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Stock Annex: Other deep-water sharks and skates from the Northeast Atlantic (ICES Subareas 4–14)

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Other deep-water sharks and skates from the Northeast Atlantic (ICES Subareas 4–14)
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A. General

This stock annex includes information about deep-water elasmobranch species other than Portuguese dogfish (*Centroscymnus coelolepis*) and leafscale gulper shark (*Centrophorus squamosus*), kitefin shark (*Dalatias licha*) and Greenland shark (*Somniosus microcephalus*).

The shark species:

- gulper sharks *Centrophorus* spp.
- birdbeak dogfish *Deania calcea*
- longnose velvet dogfish *Centroscymnus crepidater*
- black dogfish *Centroscyllium fabricii*
- lanternsharks nei *Etmopterus* spp.
- knifetooth dogfish *Scymnodon ringens*
- arrowhead dogfish *Deania profundorum*
- bluntnose sixgill shark *Hexanchus griseus*
- mouse catshark *Galeus murinus*
- deep-water catsharks *Apristurus* spp.
- frilled shark *Chlamydoselachus anguineus*
- great lanternshark *Etmopterus prince*
- sailfin roughshark (sharpback shark) *Oxynotus paradoxus*

The skate species (Rajidae):

- Arctic skate *Amblyraja hyperborean*
- Jensen's skate *Amblyraja jenseni*
- Krefft's skate *Malacoraja kreffti*
- roughskin skate *Malacoraja spinacidermis*
- deep-water skate *Rajella bathyphila*
- pallid skate *Bathyraja pallida*
- Richardson's skate *Bathyraja richardsoni*
- Bigelow's skate *Rajella bigelowi*
- round skate *Rajella fyllae*
- Mid-Atlantic skate *Rajella kukujevi*
- spinytail skate *Bathyraja spinicauda*

- sailray *Rajella lintea*
- Norwegian skate *Dipturus nidarosiensis*
- blue pygmy skate *Neoraja caerulea*
- Iberian pygmy skate *Neoraja iberica*

Other elasmobranch species such as common skate complex, shagreen skate *Leucoraja fullonica*, starry ray *Amblyraja radiata* and longnose skate *Dipturus oxyrinchus* may also be found in deep water, but their main areas of distribution are in shallower waters down to 500 m and they are not considered in this section.

The electric ray *Torpedo nobiliana* may also occur in deep waters.

Eight species of rabbitfish (Chondichthyes; Holocephali), including members of the genera *Chimaera*, *Hariotta* and *Rhinochimaera* are a bycatch of some deep-water fisheries and are sometimes marketed. Catches of Chimaeridae are included in the reports of the ICES Working Group on Deep-water Fisheries Resources (WGDEEP).

A.1. Stock definition

Limited information exists on the majority of the deep-water elasmobranchs considered and the stock units for these species are unknown.

A.2. Fishery

A.2.1 General description

Most of the species of other deep-water sharks and skates are caught in mixed trawl, longline and gillnet fisheries together with the Portuguese dogfish, leafscale gulper shark and deep-water teleosts.

A.2.2 Fishery management regulations

Prior to 2010, a combined TAC in EC waters was set for a group of deep-water sharks:

- Portuguese dogfish *Centroscymnus coelolepis*
- leafscale gulper shark *Centrophorus squamosus*
- birdbeak dogfish *Deania calcea*
- kitefin shark *Dalatias licha*
- greater lanternshark *Etmopterus princeps*
- velvet belly lanternshark *Etmopterus spinax*
- black dogfish *Centroscyllium fabricii*
- gulper shark *Centrophorus granulosus*
- blackmouth cat-shark *Galeus melastomus*
- mouse catshark *Galeus murinus*
- longnose velvet dogfish *Centroscymnus crepidater*
- frilled shark *Chlamydoselachus anguineus*
- bluntnose six-gill shark *Hexanchus griseus*
- sailfin roughshark *Oxynotus paradoxus*
- Greenland shark *Somniosus microcephalus*
- knifetooth dogfish *Scymnodon ringens*
- deep-water catsharks *Apristurus* spp.

In ICES subarea 27.12 rough longnose dogfish *Deania histricosa* and arrowhead dogfish *Deania profundorum* were also included on the list.

In 2010, TACs in all areas were reduced to zero with an allowance for bycatch of 10% of 2009 TACs. For 2011, the bycatch allowance was reduced to 3% of 2009 TACs and isince 2012 no allowance for bycatch was permitted.

Following ICES Advice for 2013 (ICES Advice 2013, Book 11, Section 11.2.2.1), in 2014, the EU list of deep-water sharks was updated to include all *Centrophorus* species. Also the blackmouth catshark (*Galeus melastomus*) was removed from the EU list.

A by-catch 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 (Council regulation (EU) 2016/2285; Council regulation (EU) 2018/2025). According to this limited landing of unavoidable by-catches of deep-sea sharks were allowed and Member States should develop regional management measures for the black scabbardfish fishery and establish specific data-collection measures for deep-sea sharks to ensure their close monitoring. Specifically, 10 tonnes were allowed in each of the years 2017 and 2018 and 7 tonnes were allowed for each of the years 2019 and 2020 for deep-sea sharks in Union and international waters of ICES subareas 5, 6, 7, 8 and 9, in Union and international waters of ICES Subarea 10 and in Union waters of CECAF 34.1.1, 34.1.2 and 34. 2. This allowance was in accordance with ICES indications according to which in the artisanal deep-sea longline fisheries for black scabbardfish, the restrictive catch limits lead to misreporting of unavoidable by-catches of deep-sea sharks, which are currently discarded dead. The Council regulation (EU) 2016/2285 affects specifically the Portuguese deep-water longline fishery targeting black scabbardfish in ICES Division 9.a and Subarea 10. As a response Portugal has proposed an action plan focusing the black scabbardfish fishery and this plan is coordinated by the Portuguese General Directorate of Fisheries. Among other objectives, under this plan different management strategies were expected to be evaluated.

Since 2013 under NEAFC Recommendation 7 it was required that Contracting Parties prohibit vessels flying their flag in the Regulatory Area from directed fishing for deep-sea sharks on the following list: *Centrophorus granulosus, Centrophorus squamosus, Centroscyllium fabricii, Centroscymnus coelolepis, Centroscymnus crepidater, Dalatias licha, Etmopterus princeps, Apristurus spp, Chlamydoselachus anguineus, Deania calcea, Galeus melastomus, Galeus murinus, Hexanchus griseus, Etmopterus spinax, Oxynotus paradoxus, Scymnodon ringens* and *Somniosus microcephalus*.

Deep-water skates are included in EU TACs for "Skates and Rays Rajidae". In EU waters of Divisions 6.a-b, 7a-c and 7e-k, Norwegian skate *Dipturus nidarosiensis* is one of a group of species which may not be retained on board and must be promptly released unharmed to the extent practicable.

In 2005, the use of trawls and gillnets in waters deeper than 200 m in the Azores, Madeira and Canary Island areas was banned (Council Regulation (EC) No 1568/2005). In 2007 the use of gillnets by Community vessels at depths greater than 600 m in ICES Divisions 6.a-b, 7.b-c, 7.j-k and Subarea 12 was banned while a maximum bycatch of deep-water shark of 5% in hake and monkfish gillnet catches was allowed (Council Regulation (EC) No 41/2007). A gillnet ban in waters deeper than 200 m is also in operation in the NEAFC regulatory Area (all international waters of the ICES Area). NEAFC also ordered the removal of all such nets from NEAFC waters by the 1st February 2006.

Since 2009 the "rasco (gillnet)" fishing gear was banned at depths lower than the 600 m isobath (EC Regulation 43/2009,). The regulation affected 4–6 boats in the Basque Country that used this technique. The "rasco" fleet targets anglerfish *Lophius spp*., which represents around 90% of catch weight. This métier is highly seasonal, with the highest activity occurring during winter months. Catches during these months tend to occur in deeper waters, where the nets are sunk to depths down to 1000 m.

B. Data

B.1. Commercial catch

B.1.1 Landings data

During WKSHARK2, landing data provided by country was revised in relation to data quality (including taxonomic categories). Protocols to better document the decisions to be made when estimating WG landings were also developed (ICES, 2016)

Historical landings from 1990 to 2004 are presented in Table B.1.1. Historical French catches of 'aiguillat noir' (which may include *C. fabricii*, *C. crepidater* and *Etmopterus* spp.) are also presented.

Landings reported by UK vessels for 2003/2004 were considered to be unreliably identified and were therefore amalgamated into a mixed deep-water shark (siki) category together with Portuguese dogfish and leafscale gulper shark. Since 2005/2006, UK landings for most species were considered to be more reliably identified; however, reported landings of gulper shark are still considered to be unreliable and have been added to landings of siki sharks.

Table B.1.1. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings by species (1990–2004).

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Gulper shark	1056	801	958	886	344	423	242	291
Birdbeak dogfish								
Black dogfish								
Longnose velvet dogfish								
Velvet belly lanternshark				27	+	10	8	32
Lanternshark NEI					846	2388	2888	2150
Angular roughshark								
TOTAL	1127	876	1042	974	1269	2893	3238	2588
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	
Gulper shark	187	95	54	96	167	203	89	
Birdbeak dogfish			13	38	72	75	195	
Black dogfish			467	486	47	90	49	
Longnose velvet dogfish			86	71	17	33	16	
Velvet belly lanternshark	359	128	25	52	85			
Lanternshark NEI	2043	+	38	338	99			
Angular roughshark							75	
TOTAL	2708	303	894	1340	641	523	562	

B.1.1.1 Gulper sharks *Centrophorus* spp. (not *C. squamosus*)

Almost all landings of gulper sharks (other than leafscale gulper shark) have been from the Portuguese longline fishery in Subarea 27.9.a. Until 2008, annual landings from this fishery were around 100 t, but in 2009, Portuguese landings reduced to 2 t. Other countries reported very small landings of *C. granulosus* from subareas 6 and 7 since 2002.

B.1.1.1.1 Data coverage and quality

Misidentification problems on gulper sharks Portuguese landings of were detected in mainland Portuguese landing ports with two different species of *Centrophorus* being observed in catches: *Centrophorus granulosus* and *Centrophorus uyato*.

Reported landings of gulper sharks by UK vessels in subareas 6 and 7 are considered to be misidentified and these data were included in the Working Group estimates of "siki sharks".

B.1.1.2 Birdbeak dogfish *Deania calcea*

Five European countries reported landings of birdbeak dogfish: Norway, Ireland, UK, Spain and Portugal. In 2005, the total reported landings for all subareas reached 195 t; however this declined over the years due to the zero TAC.

Catches of this species by Russian deep-water longline fisheries in the Faroese Fishing Zone and other Northeastern Atlantic areas were reported in working documents to WGEF (Vinnichenko and Fomin, 2009 WD; Vinnichenko *et al*., 2010 WD). Landings data from this fishery were not subsequently available to the working group.

B.1.1.2.1 Data coverage and quality

In ICES Subarea 27.10, it is likely that landings reported as *Deania calcea* include other species in the same genus (Pinho, 2010 WD). In ICES Division 27.9.a misidentification problems were detected in mainland Portuguese landing ports with two different species of *Deania* being observed in catches: *D. calcea* and *D. profundorum*. However, mostly correspond to *D. calcea*.

B.1.1.3 Longnose velvet dogfish *Centroscymnus crepidater*

European countries that have reported landings from subareas 6–9 are: UK, France, Ireland and Portugal. Highest landings (420 t) were recorded in 2006 and were principally derived from the UK registered deep-water gillnet fleet. Since then, reported landings have declined to zero, most likely as a result of the ban on deep-water gillnet fishing and reduced EU TACs for deep-water sharks.

B.1.1.3.1 Data coverage and quality

Landings of *Centroscymnus crepidater* are likely to have been included in "siki sharks" landings or in other mixed categories.

B.1.1.4 Black dogfish *Centroscyllium fabricii*

Landings of *Centroscyllium fabricii* have been reported by UK, Iceland, France and Spain and were derived from divisions 27.4.a, 27.5.b and subareas 27.7 and 27.12.

France reported the majority of the landings of black dogfish in the ICES area, starting to report landings in 1999. French annual landings peaked at about 400 t in 2001 and have since declined. These landings are mainly from Division 27.5.b and Subarea 27.6. Iceland reported few landings, all from Division 27.5.a. The largest annual landings

reported by Spain came from Subarea 12 in 2000 (85 t) and 2001 (91 t), but recent data are lacking.

Since 2009, only Iceland has reported catches of black dogfish, mainly from Subarea 27.5, but always in small amounts (1 t in 2013).

B.1.1.4.1 Data coverage and quality

Landings of *Centroscyllium fabricii* may also be included in the grouped category "*Aiguillat noir*" or in other mixed categories, including siki sharks.

B.1.1.5 "*Aiguillat noir*"

This is a commercial category only used by France (Table B.1.2.) to record landings on small, deep-water squaliform sharks, mainly black dogfish *Centroscyllium fabricii* with smaller quantities of longnose velvet dogfish and lanternsharks. Reported landings started in 2000 (249 t) then declined from 266 t in 2001 to 1 t in 2007, since when there have been no reported landings.

Table B.1.2. Other deep-water sharks and skates from the Northeast Atlantic. Working Group estimates of landings of "*aiguillat noir*".

	FRANCE	TOTAL
2000	123	123
2001	165	165
2002	11	11
2003	37	37
2004	21	21
2005	5	5

B.1.1.6 Norwegian skate *Dipturus nidarosiensis*

Dipturus nidarosiensis was occasionally landed in three French ports mostly under the landing name "*D. oxyrinchus*" with the FAO code RJO. The individuals landed mostly come from the ICES Division 27.6.a.

B.1.1.6 Other skates

Surveys of French fish markets show that *Rajella lintea*, *Rajella kukujevi*, *Rajella fyllae* and *Bathyraja spinicauda* are occasionally landed from ICES Division 6.a, but without specific landing names.

B.1.2 Discards estimates

B.1.2.1 Portugal (Azores)

Discards data from the Azorean observer programme were provided in Pinho and Canha (2011 WD; Table B.1.3). Since then, this information has not been updated.

Table B.1.3. Other deep-water sharks and skates from the Northeast Atlantic. Discards of deep-water shark species (numbers) recorded by Azores observers 2005–2010.

Species	Damaged	Non commercial	Undersized	Not identified	Total
Centrophorus granulosus		2			2
Dalatias licha		41	3		44
Deania calcea	6	254	1		261
Etmopterus spinax	8	6302	8	1	6319
Hexanchus griseus		2	1	2	5

B.1.2.2 Portugal (mainland)

Discards data from the Portuguese longline fishery were presented in 2014 (Prista *et al.*, 2014 WD). *Etmopterus* spp. and *C. crepidater* are the species with higher percentages of discards along the time-series (although *C. crepidater* was not sampled in 2013). Other elasmobranchs were rarely discarded (Prista *et al.*, 2014 WD). Estimates of percentage discarded by species from deep-water longlines and demersal bottom trawls are given in Table B.1.4.

To evaluate the level of bycatch and discards of deep-water sharks in the Portuguese trammelnet fishery, a pilot study was undertaken in ICES Division 9.a (Moura *et al*., 2015 WD). Results show that the fishery targeting anglerfish and operating at depths of 200–600 m has a low frequency of occurrence of deep-water sharks (Table B.1.5). Results further suggest that relatively higher frequencies of occurrence are likely to be observed deeper than 600 m, according to the depth ranges reported for most of these species.

Table B.1.4. Other deep-water sharks and skates from the Northeast Atlantic. Frequency of occurrence (%) of deep-water sharks in the discards of the hauls sampled on board the Portuguese fisheries by gear type: crustacean bottom otter trawl - OTB_CRU; demersal fish bottom otter trawl - OTB_DEF; deep-water set longline fishery that targets black scabbardfish LLS_DWS (2004–2013). "---" indicates no occurrence; NA, information not available by species.

FISHERY	YEAR	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
OTB_CRU	*Deania calcea*	5	5	3	4	9	2	2	2	4	NA
	Centrophorus granulosus	---	---	---	---	---	---	1	---	1	NA
	Deania profundorum	---	---	---	---	---	---	---	2	---	NA
	Etmopterus spp.	36	24	50	22	17	8	11	23	29	7
OTB_DEF	*Deania calcea*	1	---	---	---	---	---	---	---	---	NA
	Etmopterus spp.	4	3	1	---	---	2	---	---	---	---
LLS_DWS	*Centroscymnus crepidater*	---	---	80	67	25	17	22	17	11	---
	Centroscymnus cryptacanthus	---	---	---	---	25	---	---	---	---	NA
	Deania calcea	---	---	---	---	25	17	11	---	22	NA
	Squalus spp.	---	---	---	---	---	---	---	---	11	NA
	Deep-water sharks nei	---	---	---	---	---	---	22	---	---	NA
	Deania profundorum	---	---	---	---	---	---	---	---	11	NA
	Etmopterus spp.	---	100	100	100	100	100	100	100	100	100
	Scymnodon ringens	---	67	---	67	---	17	---	---	---	NA

Table B.1.5 Other deep-water sharks and skates from the Northeast Atlantic. Number and catch weight of anglerfish (*Lophius* spp.) and number of sharks by 100 m depth strata sampled from the pilot study on the trammelnet fishery targeting anglerfish in Portuguese waters (Division 9.a) (2012–2014). *Lophius spp.* combines *Lophius piscatorius* and *Lophius budegassa*. N = number of sampled specimens; W_{est}, estimated weight (based on length–weight relationships). From Moura *et al.* (2015 WD).

		Depth stratum (m)					
	Total	100–200	200–300	300–400	400–500	500–600	>600
Species	**n**	n	n	n	n	n	n
*Centroscymnus crepidater**	**2**		1				1
*Scymnodon ringens**	**3**					1	2
*Chlamydoselachus anguineus**	**8**			2		1	5
*Dalatias licha**	**6**		1			1	4
*Centrophorus granulosus**	**1**			1			
*Deania calcea**	**13**			3		2	9
*Etmopterus spinax**	**4**			4			
Etmopterus pusillus	**3**		1	2			
Squaliformes NI	**1**					1	
Mitsukurina owstoni	**2**				2		
Galeus atlanticus	**1**			1			
Galeus spp.	**50**	3	6	12	12	5	12
Scyliorhinus canicula	**177**	29	107	40	1	0	0
Mustelus spp.	**1**		1				
Isurus oxyrhinchus	**1**	1					
Prionace glauca	**5**	4		1			
Galeorhinus galeus	**3**		3				
Lophius spp. (n)	**3229**	344	2040	716	13	25	91
Lophius spp. (weight, kg)	**11 711.1**	1254.4	6564.7	2416.5	149.9	187.9	1137.8
No hauls	**90**	**16**	**50**	**14**	**2**	**2**	**6**

*** sharks included in the EU deep-water shark list.**

B.1.2.3 Spain

The Discards Sampling Programme for Otter and Pair Bottom Trawl (OTB and PTB) fleets, covering ICES subareas 6, 7, Division 8.c and 9 (North), started in 1988; however, it did not occur annually until 2003. The sampling strategy and the estimation methodology used follows the "Workshop on Discard Sampling Methodology and Raising Procedures" guidelines (ICES, 2003) and more detail of this applied to this area was explained in Santos *et al*. (2010). Preliminary estimates of Spanish deep-water elasmobranch discards (2003–2014) are presented in Table B.1.6.

Table B.1.6. Other deep-water sharks and skates from the Northeast Atlantic. Spanish discard data of deep-water shark species. In bold weight discarded (tonnes) of demersal elasmobranches and below in italics. CV of estimations by fishing ground. For detailed information see Santos *et al*. (2010).

Fishing Ground Species	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Celtic Sea (Subareas 6–7)												
Dalatias licha	0	90.9	13.9	1.3	0	0	2.9	0.5	47.7	0.4		
	-	99.7	99.7	98.8	-	-	99.3	99.5	99.7	99.6		
Deania calcea	0	9.8	87.3	17.3	22.2	6.1	2.6	3.6	0	6.2		
	-	99.7	76	49.5	99.7	62.1	99.3	99.5	-	72		
Etmopterus spinax	16.2	296.1	117.7	2.8	6.6	653.6	60.1	206.1	167.2	16.9		
	63.5	94.4	59.5	84.7	99.7	92.9	39.1	76.3	80.5	96.8		
Galeus melastomus	90.1	504.4	169.5	12.8	220.7	456.6	984.6	1045.7	737.1	395.1		6.3
	95.1	64.3	57.1	36.6	47.8	73.5	81.3	77	44.6	89.7		
Iberian Waters (Divisions 8.c–9.a)												
Dalatias licha	0	0	1.3	2.6	0	0	0	3.8	0	0.1	2.0	
	-	-	102.6	100.2	-	-	-	99.7	-	99.7	84.3	
Deania calcea	10.8	51.4	5.5	22.8	1.8	17.9	27.6	157.4	32.4	39.5	164	
	54.9	81.3	61.4	84.5	69.9	96.6	53.9	62.1	43.4	49.9	47.7	
Etmopterus spinax	0.5	332.1	5.6	1.8	1.7	19.5	37.9	28.8	23.3	78.5	14.7	
	90.5	90.8	49.5	68.5	59.4	58.9	75.6	58.6	79.5	72.7	58.1	
Galeus melastomus	588.8	243.5	527.3	553.2	1063.4	225.8	903.7	1271.9	730.7	1433	749	1123
	31.4	54.8	36	60.7	36.7	28.5	62.8	51.1	34.8	40.5	31.8	

B.2. Biological sampling

B.2.1 Maturity

B.2.1.1 *Centroscymnus crepidater*

Moore *et al.* (2013) provide length of first maturity of *Centroscymnus crepidater* (57.2 cm total length (TL) for males and 75.4 cm TL for females) from the Rockall Trough.

B.2.1.2 *Apristurus aphyode*

Moore *et al.* (2013) provide length of first maturity of *Apristurus aphyodes* (49.0 cm TL for males and 56.9 cm TL for females) from the Rockall Trough.

B.2.2 Natural mortality

No information is available.

B 2.3 Length and age composition of landed and discarded fish in commercial fisheries

B.2.3.6 Norwegian skate *Dipturus nidarosiensis*

The length–frequency distribution of *Dipturus nidarosiensis* observed in the 2012–2014 French landings are presented in Figure B.2.1

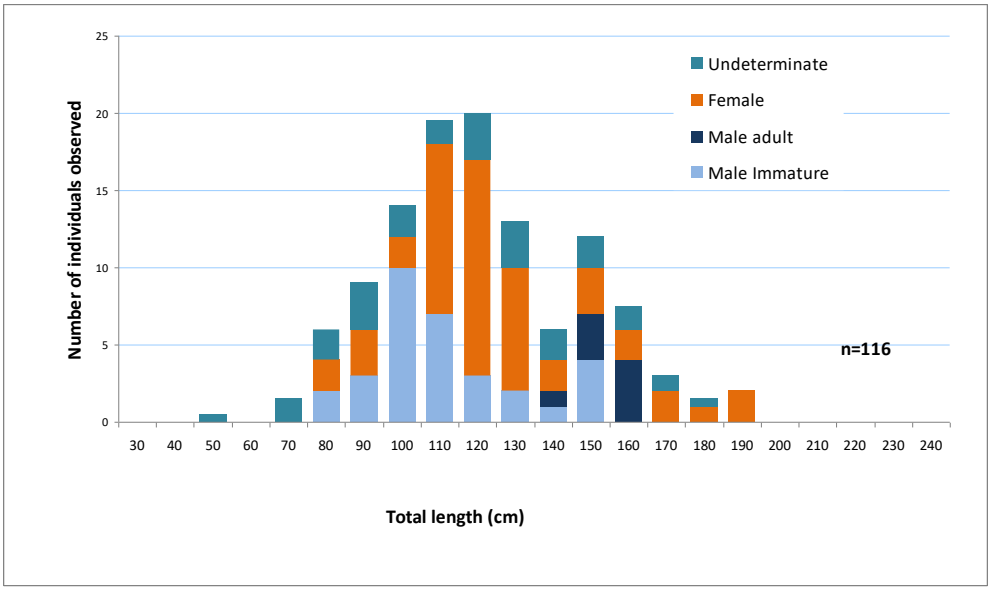

Figure B.2.1. Other deep-water sharks and skates from the Northeast Atlantic. Length–frequency distribution of *Dipturus nidarosiensis* observed in the 2012–2014 French landing and coming from ICES subareas 6–7.

B.3. Surveys

B.3.1. Data available

B.3.1.1. ICES Subarea 6

The Scottish deep-water trawl survey has operated from 1996 to 2017 at depths of 300–2000 m along the continental slope between approximately 55°N and 59°N (see Neat *et al*., 2010 for details).

Neat *et al*. (2015) analysed catches of deep-water elasmobranch species from the Scottish deep-water trawl survey in Division 6.a. Selected results are presented below.

Scientific dual-warp bottom-trawls with rock-hopper ground gear (for details see Neat *et al*., 2010) were carried out at 527 sites along the deep-water slopes, banks and seamounts of the Rockall Trough, to the west of Scotland. Surveys were carried out from 1996–2013 at depths of 300–2030 m. In 1996 FRV Scotia IV was in service, but was replaced by FRV Scotia V in 1998. Most of the records in the database derive from Scotia V and in particular from surveys carried out in September that used the Jackson BT-184 deep-water bottom trawl. For species distribution mapping all data were used, but

for statistical analyses over time only data from 1998 onwards (Scotia V only) and only data collected with the same trawl net (Jackson BT184) from the continental slope during the month of September were used.

For some species of the genus *Apristurus* there has been an ongoing taxonomic debate, for example *A. melanoasper* was only formally described in 2004. Therefore time-series analyses were restricted to two of the more common *Apristurus* species (*A. aphyodes* and *A. microps*) that did not pose identification problems or nomenclature changes during the survey period.

For each species, the relationship between number caught per hour of trawling and depth were visually inspected and a core depth range established that included >99% of individuals. All hauls within this range (including those with zero catch of that species) were used to generate estimates of catch per unit of effort. As a consequence of variable depth ranges of each species, the sample sizes (number of hauls) vary from species to species.

Distribution maps for each species were produced using ARC GIS. To assess areas of relatively high abundance in close proximity to each other, the 'Hot Spot Analysis' tool in ARC GIS was used. This calculates the 'Getis-Ord Gi' statistic for each feature in a dataset. The resultant values indicate where features with either high or low values cluster spatially based on the proximity of neighbouring features. The analysis highlights samples with a high value that are surrounded by other features with high values as well. It is a useful tool for visualising the spatial distribution of high abundance data.

Generalized additive models (Zuur *et al*., 2009) were used to analyse trends over time, as the relative abundance of most species showed non-linear relationships with depth and over time. The GAM uses a smoothing function to account for non-linear relationships. Latitude was also included in the model as a continuous variable as there was often a weak but significant relationship. Negative binomial or Tweedie variance structures were used to account for the variable occurrence of hauls with zero catch. GAMs were applied to eleven species that were regularly encountered from year-to-year. Several species were too infrequently sampled to analyse.

B.3.1.2. ICES Subarea 7

The Spanish survey on the Porcupine Bank (SpPGFS-WIBTS-Q4) in ICES divisions 7.c and 7.k covers an area from longitude 12°W to 15°W and from latitude 51°N to 54°N following the standard IBTS methodology for the western and southern areas (ICES, 2010). The sampling design is a random stratified (Velasco and Serrano, 2003) with two geographical sectors (North and South) and three depth strata (<300 m, 300–450 m and 450–800 m). Haul allocation is proportional to the strata area following a buffered random sampling procedure (as proposed by Kingsley *et al*., 2004) to avoid the selection of adjacent 5×5 nm rectangles. More details on the survey design and methodology are presented in ICES (2017).

B.3.1.3. ICES divisions 8.c and 9.a

The Spanish survey in the Cantabrian Sea and Galician waters (SpGFS-WIBTS-Q4) has covered this area annually since 1983 (except 1987), obtaining abundance indices and length distributions for the main commercial species and elasmobranchs. A new vessel (R/V Miguel Oliver) is in use since 2013. . The majority of the deep-water sharks species caught in the Spanish SpGFS-WIBTS-Q4 survey are usually found at deeper waters than those covered by the survey and thus the abundance indices must be treated with

caution. More details on the survey design, methodology and results can be found in ICES (2017).

B.3.2. Survey data analysis

Data from the Porcupine Bank survey (SpPGFS-WIBTS-Q4) and from the Spanish survey in the Cantabrian Sea and Galician waters (SpGFS-WIBTS-Q4) are annualy provided to WGEF, particularly for *Deania* spp., *S. ringens*, *E. spinax* and *H. griseus*. In the Spanish SpGFS-WIBTS-Q4 survey in the Cantabrian Sea and Galician waters, *D. calcea* and *D. profundorum* were recorded together until 2009. *D. profundorum* was first separately recorded in 2009 (Sanjuan *et al*., 2012). To avoid confounding effects between the two species results previous to 2009 combine the two species and were referred as *Deania* spp..

B.3.2.1 Birdbeak dogfish *Deania calcea* and Arrowhead dogfish *Deania profundorum*

The abundance of *Deania calcea* in hauls within the core depth range of 400–1500 m on the Scottish slope has fluctuated generally between 0.7 and 2.2ind.h–1 with no evident trend (since 1998; Table B.3.1). The catch rate in 2013 was anomalously high at 5 ind.h–1, the highest in the series. Preliminary analyses by Neat *et al*. (2015) showed a significant positive trend (p = 0.001) over time (Figure B.3.1.). The results of this analysis were considered as preliminary and indicative only of general trends.

Table B.3.1. Other deep-water sharks and skates from the Northeast Atlantic. Summary data for Birdbeak dogfish *D. calcea* from Scottish deep-water survey. (N HAULS- number of hauls; N FISH- number of fishes; MEAN NPH – mean number per hour).

Year	N hauls	N fish	Mean NpH	proportion of positive hauls
1998	19	28	0.7	0.63
2000	31	134	2.2	0.9
2002	27	79	1.6	0.84
2004	24	73	1.7	0.63
2005	18	35	1.0	0.47
2006	28	109	2.1	0.68
2007	18	59	1.7	0.47
2008	25	41	1.0	0.26
2009	31	19	0.7	0.42
2011	21	14	0.6	0.37
2012	21	34	1.8	0.58
2013	23	109	5.0	0.63

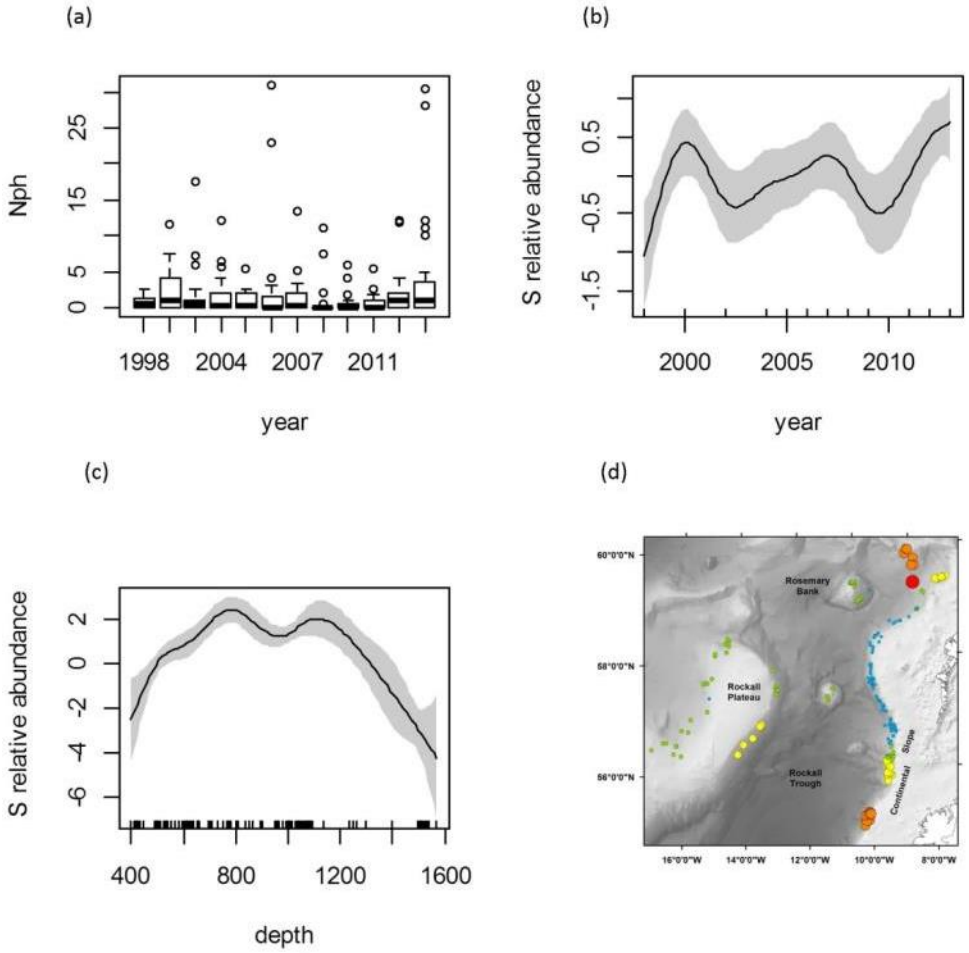

Figure B.3.1. Other deep-water sharks and skates from the Northeast Atlantic. Results of GAM analysis of catches of birdbeak dogfish *Deania calcea* in Scottish deep-water trawl survey from Neat *et al.* (2015) showing (a) Box-whisker plot of numbers per hour for each year. (b) Smoothed function of relative abundance of across years. (c) Smoothed function of relative abundance of across depths. (d) Distribution of abundance across the survey area graded from large red dots that indicate hauls of high abundance in close proximity to other hauls of high abundance to small blue dots that indicate hauls of low abundance in close proximity to other hauls of low abundance.

B.3.1.2 Velvet belly lanternshark *Etmopterus spinax*

The relative abundance of *E. spinax* derived from Scottish deep-water survey at depths from 300 to 1100 m has varied with no overall trend (between 3–10 ind.h–1) since 1998 (Table B.3.2 and Figure B.3.2.). Preliminary analyses using GAM with Tweedie distribution suggest no significant trend over time (Neat *et al.*, 2015).

Table B.3.2. Other deep-water sharks and skates from the Northeast Atlantic Summary data for velvet belly lanternshark *Etmopterus spinax* from Scottish deep-water survey. (N HAULS- number of hauls; N FISH- number of fishes; MEAN NPH – mean number per hour).

Year	N hauls	N fish	Mean NpH	proportion of positive hauls
1998	18	319	8.5	0.39
2000	22	360	8.4	0.36
2002	20	137	3.8	0.55
2004	19	137	4.1	0.32
2005	13	98	3.8	0.31
2006	21	201	5	0.33
2007	12	221	9.4	0.42
2008	17	257	8.7	0.53
2009	24	91	4.6	0.13
2011	13	66	5	0.38
2012	27	176	7.6	0.52
2013	37	367	10.5	0.46

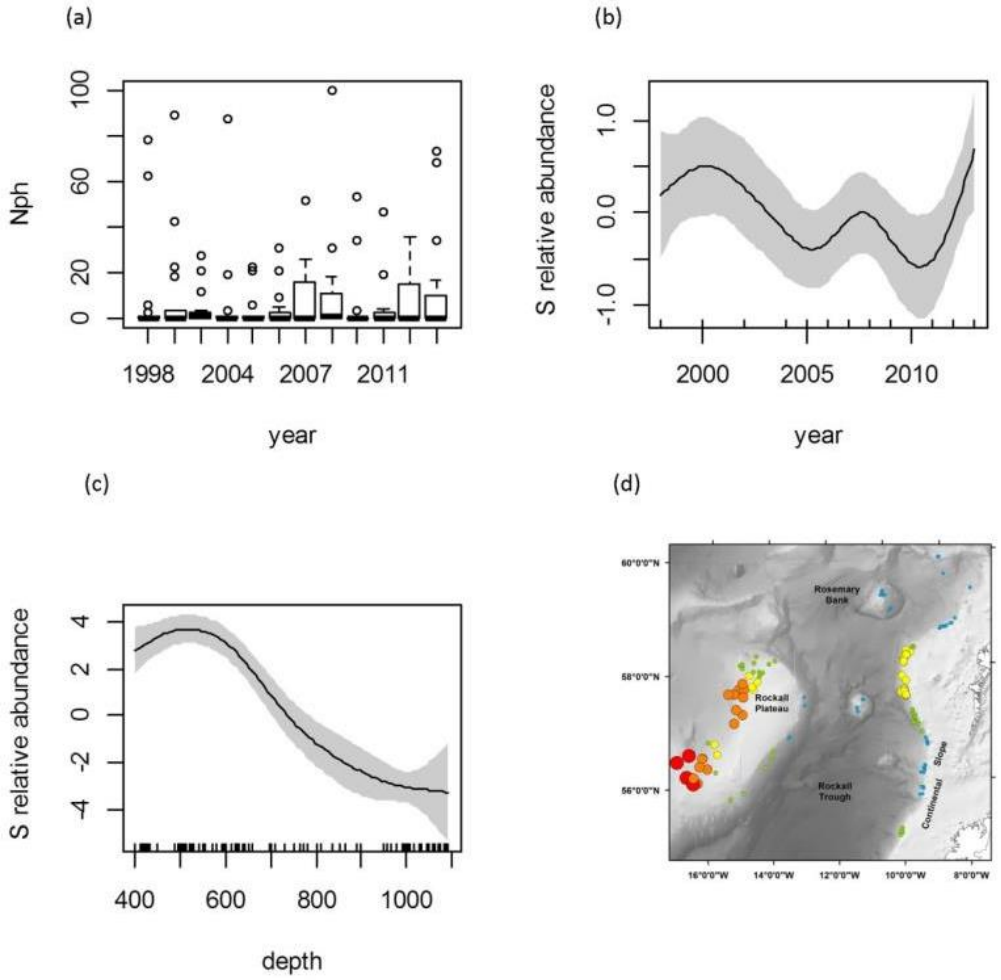

Figure B.3.2. Other deep-water sharks and skates from the Northeast Atlantic. Results of GAM analysis of catches of velvet belly *Etmopterus spinax* in Scottish deep-water trawl survey from Neat *et al.* (2015) showing (a) Box-whisker plot of numbers per hour for each year. (b) Smoothed function of relative abundance of across years. (c) Smoothed function of relative abundance of across depths. (d) Distribution of abundance across the survey area graded from large red dots that indicate hauls of high abundance in close proximity to other hauls of high abundance to small blue dots that indicate hauls of low abundance in close proximity to other hauls of low abundance.

B.3.1.3 Greater lantern shark *Etmopterus princeps*

The relative abundance of this species between depths of 800–1800 m from Scottish deep-water survey has been variable (averaging 3 ind.h–1), for the past 14 years (Table B.3.3; Figure B.3.3.). Preliminary analyses using GAM with Tweedie distribution suggest no trend over time (Neat *et al.*, 2015).

Table B.3.3. Other deep-water sharks and skates from the Northeast Atlantic. Summary data for greater lanternshark *Etmpterus princeps* from Scottish deep-water survey. (N HAULS- number of hauls; N FISH- number of fishes; MEAN NPH – mean number per hour).

Year	N hauls	N fish	Mean NpH	proportion of positive hauls
2000	20	148	3.70	0.63
2002	16	247	8.33	0.81
2004	14	123	4.48	0.54
2005	14	77	2.75	0.58
2006	19	102	3.97	0.56
2007	15	163	5.62	0.69
2008	22	57	1.74	0.55
2009	29	149	5.62	0.48
2011	21	68	2.96	0.61
2012	22	74	3.46	0.36
2013	23	118	5.2	0.52

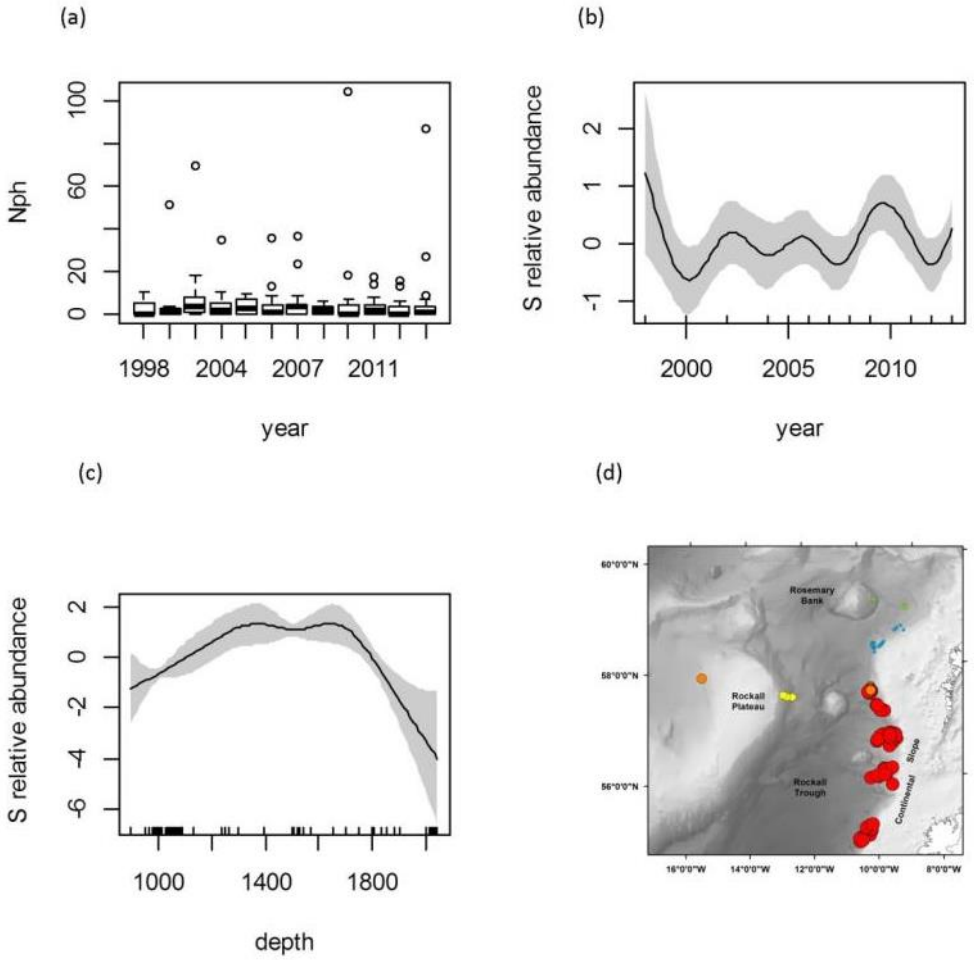

Figure B.3.3. Other deep-water sharks and skates from the Northeast Atlantic. Results of GAM analysis of catches of greater lantern shark *Etmopterus princeps* in Scottish deep-water trawl survey from Neat *et al.* (2015) showing (a) Box-whisker plot of numbers per hour for each year. (b) Smoothed function of relative abundance of across years. (c) Smoothed function of relative abundance of across depths. (d) Distribution of abundance across the survey area graded from large red dots that indicate hauls of high abundance in close proximity to other hauls of high abundance to small blue dots that indicate hauls of low abundance in close proximity to other hauls of low abundance.

B.3.1.4 Bluntnose six–gill shark *Hexanchus griseus*

The relative abundance of *H. griseus* between depths of 300–800 m from Scottish deep-water survey averaged <1 ind.h–1 over the past 14 years (Table B.3.4.). There was an anomalously high catch of 15 individuals in 2008.

Table B.3.4. Other deep-water sharks and skates from the Northeast Atlantic. Summary data for bluntnose six-gill shark *Hexanchus griseus* from Scottish deep-water survey. (N HAULS- number of hauls; N FISH- number of fishes; MEAN NPH – mean number per hour).

Year	N hauls	N fish	Mean NpH	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

B.3.1.5 Black dogfish *Centroscylium fabricii*

The relative abundance of *C. fabricii* between depths of 800–1800 m from Scottish deep-water survey has fluctuated with no trend (ca. 5 ind.h–1) since 1998 (Table B.3.5.; Figure B.3.4). Variability of the catch rates is high, wityh occasional large catches recorded. Preliminary analyses using GAM with Tweedie distribution suggest no significant trend over time (Neat *et al*., 2015).

Table B.3.5. Other deep-water sharks and skates from the Northeast Atlantic. Summary data for black dogfish *Centroscymnus fabricii* from Scottish deep-water survey. (N HAULS- number of hauls; N FISH- number of fishes; MEAN NPH – mean number per hour).

Year	N hauls	N fish	Mean NpH	proportion of positive hauls
2000	20	372	9.3	0.75
2002	15	107	3.8	0.53
2004	13	104	4.0	0.46
2005	12	158	6.6	0.58
2006	17	180	5.6	0.53
2007	12	109	4.6	0.5
2008	19	175	5.7	0.58
2009	25	138	6.4	0.56
2011	14	214	14.1	0.64
2012	14	119	9.9	0.64
2013	13	71	5.4	0.62

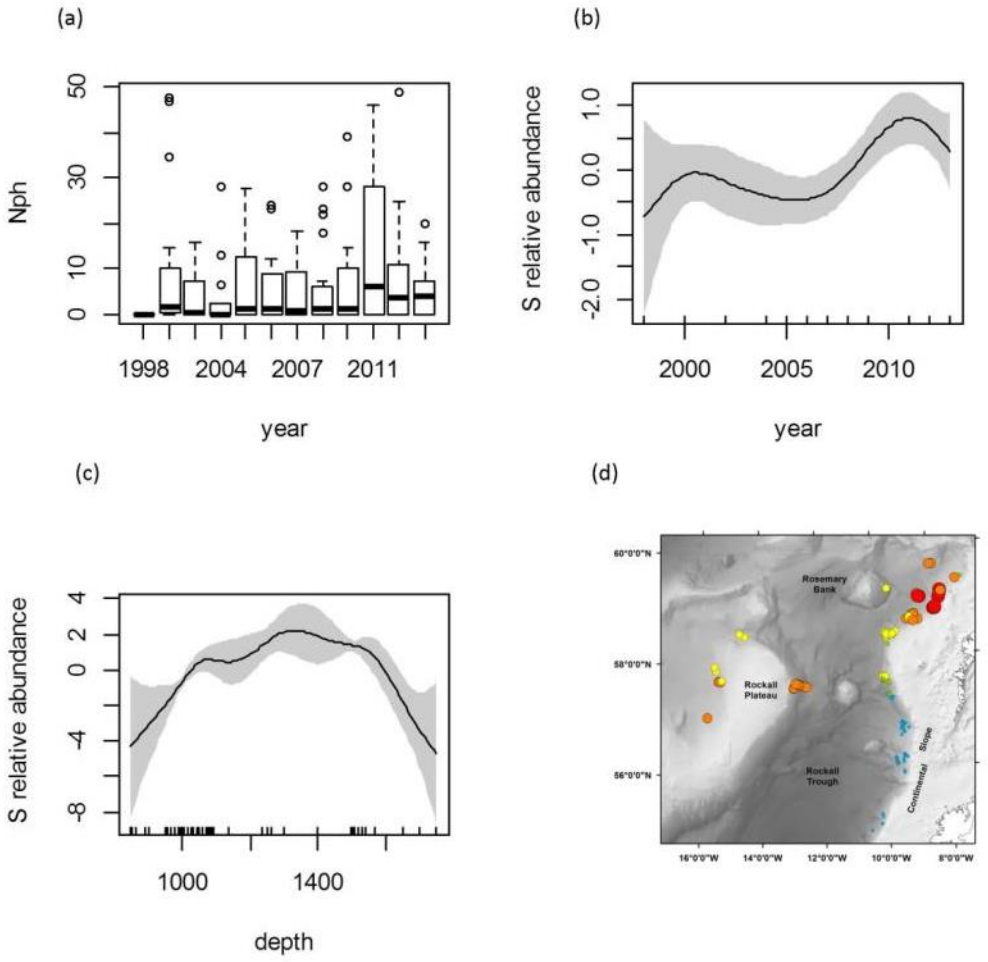

Figure B.3.4. Other deep-water sharks and skates from the Northeast Atlantic. Results of GAM analysis of catches of black dogfish Centroscymnus fabricii in Scottish deep-water trawl survey from Neat et al. (2015) showing (a) Box-whisker plot of numbers per hour for each year. (b) Smoothed function of relative abundance of across years. (c) Smoothed function of relative abundance of across depths. (d) Distribution of abundance across the survey area graded from large red dots that indicate hauls of high abundance in close proximity to other hauls of high abundance to small blue dots that indicate hauls of low abundance in close proximity to other hauls of low abundance

B.3.1.5 Longnose velvet dogfish *Centroscymnus crepidater*

The relative abundance of this species between depths of 500–1800 m from Scottish deep-water survey has been variable (averaging 5 ind.h–1, but with occasional very high catches) for the past 14 years (Table B.3.6.; Figure B.3.5.). Preliminary analyses using GAM with Tweedie distribution suggest a significant negative trend ($p < 0.001$) over time (Neat *et al*., 2015).

Table B.3.6. Other deep-water sharks and skates from the Northeast Atlantic. Summary data for long-nosed velvet dogfish *Centroscymnus crepidater* from Scottish deep-water survey. (N HAULS- number of hauls; N FISH- number of fishes; MEAN NPH – mean number per hour).

Year	N hauls	N fish	Mean Nph	proportion of positive hauls
1998	18	1054	27.2	0.78
2000	28	524	9.6	0.75
2002	23	276	6.6	0.74
2004	20	341	9.3	0.7
2005	17	248	7.3	0.71
2006	25	271	5.8	0.72
2007	15	213	7.1	0.67
2008	18	499	16.2	0.72
2009	25	192	9.1	0.64
2011	17	183	10.1	0.47
2012	16	103	7.3	0.56
2013	21	223	11.0	0.48

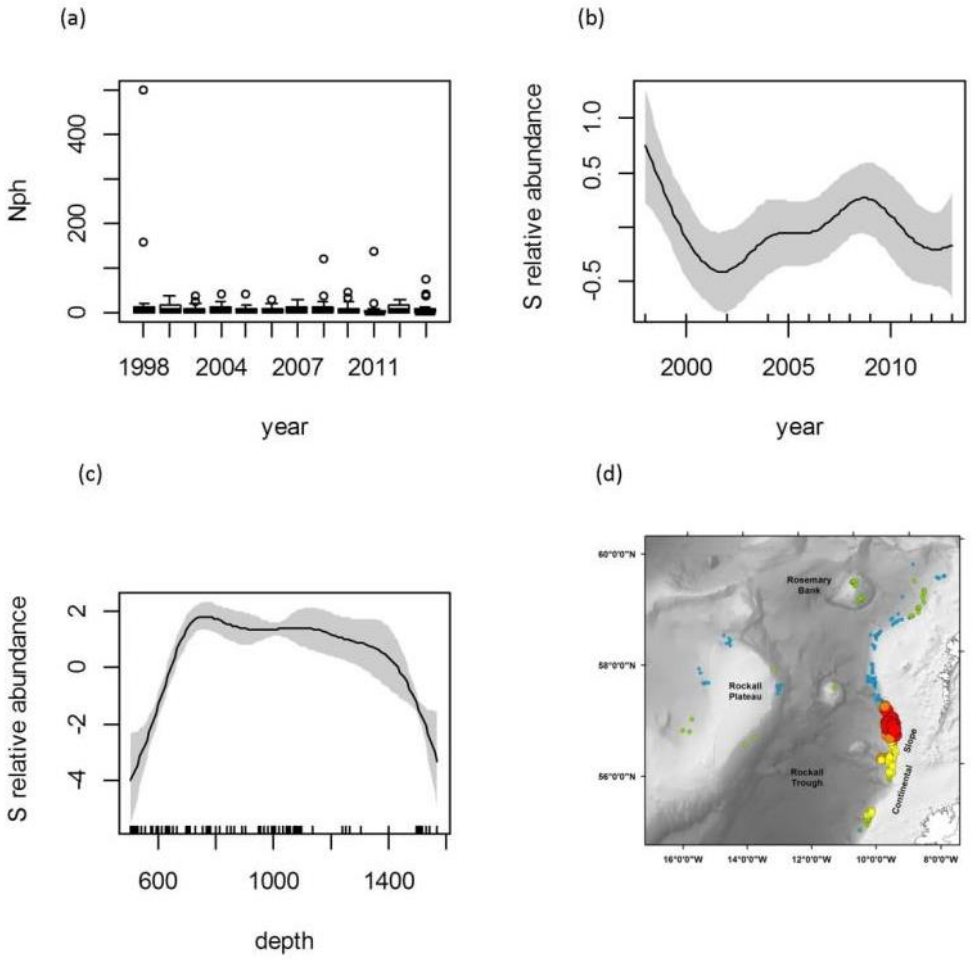

Figure B.3.5. Other deep-water sharks and skates from the Northeast Atlantic. Results of GAM analysis of catches of *Centroscymnus crepidater* in Scottish deep-water trawl survey from Neat *et al.* (2015) showing (a) Box-whisker plot of numbers per hour for each year. (b) Smoothed function of relative abundance of across years. (c) Smoothed function of relative abundance of across depths. (d) Distribution of abundance across the survey area graded from large red dots that indicate hauls of high abundance in close proximity to other hauls of high abundance to small blue dots that indicate hauls of low abundance in close proximity to other hauls of low abundance.

B.3.1.6 Small-eye cat shark *Apristurus microps*

The relative abundance of this species at depths of 500–1500 m from Scottish deep-water survey was, on average, 1 ind.h–1 over the past 14 years (Table B.3.7.; Figure B.3.6).

Table B.3.7.. Other deep-water sharks and skates from the Northeast Atlantic. Summary data for mouse catshark *Galeus murinus* from Scottish deep-water survey. (N HAULS- number of hauls; N FISH- number of fishes; MEAN NPH – mean number per hour).

Year	N hauls	N fish	Mean NpH	proportion of positive hauls
1998	7	16	0.984615	0.57
2000	15	38	1.271612	0.6
2002	10	56	3.146067	0.6
2004	8	18	1.142857	0.5
2005	8	2	0.125	0.12
2006	10	30	1.578947	0.6
2007	6	33	2.8125	0.83
2008	9	12	0.75	0.56
2009	16	38	3.064516	0.75
2011	7	4	0.541761	0.43
2012	8	12	1.773399	0.75
2013	9	10	1.149425	0.22

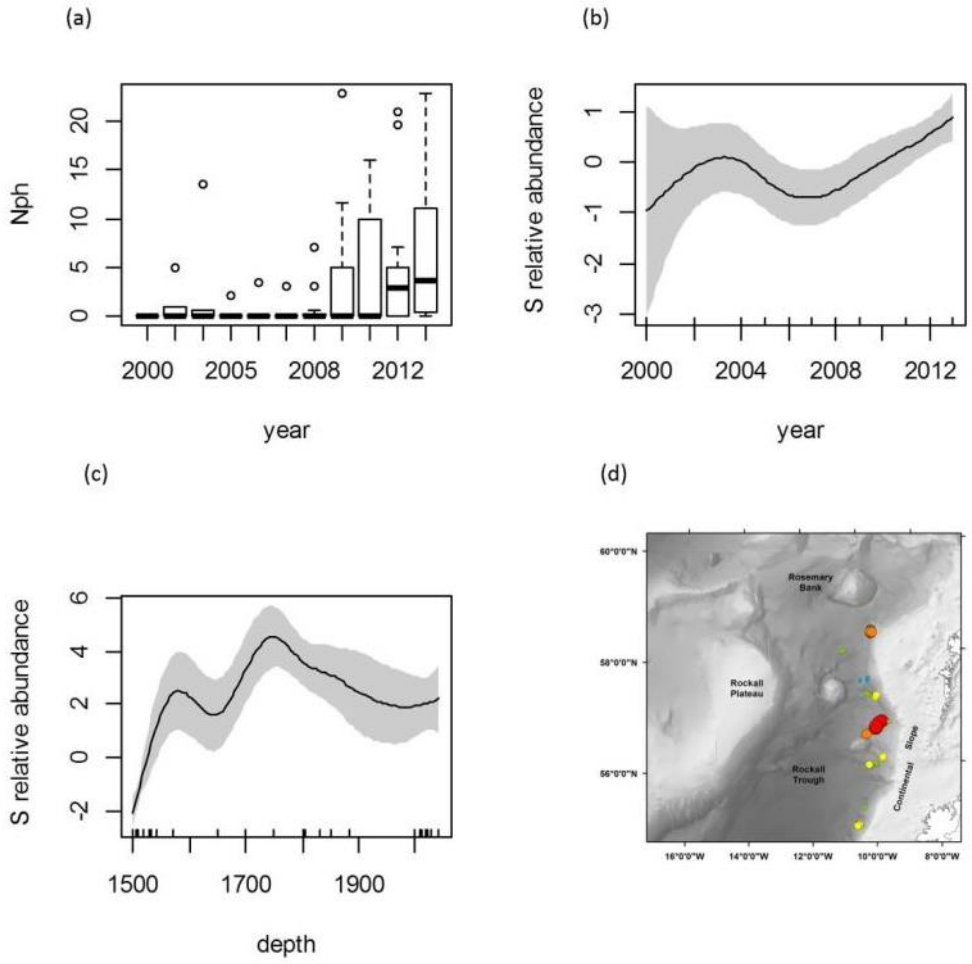

Figure B.3.6. Other deep-water sharks and skates from the Northeast Atlantic. Results of GAM analysis of catches of *Apristurus microps* in Scottish deep-water trawl survey from Neat *et al.* (2015) showing (a) Box-whisker plot of numbers per hour for each year. (b) Smoothed function of relative abundance of across years. (c) Smoothed function of relative abundance of across depths. (d) Distribution of abundance across the survey area graded from large red dots that indicate hauls of high abundance in close proximity to other hauls of high abundance to small blue dots that indicate hauls of low abundance in close proximity to other hauls of low abundance.

B.3.1.7 Pale catshark *Apristurus aphyodes*

The relative abundance of this species between depths of 800–2030 m from Scottish deep-water survey was on average 4 ind.h–1 for the past 14 years (Table B.3.8.; Figure B.3.7.). Preliminary analyses using GAM with Tweedie distribution suggest an increasing trend over time ($p < 0.001$) (Neat *et al.,* 2015).

Table B.3.8. Other deep-water sharks and skates from the Northeast Atlantic. Summary data for pale catshark *Apristurus aphyodes* from Scottish deep-water survey. .(N HAULS- number of hauls; N FISH- number of fishes; MEAN NPH – mean number per hour)

YEAR	N HAULS	N FISH	MEAN NPH	PROPORTION OF POSITIVE HAULS
2000	20	43	1.08	0.2
2002	16	49	1.55	0.44
2004	14	81	2.89	0.57
2005	14	96	3.43	0.54
2006	19	174	5.03	0.61
2007	15	89	2.94	0.46
2008	22	100	3.16	0.6
2009	29	64	2.22	0.3
2011	21	178	7.80	0.56
2012	26	105	4.32	0.58
2013	18	88	5.0	0.39

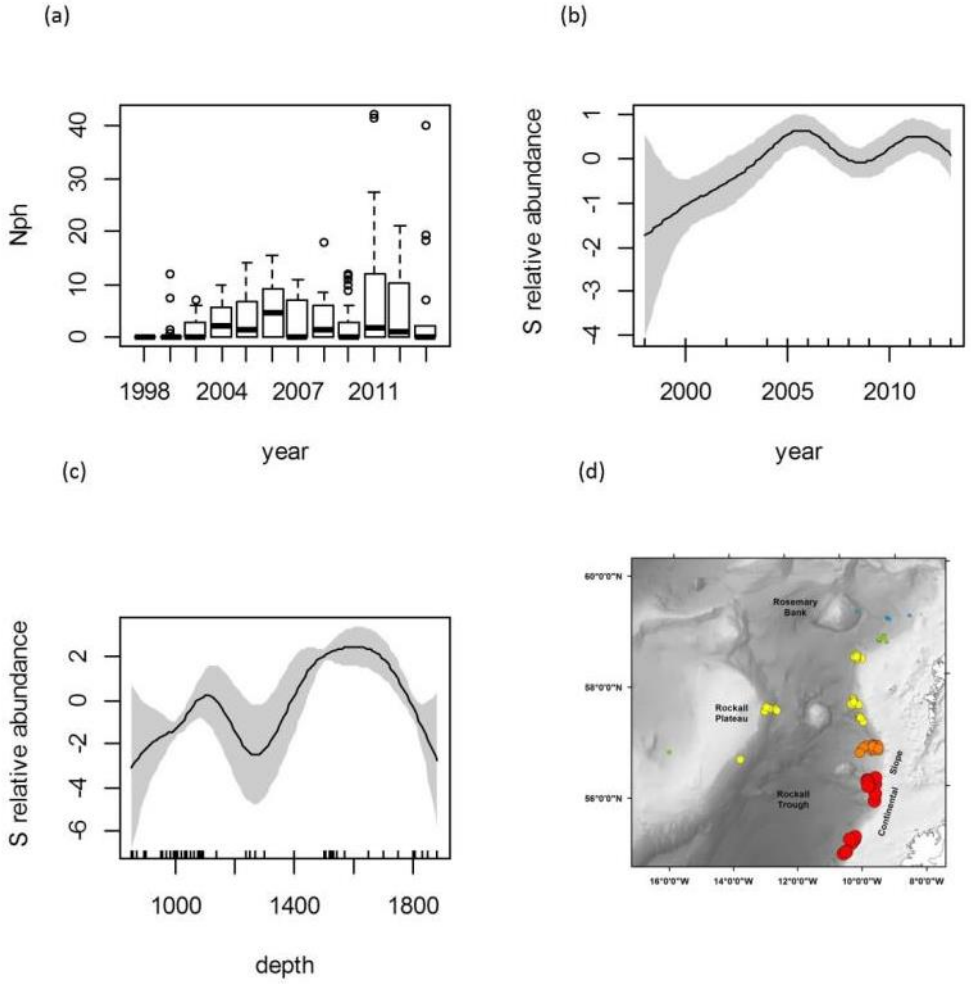

Figure B.3.7.. Other deep-water sharks and skates from the Northeast Atlantic. Results of GAM analysis of catches of *Apristurus aphyodes* in Scottish deep-water trawl survey from Neat *et al.* (2015) showing (a) Box-whisker plot of numbers per hour for each year. (b) Smoothed function of relative abundance of across years. (c) Smoothed function of relative abundance of across depths. (d) Distribution of abundance across the survey area graded from large red dots that indicate hauls of high abundance in close proximity to other hauls of high abundance to small blue dots that indicate hauls of low abundance in close proximity to other hauls of low abundance.

B.3.1.8 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 kreffti*) each year are shown in Table B.3.9.

Table B.3.9. Other deep-water sharks and skates from the Northeast Atlantic. 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 kreffti*).

YEAR	N. CAERULEA	R. KUKUKUJEVI	R.FYLLAE	R.BATHYPHILA	R.BIGELOWI	B. RICHARDSONI	A. JENSENI	M. KREFTI
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

B.4. Commercial CPUE

B.5. Other relevant data

B.5.1.1 *Deania calcea*

Deania calcea is known to be spatially segregated by size, sex and maturity (Moura *et al.*, 2014) found that. Pregnant females inhabit shallower and warmer waters while large immature specimens are deeper. Mature males are more broadly distributed than mature females, supporting the possibility of sex-biased dispersal.

B.5.1.2 *Galeus murinus*

Rodriguez-Cabello *et al*. (2013) showed that the distribution of Galeus murinus extended southward, to Cantabrian Sea, and Neoraja caerulea and northwards the distribution of Neoraja iberica.

B.5.1.3 *Etmopterus spinax*

The results from the demographic analysis conducted in *E. spinax* using an age-based model (Coelho *et al.*, 2014), showed that the population was stable if there is a two year reproductive cycle but would be declining if there is a three year cycle. Those results highlighted the necessity of having accurate knowledge on reproductive periodicity.

C. Assessment: data and method

No assessment model adopted for any of these species.

G. Biological Reference Points

No reference points defined for any of these species.

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