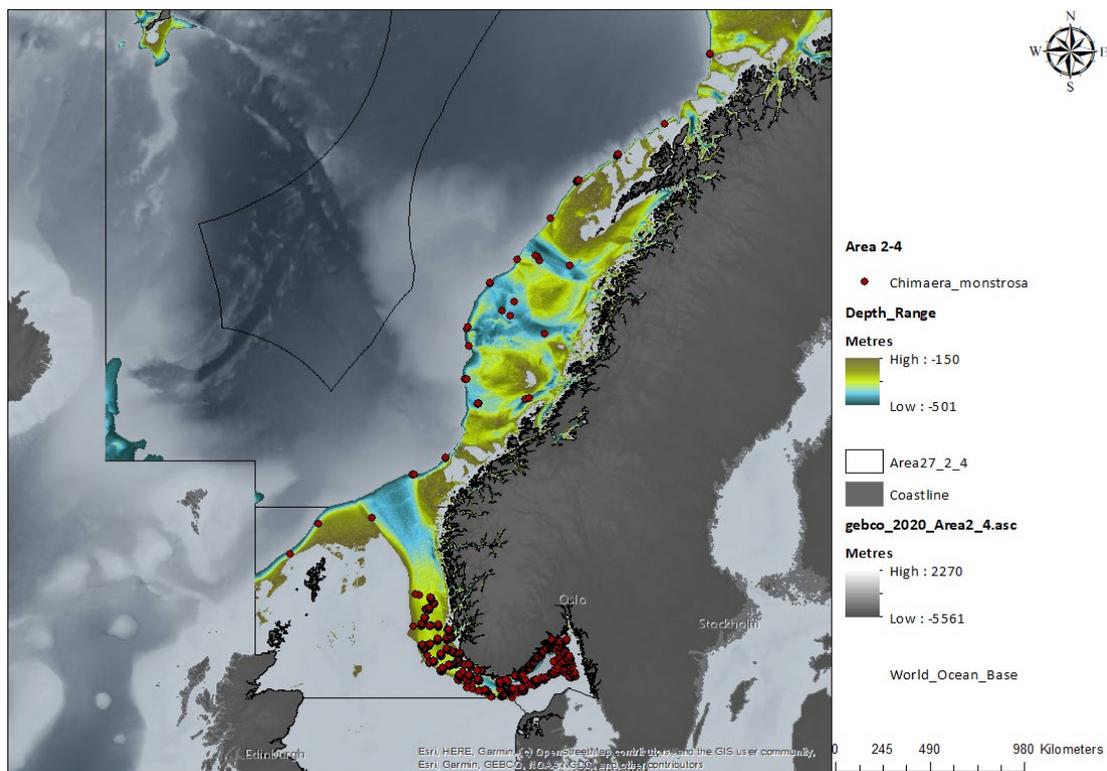


Figure A.22 Recorded distribution of survey catches (red dots) of *Chimaera monstrosa* in ICES subareas 27.2–27.4.

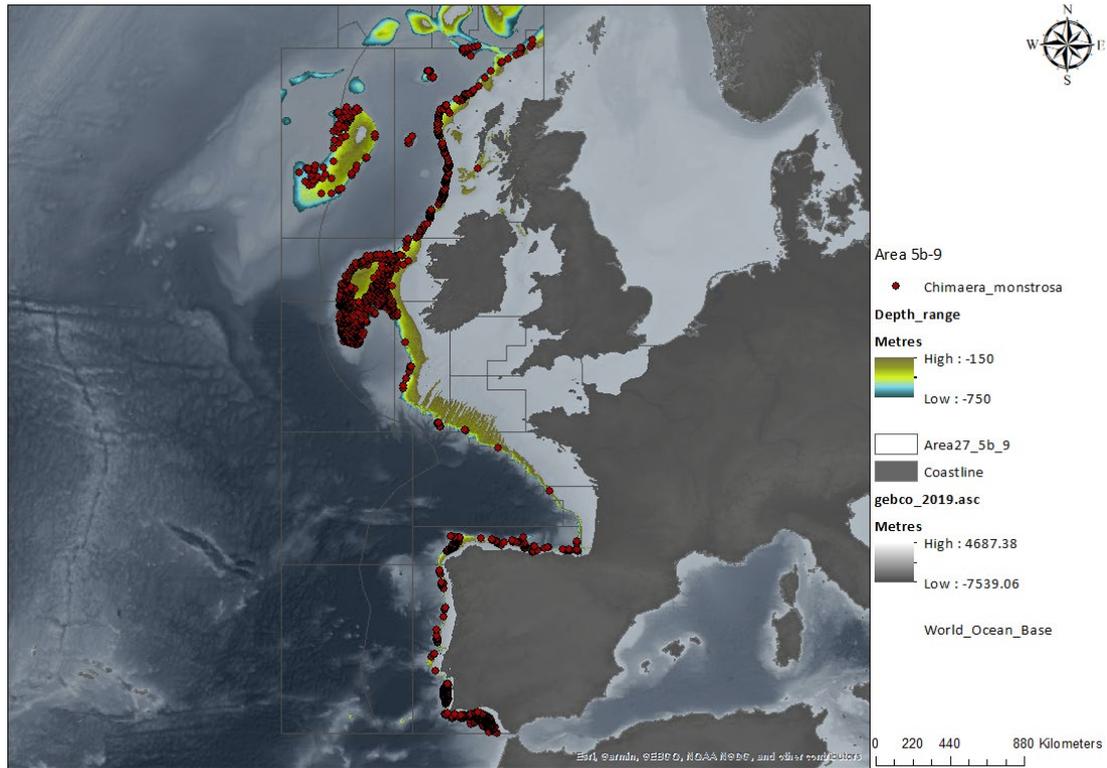


Figure A.23 Recorded distribution of survey catches (red dots) of *Chimaera monstrosa* in ICES Division 27.5.b–Subarea 27.9.

Chlamydoselachus anguineus

Only two records of *C. Anguineus* are reported from ICES Division 27.5.b–Subarea 27.9, and none from any other area (Figure A.24). The species is not abundant.

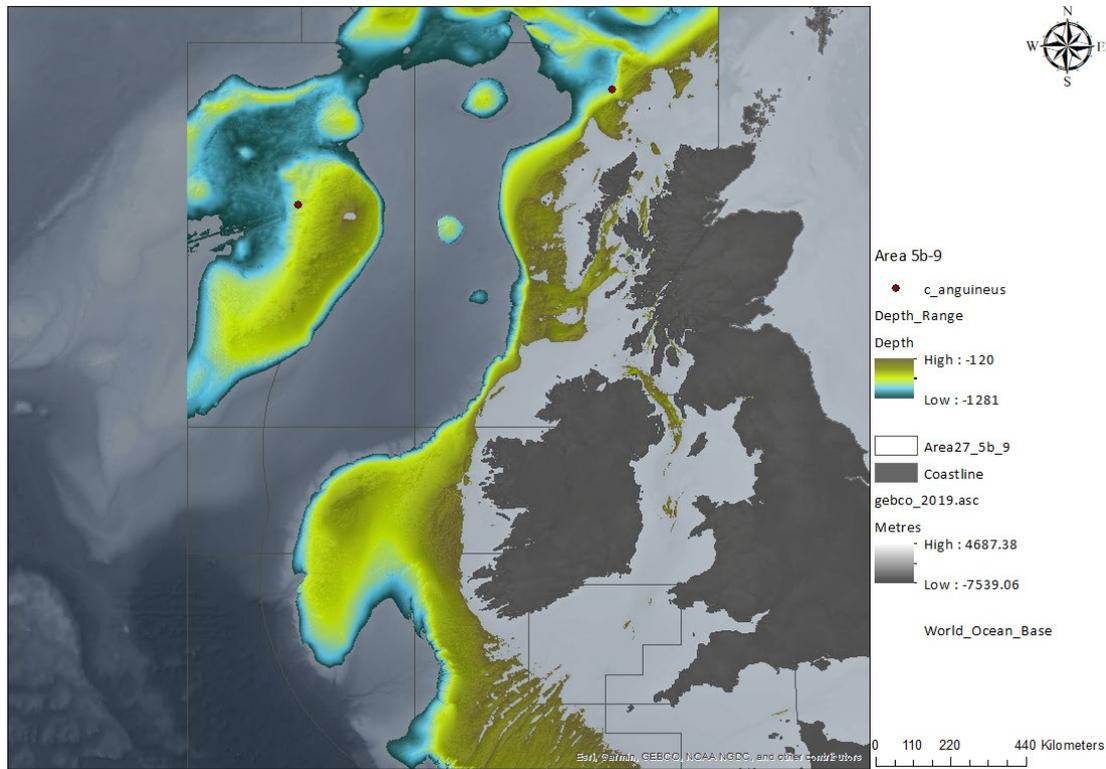


Figure A.24 Recorded distribution of survey catches (red dots) of *Chlamydoselachus anguineus* in ICES Division 27.5.b–Subarea 27.7.

Dalatias licha

Dalatias licha is distributed throughout the sampled range in ICES Division 27.5.b–Subarea 27.9. It has not been reported from Iceland or Norway. Records are available from around the Porcupine Seabight and the Algarve coast of Portugal (Figure A.25).

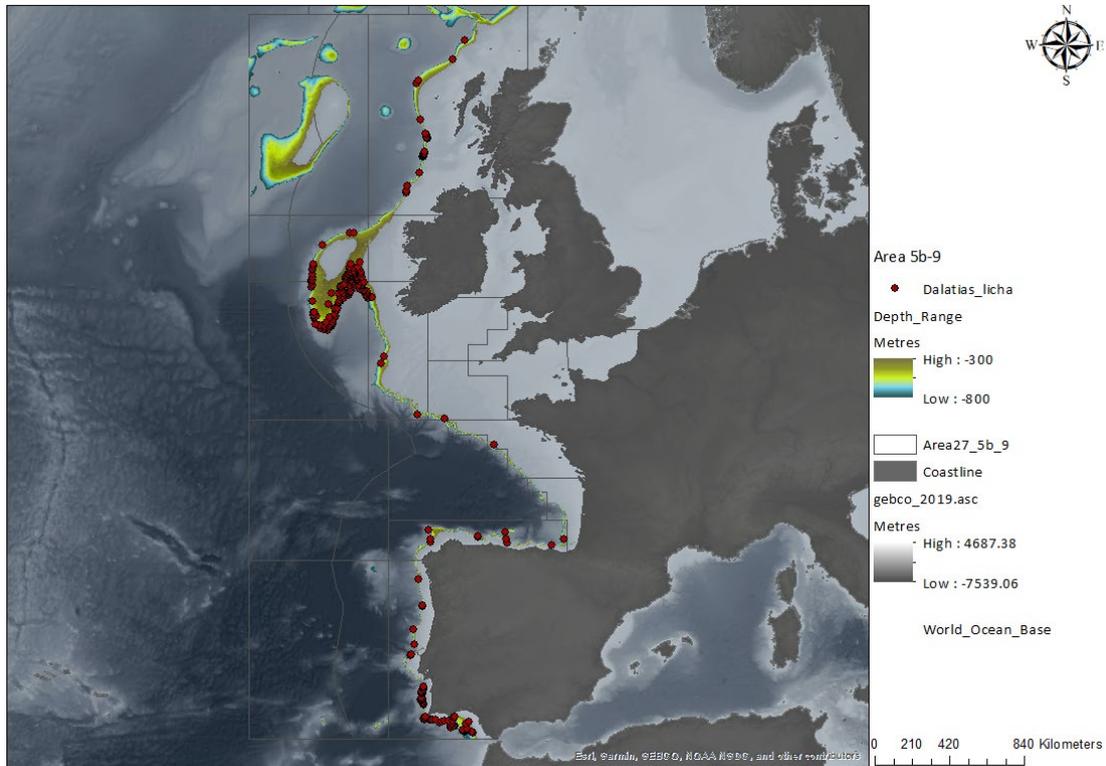


Figure A.25 Recorded distribution of survey catches (red dots) of *Dalatias licha* in ICES Division 27.5.b–Subarea 27.9.

Deania calcea

Deania calcea is one of the most abundant deep-water shark species. It is distributed from the southern coast of Iceland (Figures A.26 and A.27) to the Portuguese coast (Figure A.28), mainly at depth ranges of 500–900 m.

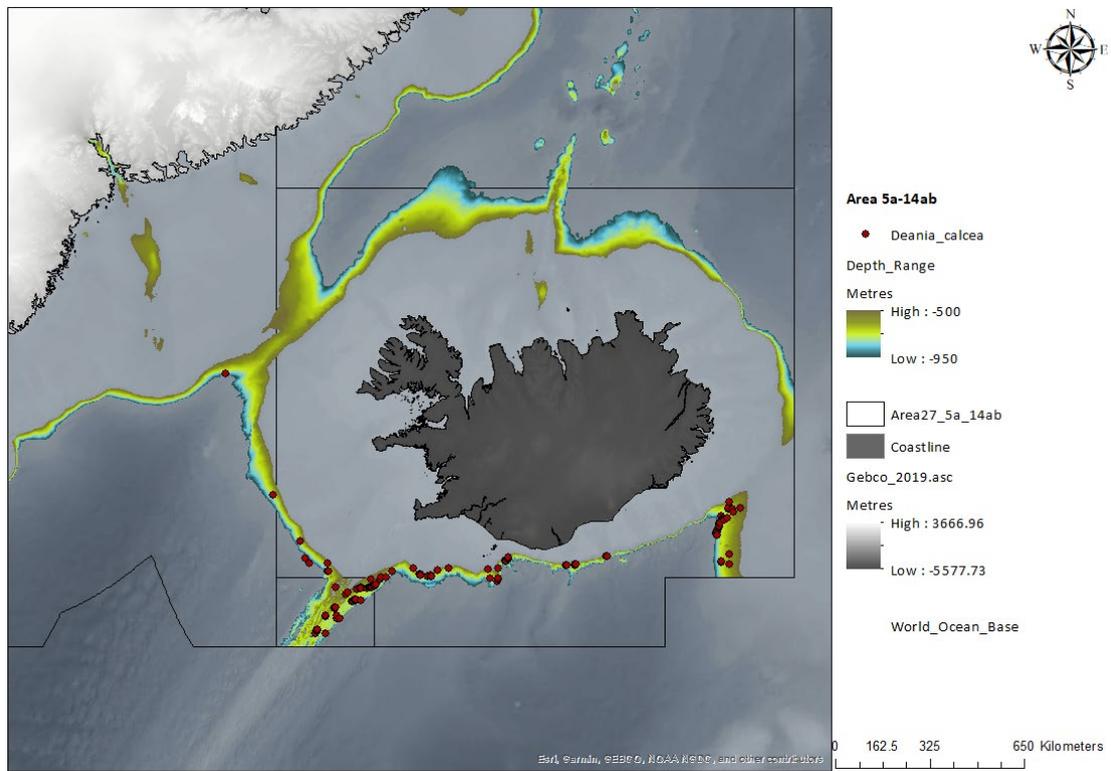


Figure A.26 Recorded distribution of survey catches (red dots) of *Deania calcea* in ICES subareas 27.5 and 27.14.

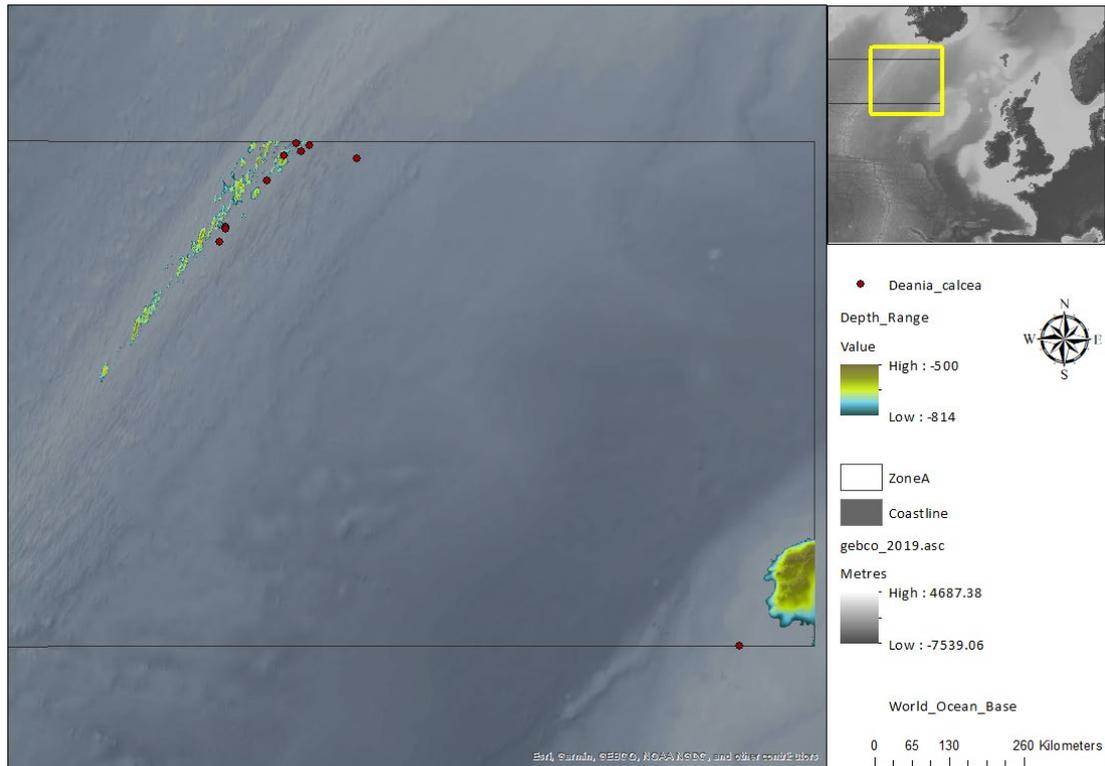


Figure A.27 Recorded distribution of survey catches (red dots) of *Deania calcea* in parts of ICES Division 27.12.ab.

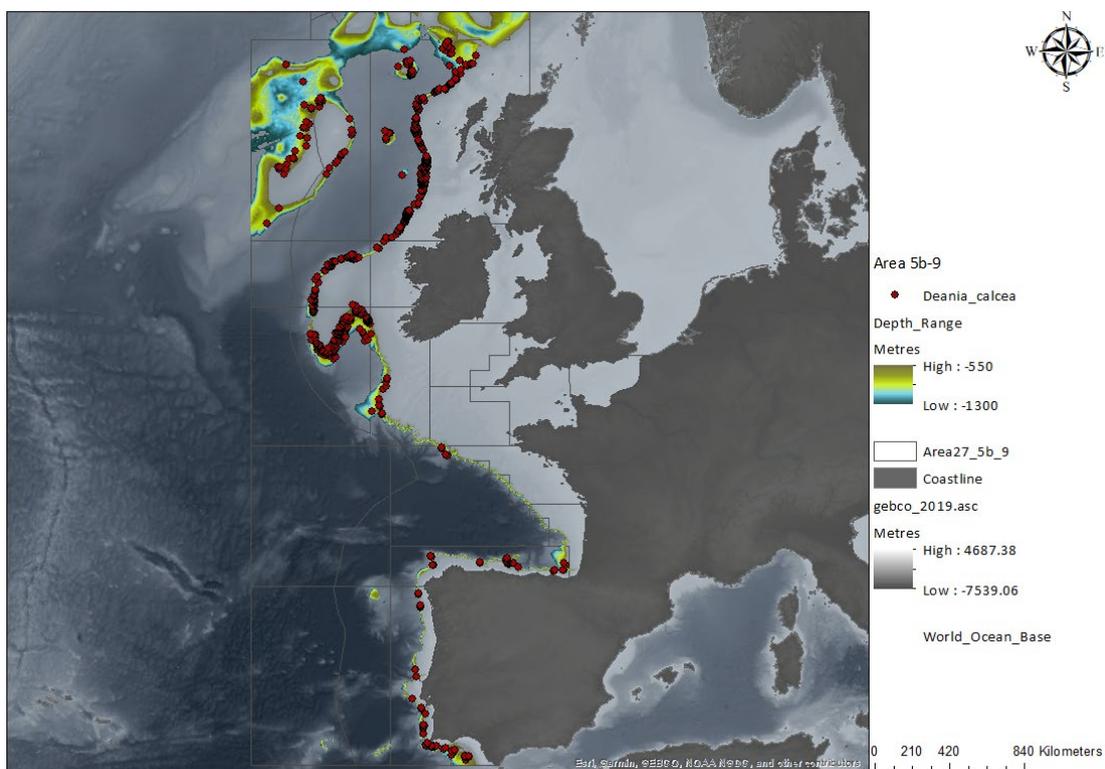


Figure A.28 Recorded distribution of survey catches (red dots) of *Deania calcea* in ICES Division 27.5.b-Subarea 27.9.

Dipturus nidarosiensis

Dipturus nidarosiensis is only occasionally encountered in surveys. Records are primarily from the Porcupine Seabight and the Rockall Bank (Figure A.29). There are a small number of records from the Bay of Biscay and Iberia. Misidentification with *D. intermedius*, *D. batis*, or *D. oxyrinchus* may occur.

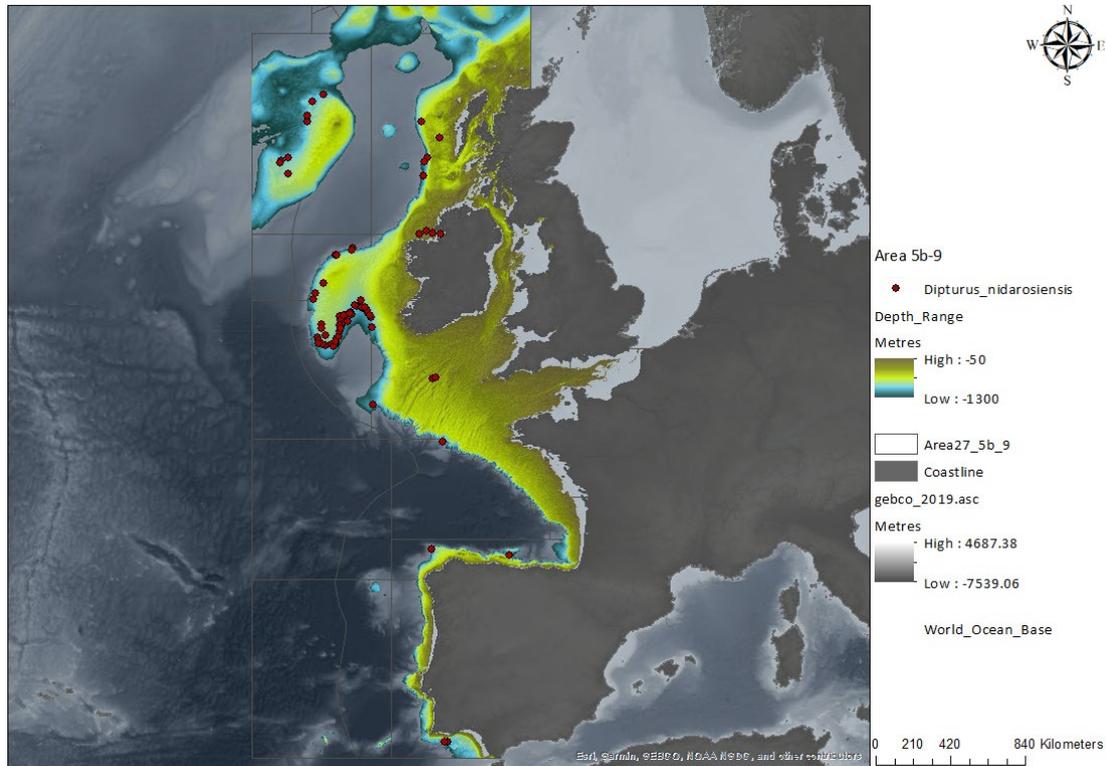


Figure A.29 Recorded distribution of survey catches (red dots) of *Dipturus nidarosiensis* in ICES Division 27.5.b–Subarea 27.9.

Etmopterus princeps

Etmopterus princeps is the less common of the two Etmopteridae species encountered in surveys. It is found throughout ICES Area, although with a northern bias. It is recorded throughout the southern coast of Iceland (Figures A.30 and A.31). From there, its distribution continues along the Rockall Bank (Figure A.32) and the western shelf edge. There are few records from the Bay of Biscay and Iberia (Figure A.33).

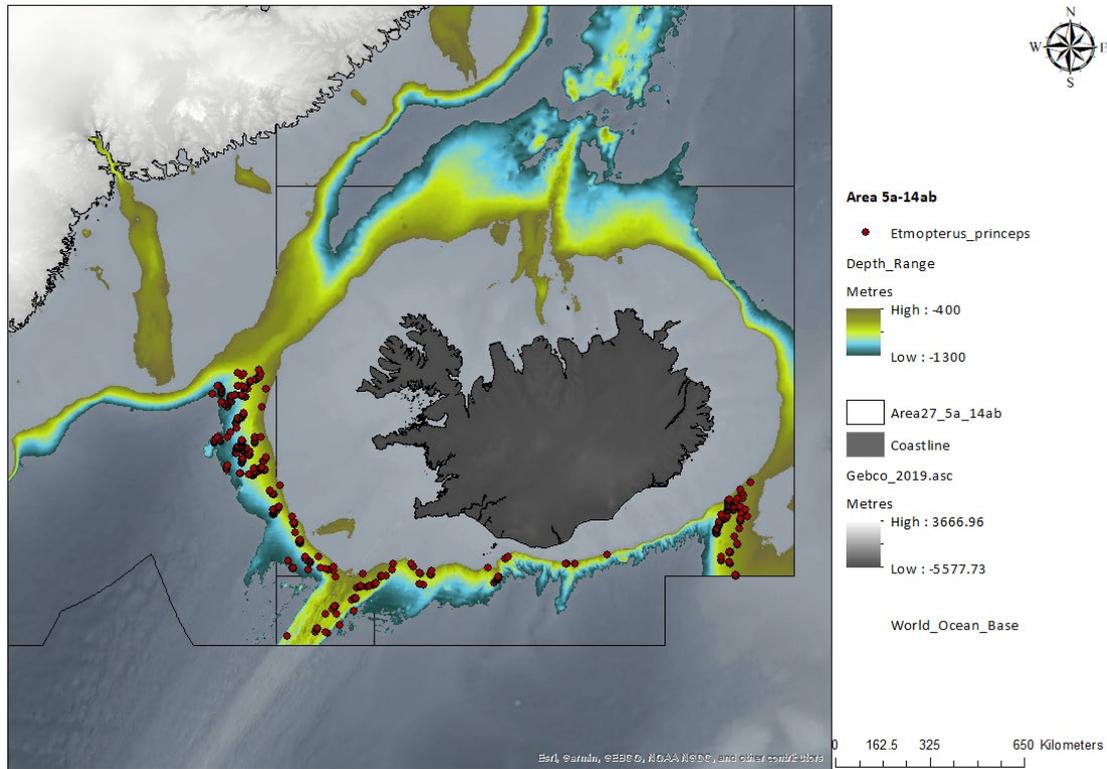


Figure A.30 Recorded distribution of survey catches (red dots) of *Etmopterus princeps* in ICES Division 27.5.a and Subarea 27.14.

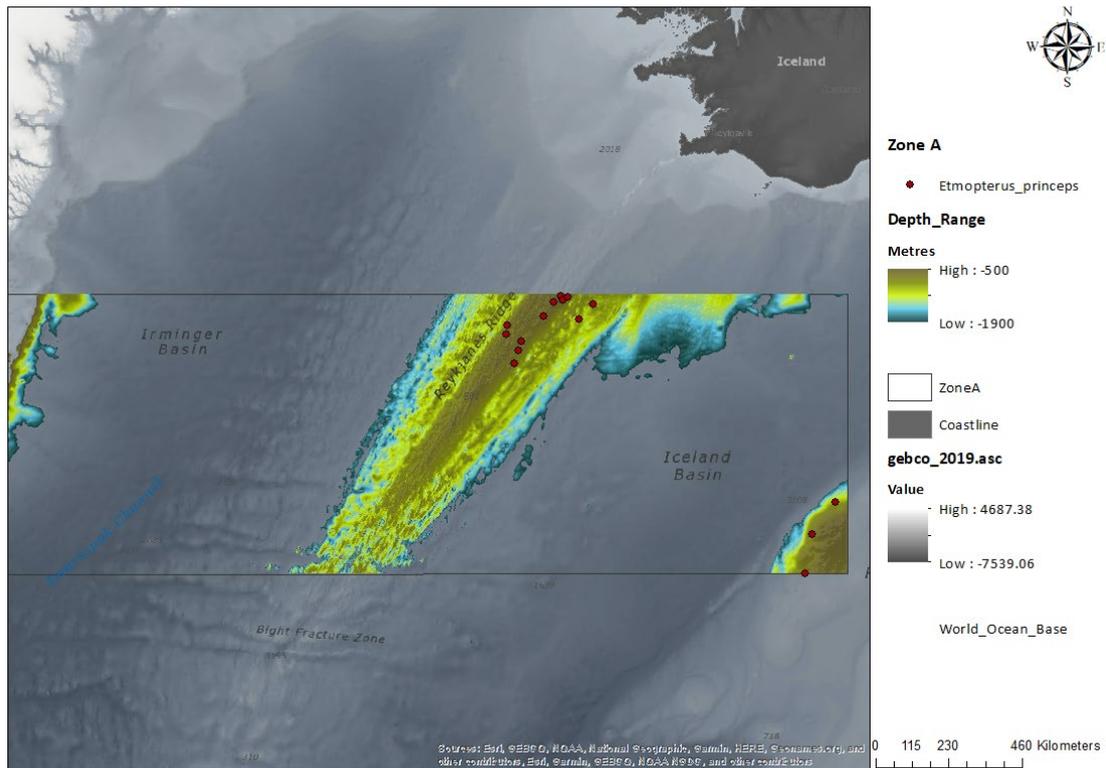


Figure A.31 Recorded distribution of survey catches (red dots) of *Etmopterus princeps* in parts of ICES Divisions 27.12ab and 14b (Reykjanes Ridge).

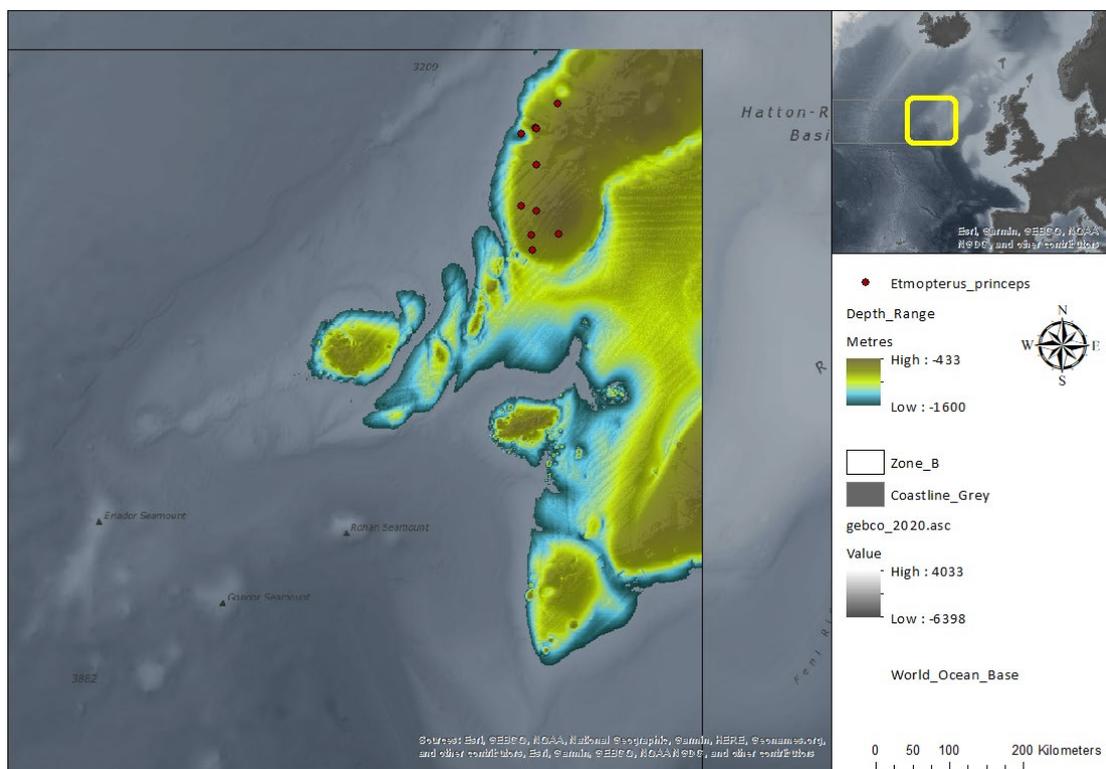


Figure A.32 Recorded distribution of survey catches (red dots) of *Etmopterus princeps* in ICES Subarea 27.12 (Mid-Atlantic Ridge).

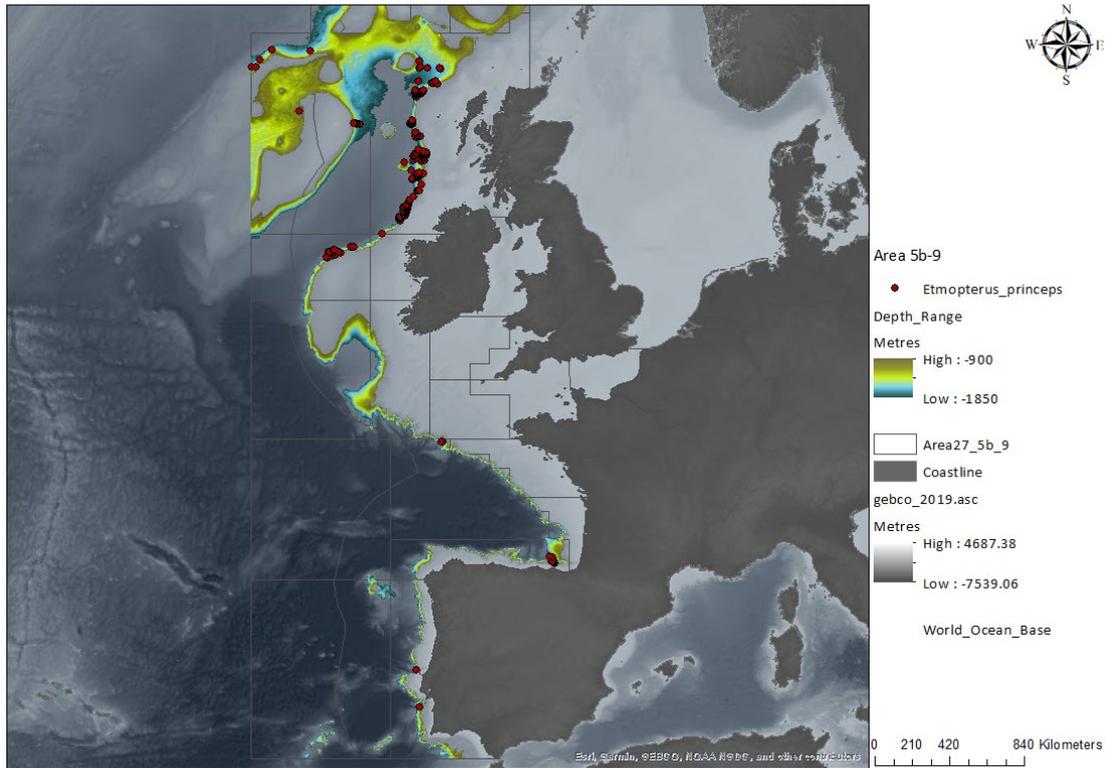


Figure A.33 Recorded distribution of survey catches (red dots) of *Etmopterus spinax* in ICES Division 27.5.b–Subarea 27.9.

Etmopterus pusillus

Etmopterus pusillus was not recorded in any of the submitted surveys.

Etmopterus spinax

Etmopterus spinax is the more common of the two Etmopteridae encountered in surveys. It is found throughout ICES Area. The main areas are around the southern Icelandic coast (Figure A.34), the southern coast of Norway (Figure A.35), the Porcupine Seabight, and the Algarve coast of Portugal (Figure A.36).

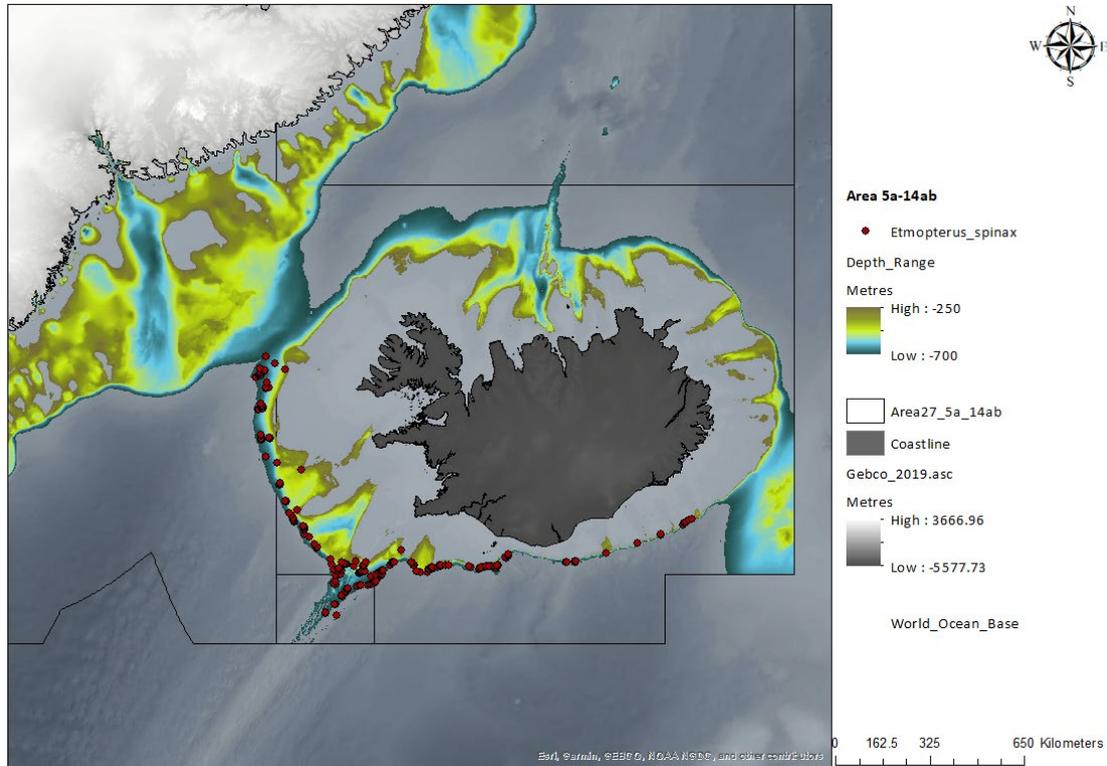


Figure A.34 Recorded distribution of survey catches (red dots) of *Etmopterus spinax* in ICES Division 27.5.b and Subarea 27.14.

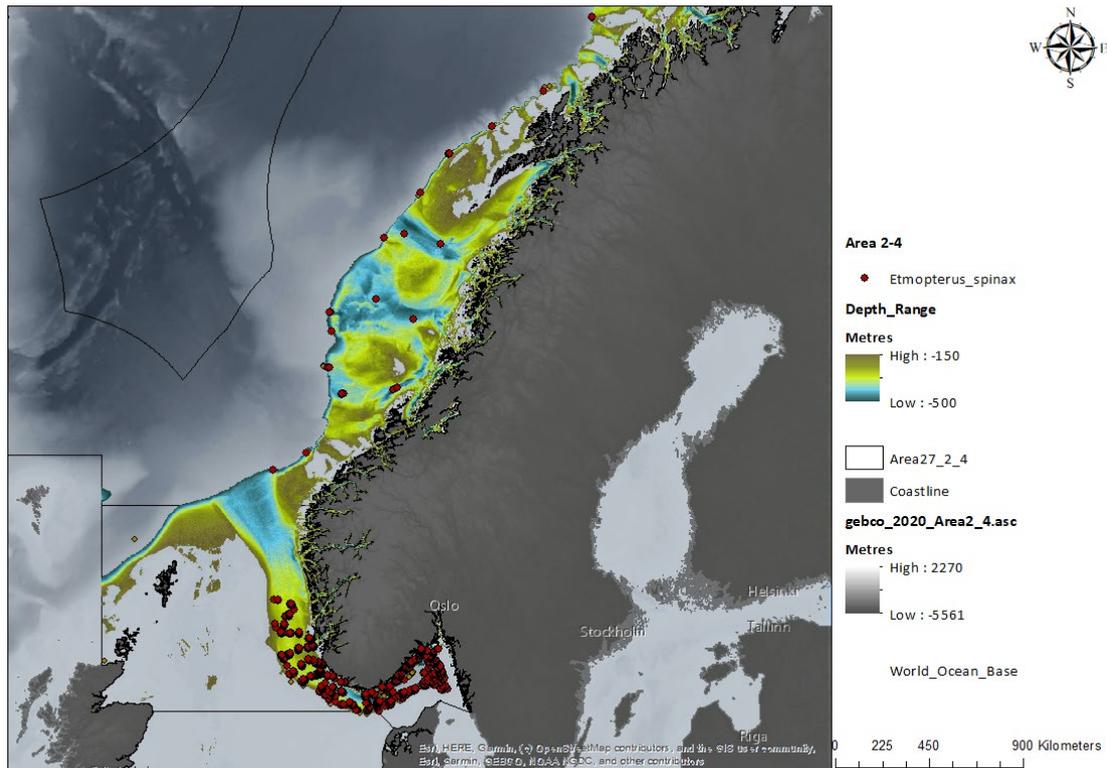


Figure A.35 Recorded distribution of survey catches (red dots) of *Etmopterus spinax* in ICES subareas 27.2–27.4.

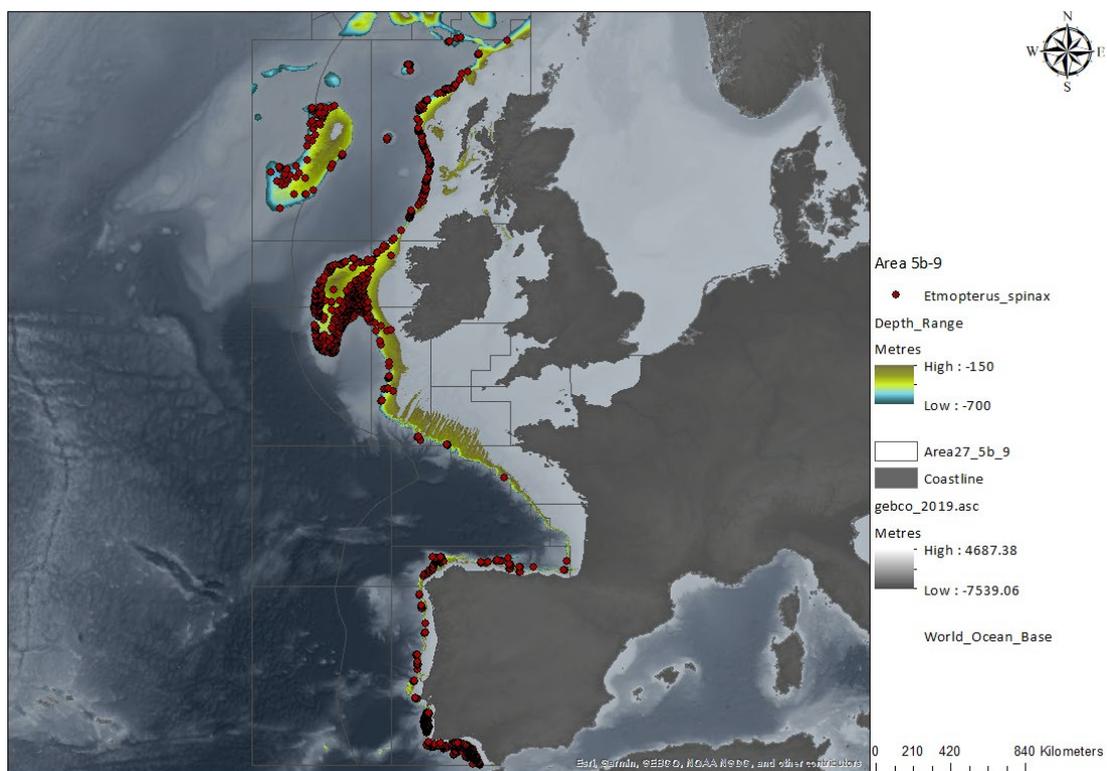


Figure A.36 Recorded distribution of *Etmopterus spinax* in ICES Division 27.5.b–Subarea 27.9.

Galeus melastomus

Galeus melastomus is distributed from Norway (Figure A.37) to Portugal in ICES Area (Figure A.38). It is absent from Iceland. It is most abundant in the Porcupine Seabight area to the west of Ireland.

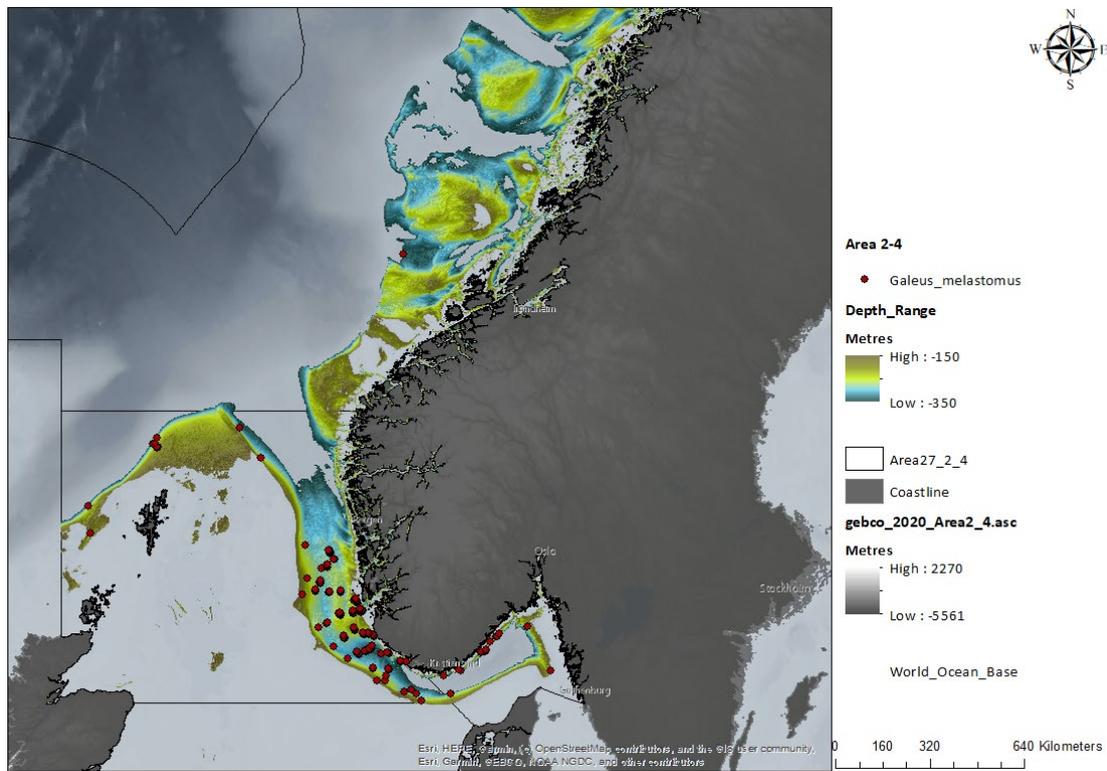


Figure A.37 Recorded distribution of survey catches (red dots) of *Galeus melastomus* in ICES subareas 27.2–27.4.

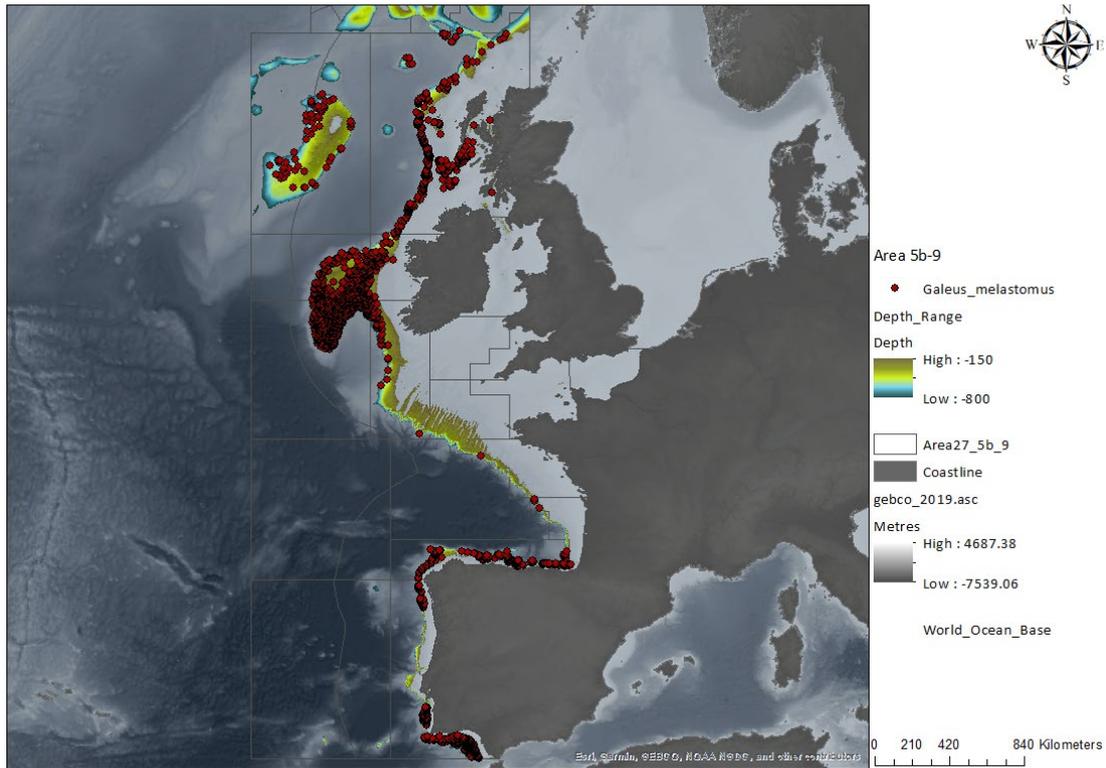


Figure A.38 Recorded distribution of survey catches (red dots) of *Galeus melastomus* in ICES Division 27.5.b–Subarea 27.9.

Galeus murinus

Galeus murinus has a northern distribution bias. Most records are from Iceland (Figures A.39 and A.40), with no records reported southwest of Ireland (Figure A.41).

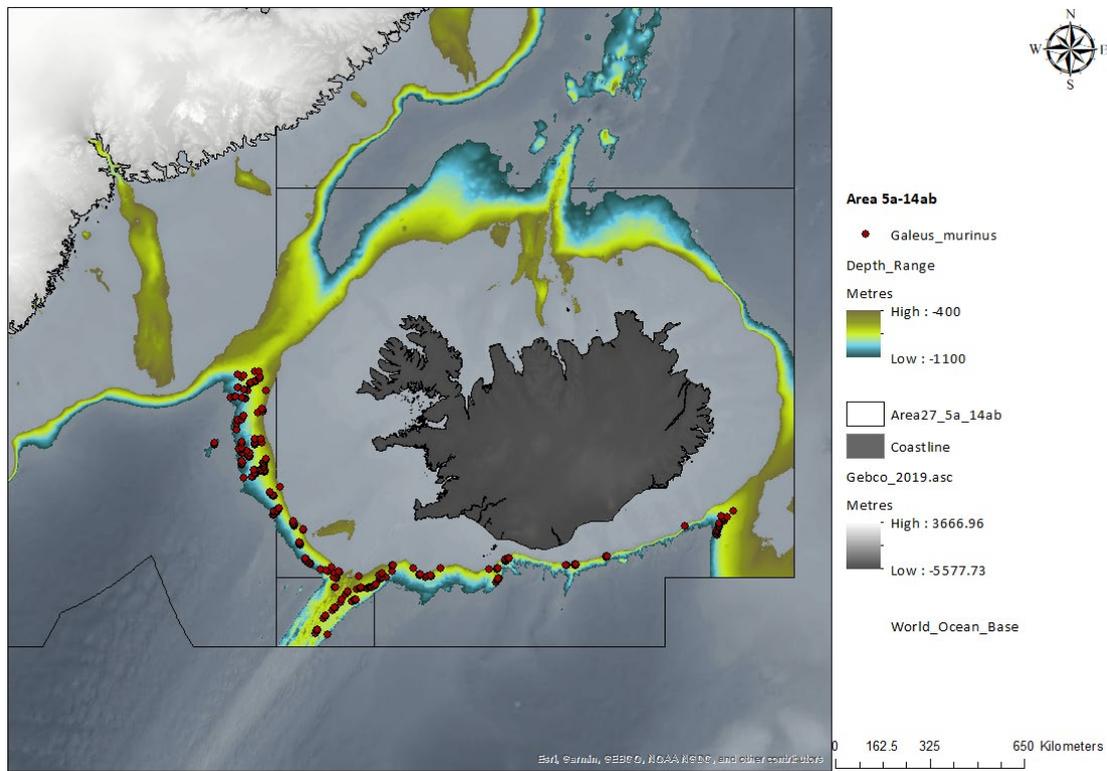


Figure A.39 Recorded distribution of survey catches (red dots) of *Galeus murinus* in ICES Division 27.5.a and Subarea 27.14.

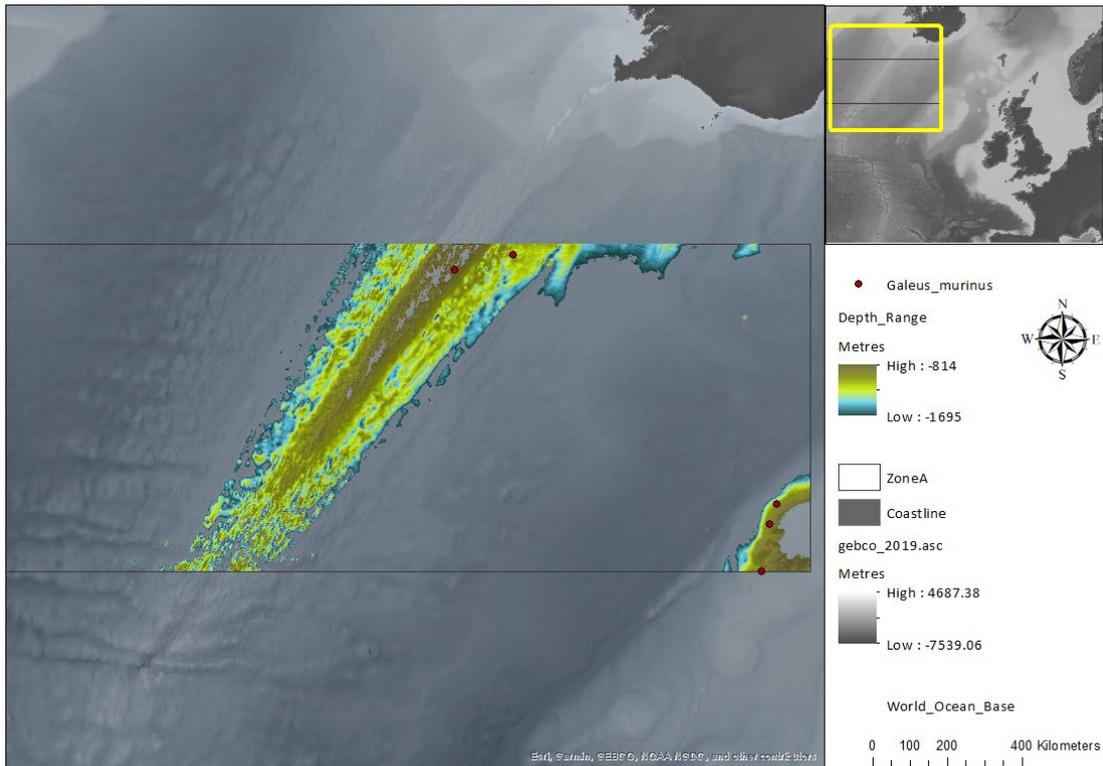


Figure A.40 Recorded distribution of survey catches (red dots) of *Galeus murinus* in parts of ICES Divisions 27.12.ab.

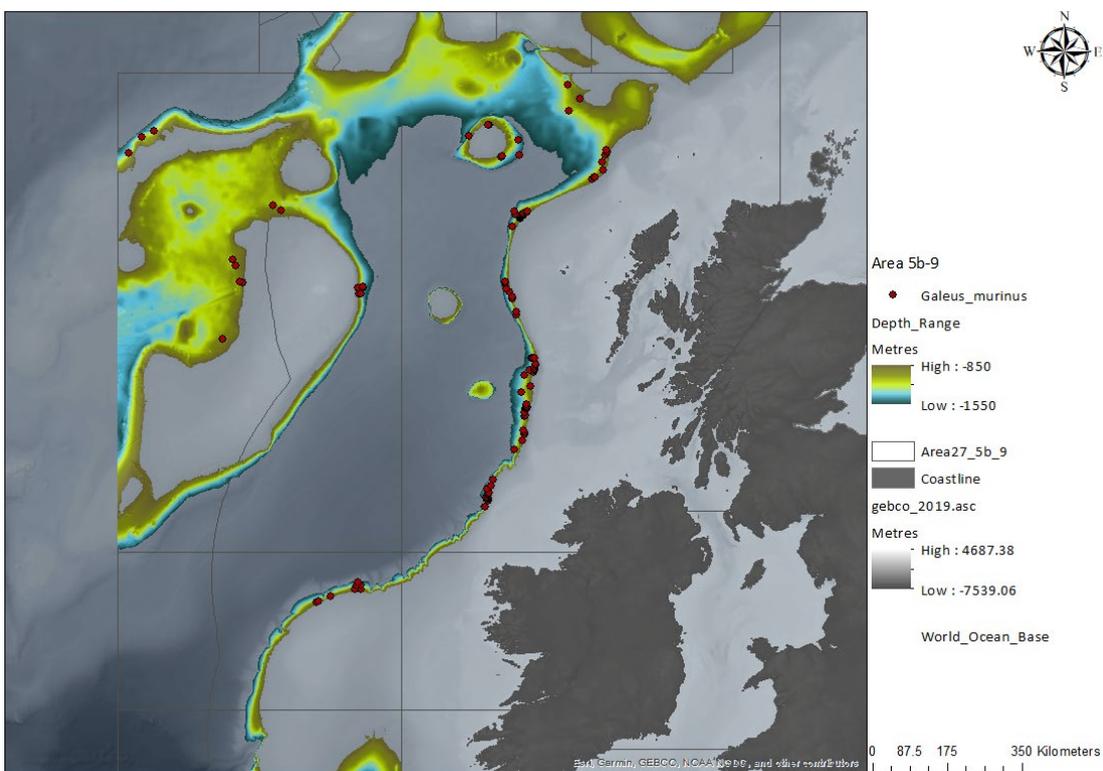


Figure A.41 Recorded distribution of survey catches (red dots) of *Galeus murinus* in ICES Division 27.5.b-Subarea 27.9.

Hexanchus griseus

Hexanchus griseus is widely distributed in ICES Area, although with a southerly bias (Figure A.42). There are no reports from ICES subareas 27.1–27.5. The main abundance appears to be around the Porcupine Seabight. However, it should be noted that these are mainly juveniles. Adults are much less common in surveys.

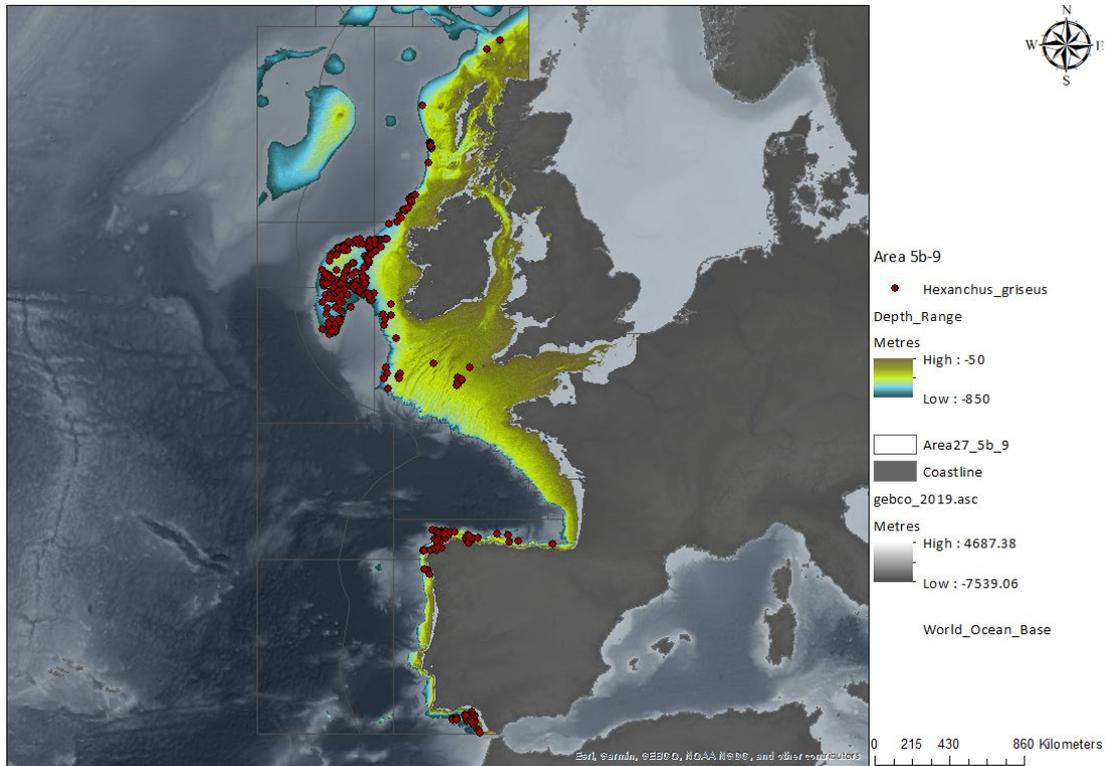


Figure A.42 Recorded distribution of survey catches (red dots) of *Hexanchus griseus* in ICES Division 27.5.b–Subarea 7.9.

Hydrolagus mirabilis

Hydrolagus mirabilis is occasionally reported from Iceland (Figures A.43 and A.44). The distribution does not appear to extend down the Mid-Atlantic Ridge (MAR).

Most survey encounters are reported to the west of Ireland and west and north of Scotland (Figure A.45). There are a few reports from the northern coast of Spain.

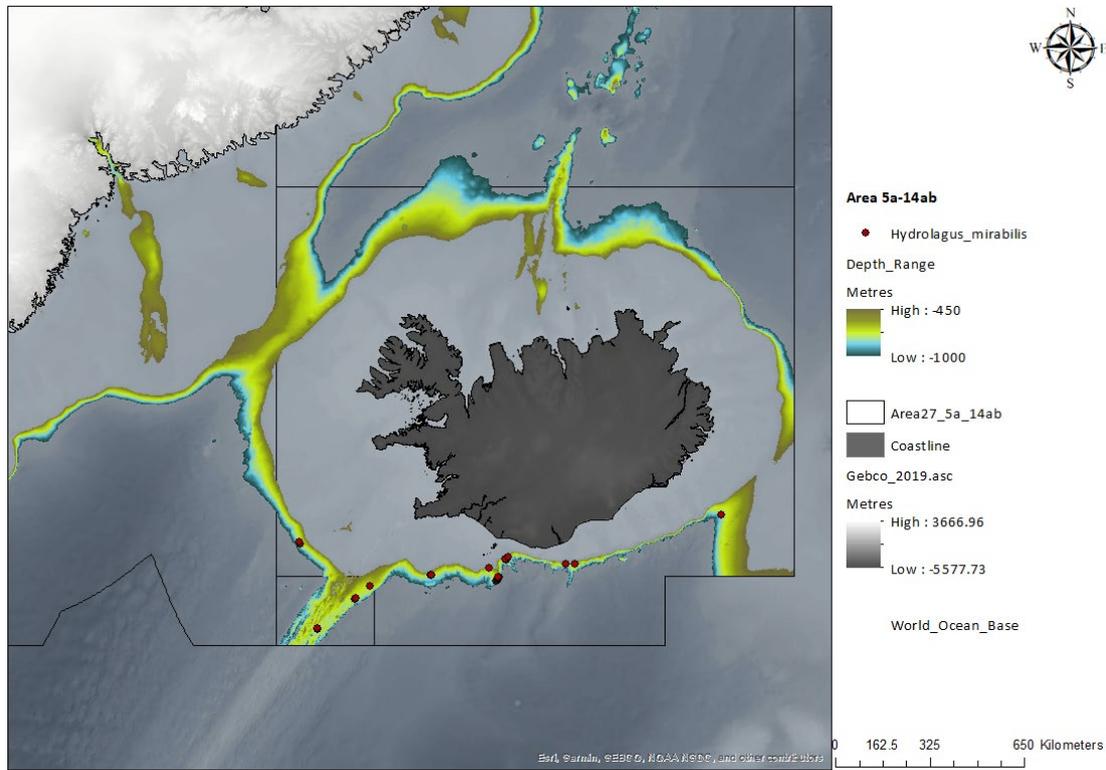


Figure A.43 Recorded distribution of survey catches (red dots) of *Hydrolagus mirabilis* in ICES Division 27.5.a and Subarea 27.14.

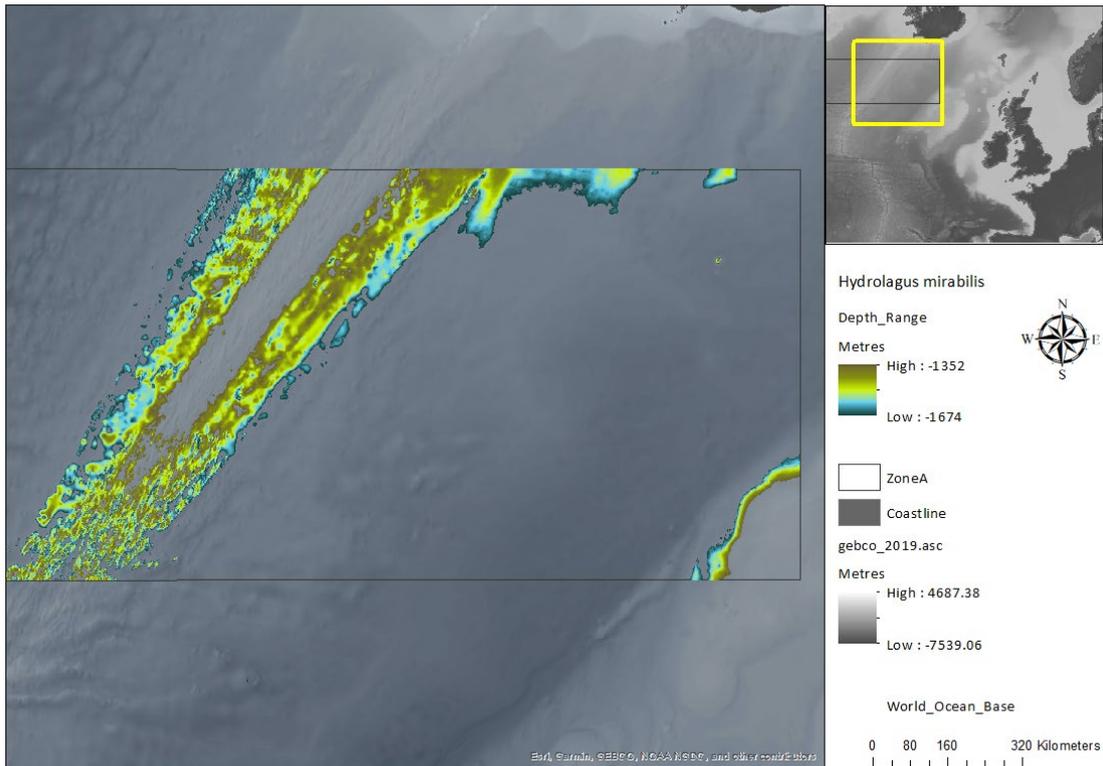


Figure A.44 Recorded distribution of survey catches (red dots) of *Hydrolagus mirabilis* in parts of ICES Divisions 27.12.ab.

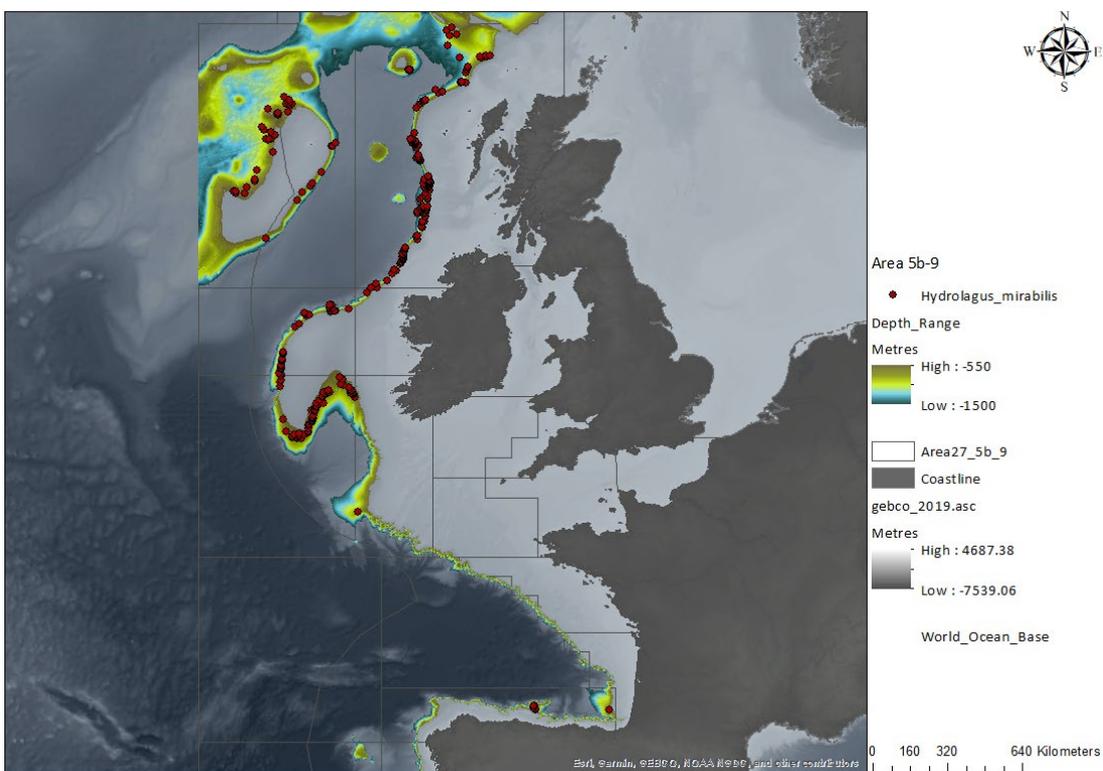


Figure A.45 Recorded distribution of survey catches (red dots) of *Hydrolagus mirabilis* in ICES Division 27.5.b-Subarea 27.9.

Oxynotus paradoxus

Only seven records of *Oxynotus paradoxus* have been reported in surveys in ICES Area (Figure A.46). Six of these are to the west of Ireland and Scotland, with one record from the Rockall Bank. One record from the Mid-Atlantic Ridge has not been mapped below. This is not an abundant species in surveys.

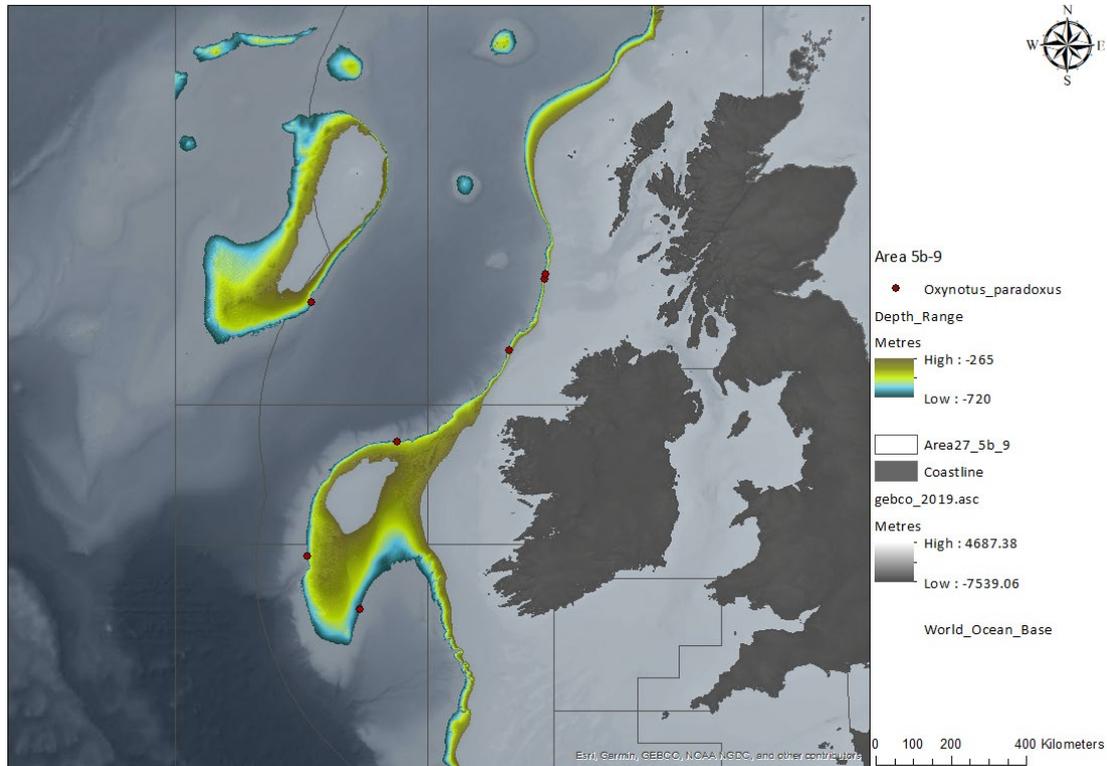


Figure A.46 Recorded distribution of survey catches (red dots) of *Oxynotus paradoxus* in ICES Division 27.5.b–Subarea 27.7.

Rajella fyllae

Rajella fyllae are only found in the northern part of ICES Area. There are no records from subareas 27.8 or 27.9. They are distributed from the eastern coast of Greenland (Figure A.47) to the southern part of Iceland, and along the Rockall Bank and the western Europe shelf (Figure A.48).

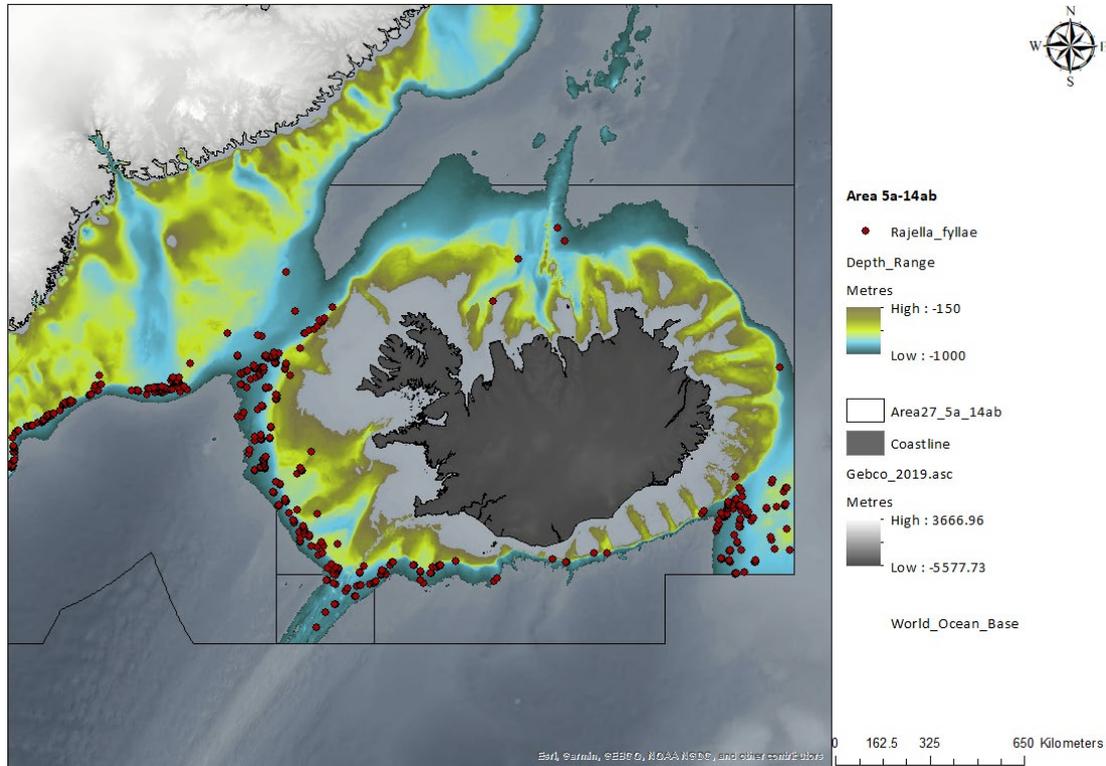


Figure A.47 Recorded distribution of survey catches (red dots) of *Rajella fyllae* in ICES Division 27.5.a and Subarea 27.14.

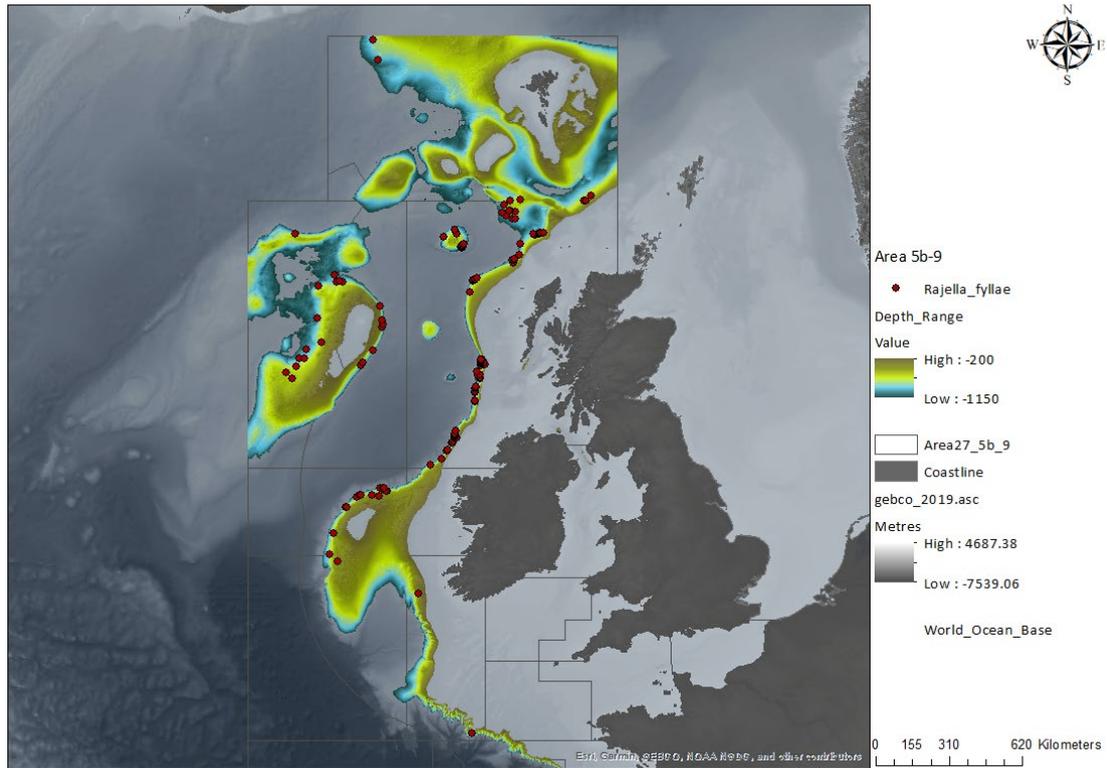


Figure A.48 Recorded distribution of survey catches (red dots) of *Rajella fyllae* in ICES Division 27.5.b–Subarea 27.8.

Rhinochimaera atlantica

Rhinochimaera atlantica are found along the southern coast of Iceland (Figure A.49), with some extension south to the Mid-Atlantic Ridge (Figure A.50). Further east, *R. atlantica* are only reported from west of Ireland and Scotland and from the Rockall Bank (Figure A.51). There is one report from the Bay of Biscay (ICES Subarea 27.8).

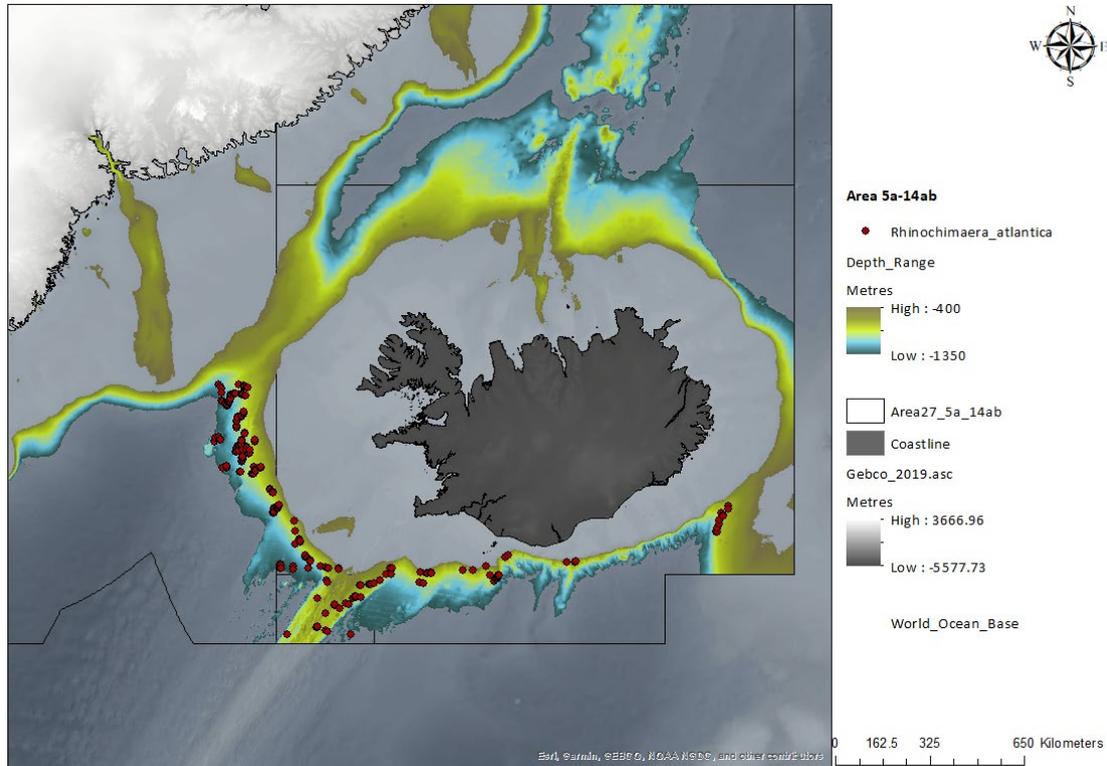


Figure A.49 Recorded distribution of survey catches (red dots) of *Rhinochimaera atlantica* in ICES Division 27.5.a and Subarea 27.14.

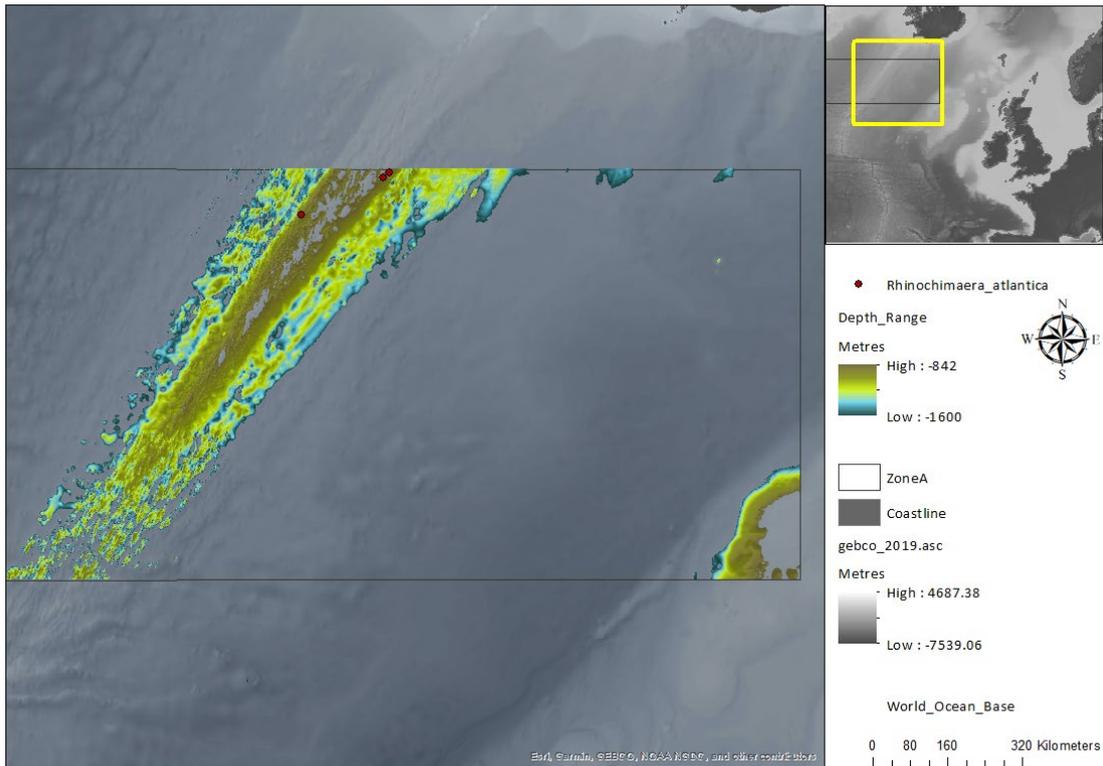


Figure A.50 Recorded distribution of survey catches (red dots) of *Rhinochimaera atlantica* in parts of ICES Divisions 27.12.ab.

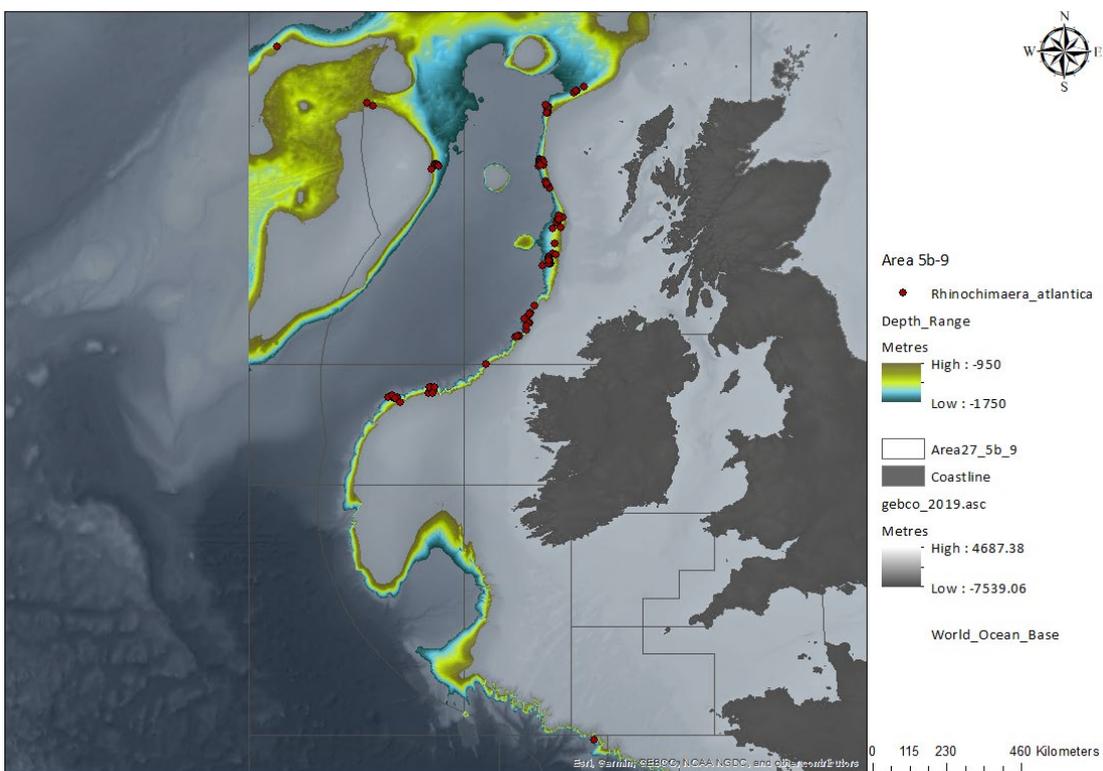


Figure A.51 Recorded distribution of survey catches (red dots) of *Rhinochimaera atlantica* in ICES Division 27.5.b-Subarea 27.9.

Scymnodon ringens

Unlike most other species in this review, *Scymnodon ringens* has a southern bias to its distribution (Figure A.52). There are many records from Iberia. While there is a large abundance around the Porcupine Seabight, there are few records further north than this, with none reported from the Rockall Bank or from Iceland or Norway.

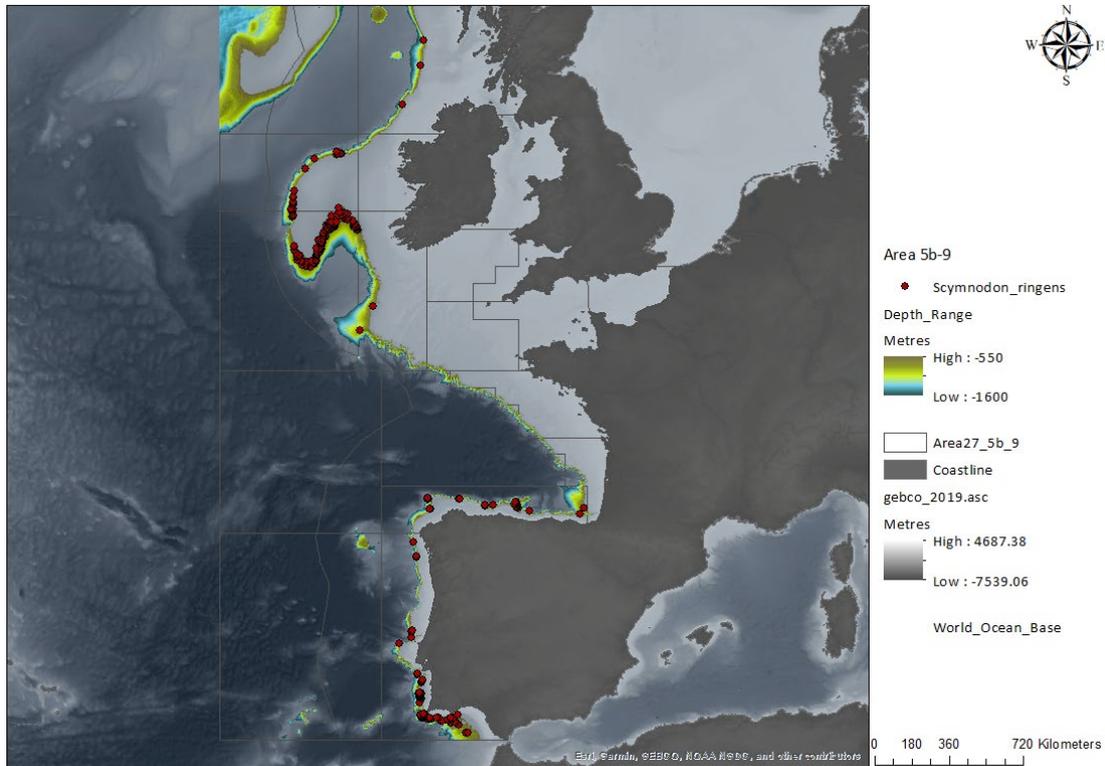


Figure A.52 Recorded distribution of survey catches (red dots) of *Scymnodon ringens* in ICES Division 27.5.b–Subarea 27.9.

Somniosus microcephalus

This large-bodied species occurs in northern waters and is not entirely a deep-water species; hence, it can occur elsewhere in the area. Most records of *Somniosus microcephalus* come from around Iceland, mainly between Iceland and Greenland (Figures A.53 and A.54). However, it is only a rare encounter in surveys. Outside this ecoregion, there are only two additional records of *S. microcephalus*. Both of these are from the Porcupine Bank area (Figure A.55).

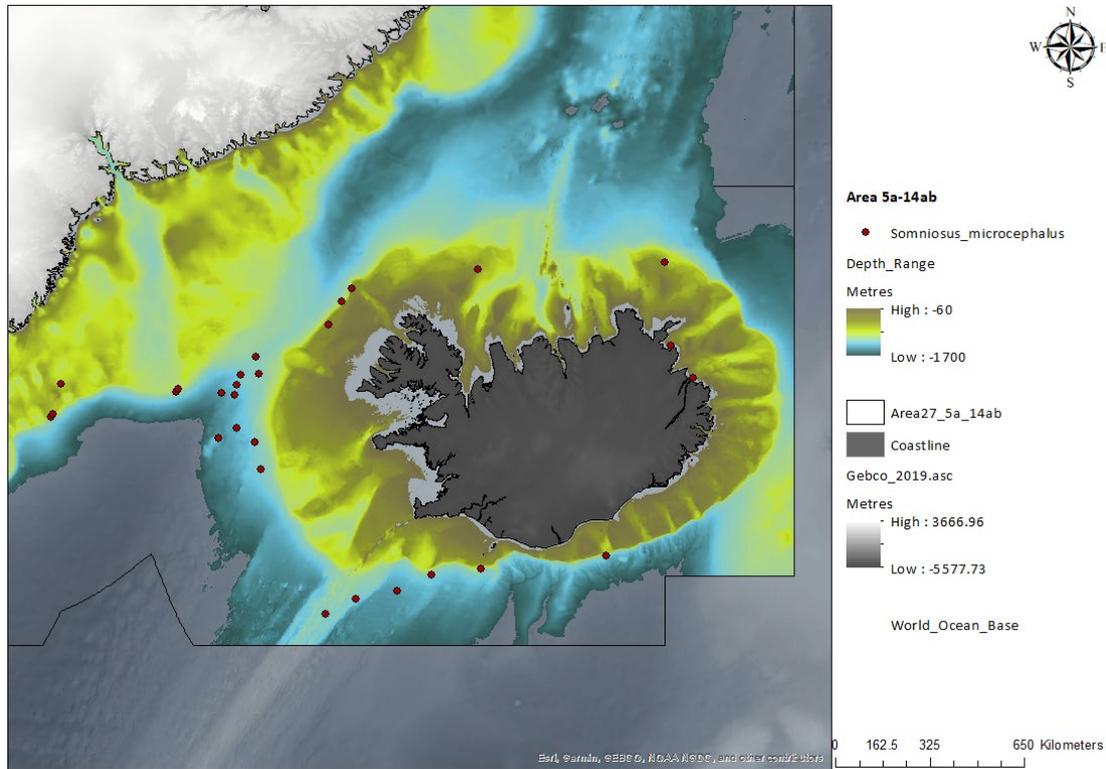


Figure A.53 Recorded distribution of survey catches (red dots) of *Somniosus microcephalus* in ICES Divisions 27.5.a and Subarea 27.14.

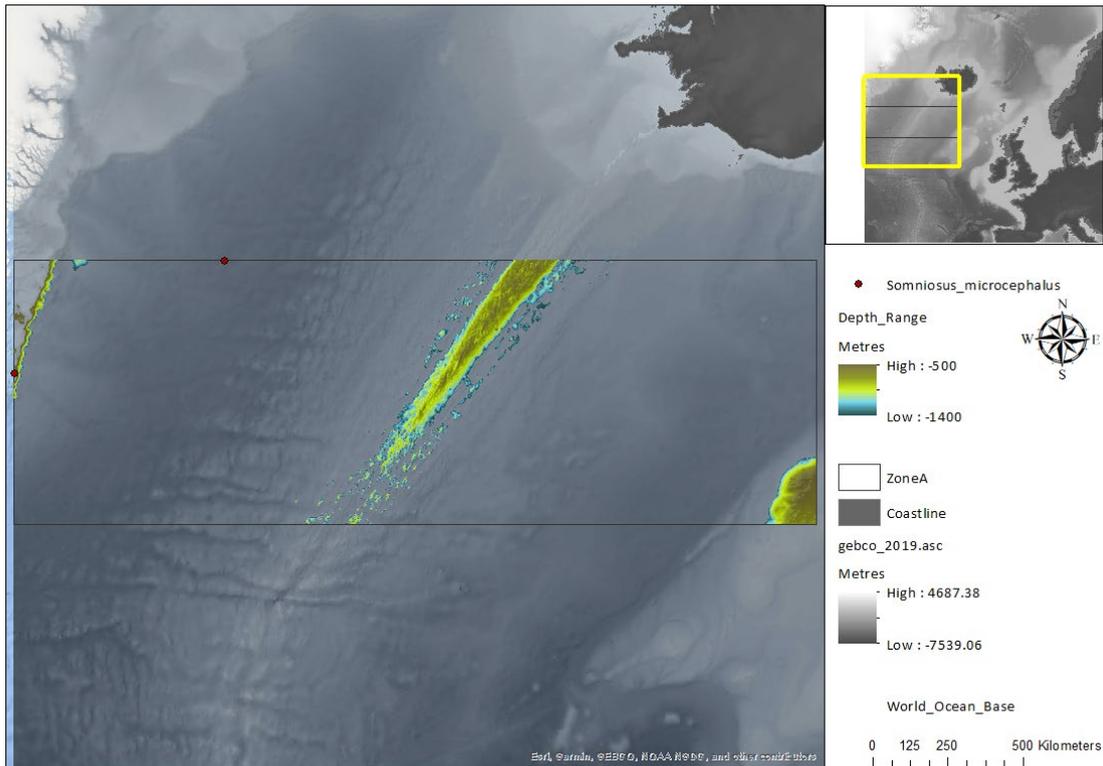


Figure A.54 Recorded distribution of survey catches (red dots) of *Somniosus microcephalus* in parts of ICES Division 27.14b and 12.ab.

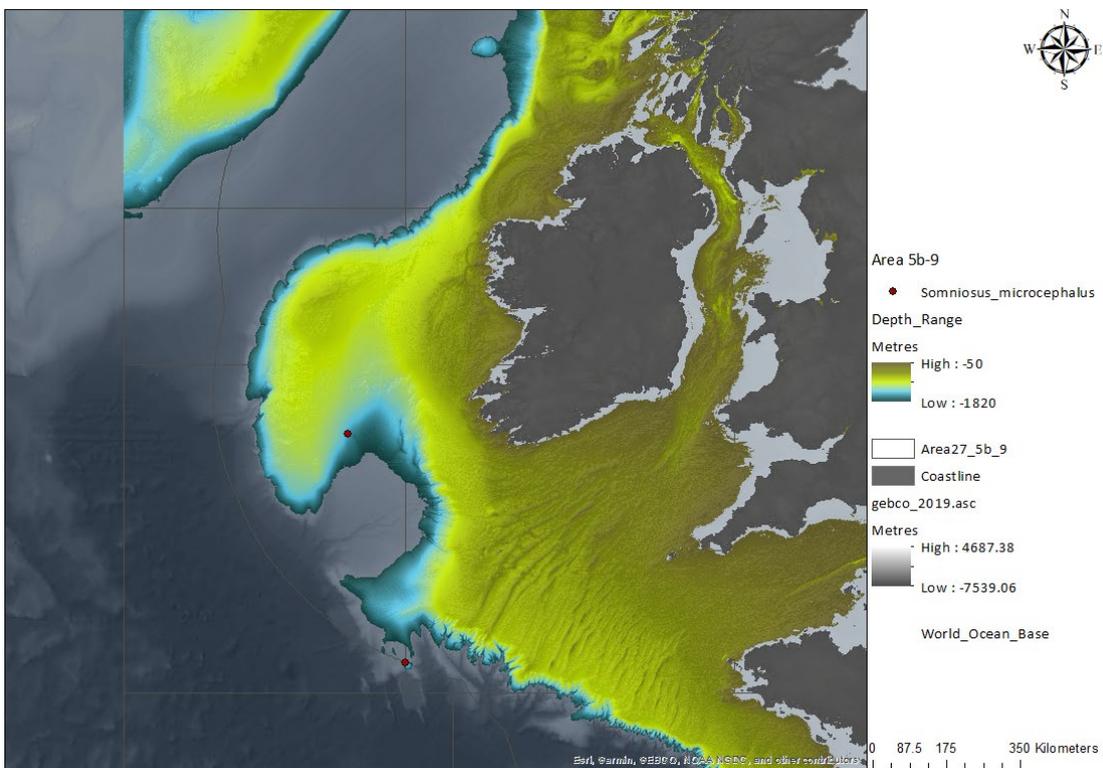


Figure A.55 Recorded distribution of survey catches (red dots) of *Somniosus microcephalus* in ICES Division 27.5.b-Subarea 27.8.