

13 Roughhead grenadier (*Macrourus berglax*) in the Northeast Atlantic

13.1 Stock description and management units

The population structure of roughhead grenadier in the Northeast Atlantic is poorly known. The species occurs at small abundance in some areas, mostly to the North of 60°N. The assessment unit considered by ICES is the whole Northeast Atlantic, although the population structure remains uncertain.

This stock is classified as Category 2 in the NEAFC categorization of deep-sea species/stocks in subareas 4, 12 and 14, which implies that directed fisheries are not authorised and that bycatches should be minimised in the NEAFC RA (NEAFC, 2016). In all other areas, this stock is classified as Category 4 in the NEAFC categorization of deep-sea species/stocks, which implies that fisheries are primarily restricted to Coastal State exclusive economic zones (EEZs) and therefore management measures are not taken by NEAFC unless complementary to coastal state conservation and management measures (NEAFC, 2016).

13.2 The fishery

There is no directed fishery for roughhead grenadier and catches are taken as by-catch from other fisheries. Unusually large catches (> 500 t) were reported in Subarea 6 in 2005–2007, in Subarea 12 in 2002, 2006 and 2009 as well as in Subarea 14 in 2010–2014. Afterwards in 2015–2017, the level of reported landings returned to past levels. However, these large catches have been considered doubtful and suspected to correspond to species misreporting. In 2021, landings returned to similar amounts of 2018, with most landings reported from ICES subareas 2 and 14, and Division 5.a.

Roughhead grenadier was mostly caught with bottom trawl but, in Subarea 14 and Division 12.a, catches with pelagic trawl, a GLORIA type in the first year (2010) and a modified alfonsinos pelagic trawl in the following years, were reported. As significant catches of the species in pelagic trawls are unexpected, these catches could represent species misreporting of roundnose grenadier catches or errors of the reported fishing gear. No catches have been reported in Subarea 12 since 2017.

The Spanish fleet fishing grenadiers on the Mid-Atlantic ridge (MAR) consists of ten trawlers with an average length of 62 m and average Gross Tonnage of roughly 1000 t. This fleet alternates the redfish and grenadier fisheries. Most landings are taken in 14.b.1, where the fishing season lasts between three and seven months. Effort and catches peak in late spring and early summer. Since 2016 the presence of the Spanish fleet in this fishery has decreased.

Most landings of roughhead grenadier from ICES Subarea 14 are from Norway and Greenland commercial trawl and longline fishery. Before 2014, the catch was dominated by trawlers, but from 2014 most catches are from the longline fishery. There are no reported landings from the Spanish fleet since 2017.

13.3 Landings trends

In subareas 1 and 2 there are landing records since 1990. The highest landings (400-800) occurred in the three first years and declined significantly thereafter. Since 2005 they are in the range of 30 to 50 t, except a higher level to 100 tonnes in 2016, 153 tonnes in 2020 and 124 tonnes in 2021. Most landings are from Norway with a smaller contribution from Russia. Landings from France are occasional and negligible, below 0.5 t in most years (Table 13.1).

Reported landings from subareas 3 and 4 also started in 1990 and have been very low, peaking in 2005 at 39 t. Historically, most landings have been reported by Norway, France, UK (Scotland) and Ireland. Since 2006, reported annual landings are negligible. (Table 13.2).

In Division 5.a, roughhead grenadier is occasionally caught. Before 2010, reported annual landings have been mostly below 10 tonnes and have increased to about 20 tonnes per year afterwards. Between 2015-2019 landings ranged between 20 and 40 tonnes. However, reported annual landings by Iceland increased to 44 tonnes in 2020. In 2021, a total of 56 tonnes were reported by Iceland and Norway (Table 13.3).

Landings have been reported in Division 5.b since 1997. The highest catch was 99 t in 1999, but in other years landings were < 12 t. Since 2013, reported landings have been reported exclusively by French and Norwegian vessels, although at quantities lower than 1 tonne per year, except 4 tonnes reported in 2018 by Norway (Table 13.4).

Landings from subareas 6 and 7 were mostly caught by the Spanish demersal multispecies fishery in Hatton Bank operated by freezer trawlers. Official records series started in 1992, with official landings peaking during the period 2011–2013, when they reached 632 tonnes in 2012 due to an exceptional report of 436 tonnes by Lithuania. France has taken part in the fishery for a longer period but with much lower landings. Other minor participants in the fishery are Norway, UK, Ireland and Russia (Table 13.5). Landings from subareas 6 and 7 have declined since 2004, particularly in the last few years with the implementation of the regulation prohibiting bottom trawling below depths of 800 m. Given the known geographical distribution of the species, any recent landings in subareas 6 and 7 are considered to be misidentification.

Occasional landings of less than 0.5 tonnes have been reported from Subarea 8. These were considered as coding errors or area misreporting as the species is not known to occur in Subarea 8 and was never caught in surveys in this Subarea.

Official records in Subarea 12 include landings from both the demersal multispecies fishery in Hatton Bank (Division 12.b) and the pelagic redfish and grenadier fishery on the MAR (Division 12.a). The historical time-series dates to 2000, reaching 2200 tonnes in 2005 and 2832 tonnes in 2009. Since 2017, no landings have been reported in these areas (Table 13.6).

Annual landings have been reported from Subarea 14 since 1993 mostly by Norway, Greenland and Russia. Between 2010–2014, Spanish vessels reported between 500 and 2700 tonnes/year in Subarea 14, sharply decreasing since then (Table 13.7). More recently, landings decreased to less than 85 tonnes in each of the years 2019–2020, increasing to 146 tonnes in 2021.

13.4 ICES Advice

The previous advice for roughhead grenadier was issued for 2016 to 2020 and stated that *"there should be no directed fisheries for roughhead grenadier, and bycatch should be counted against the TAC for roundnose grenadier to minimise the potential for species misreporting."*

The current advice was given in 2020 and states that *“when the precautionary approach is applied, there should be no directed fisheries for roughhead grenadier, and bycatch should be minimized for each of the years 2021 to 2025.”*

13.5 Management

WGDEEP is not aware of any management plan for roughhead grenadier within ICES area. Since 2015, bycatch of roughhead grenadier by EU vessels in Union and International waters should be reported under the roundnose grenadier quota for the same area and may not exceed 1% of the quota. Currently, no directed fisheries for roughhead grenadier are permitted in EU and UK waters, including EU and UK vessels in international waters. In eastern Greenland, main fishing operations are in Subdivision 14.b.2 and here, the TAC of roundnose and roughhead grenadier combined has been 1000 t since 2010. This TAC has been set by the Greenland Government and is not based on a biological assessment. Until 2020, there was a quota for European Union vessels in Greenland waters of subareas 5 and 14.

Management measures adopted by NEAFC establish a total allowable catch limitation of 574 tonnes of roundnose grenadier in 2021 and no direct fisheries for roughhead grenadier and roughsnout grenadier should be authorised in NEAFC Regulatory Area. Any bycatches of these grenadiers as well as other grenadiers (Macrouridae) should be counted against the total allowable catch of roundnose grenadier.

13.6 Data available

13.6.1 Landings and discards

Earlier years data are WG estimates based on national submissions to ICES, which are not fully included in InterCatch.

Official landing data are available from subareas 1 and 2 since 1990, from subareas 3 and 4 since 1992, from Division 5.a since 1996, from Division 5.b since 1997, from subareas 6 and 7 since 1993, from Subarea 8 for 2002 and 2006, from Subarea 12 since 2000, and from Subarea 14 since 1993.

Discard data for most years from 1996 to 2015 from subareas 6, 12 and 14, collected by Spanish scientific observers, on-board commercial Spanish trawlers were used to estimate discard rates. Discard rates, estimated as the discarded catch divided by retained catch of the species, are high, averaging 0.77 ± 0.42 (mean \pm standard deviation) for Subarea 6, 0.68 ± 0.23 for Subarea 12 and 0.53 ± 0.50 for Subarea 14.b (Table 13.8).

National catch statistics of Greenland were used to update catches in Subarea 14.b.2 from 1999 to 2021. Data from recent years may include both landings from Greenland and other countries vessels, wherefore it was unclear whether this implies double count with landings reported by other countries. Due to the lack of survey in East Greenland in 2020 and 2021, no survey data is available in 2022. A potential misreporting is suspected for roughhead grenadier, as the scientific survey of this species, has revealed that roughhead grenadier is more abundant in ICES 14.b.2. (WGDEEP 2019, WD5) – a trend which is not supported by catches (WGDEEP 2021, WD04). Similarly, it is possible that a part of landings in subareas 6 and 7 are probably misidentification, since catches from fishery-independent surveys are negligible.

Since 2019, there was virtually no Russian directed fishery in the deep waters of the Northeast Atlantic and bycatches of roughhead grenadier were obtained in longline fisheries in the Norwegian seas, and in the trawl fisheries targeting Greenland halibut (*Reinhardtius hippoglossoides*) in the eastern part of the Fishing Zone of Greenland (WGDEEP 2020, WD 23). Between 2014 and

2018 reported higher catches of roughhead grenadier by Greenland are considered to be linked to the long line fishery targeting tusk (WGDEEP 2022, WD12).

Reported landings of roughhead grenadier inside and outside the NEAFC Regulatory Area are provided in Table 13.9.

There remains some uncertainty given that historical landings and discards data are not always accurately recorded, or not provided by all countries. Therefore, it is noted that available data needs to be reviewed to provide robust estimations.

13.7 Length composition of the landings and discards

Fishery length composition of landings from the Russian fishery are shown in Figure 13.3 for 2019. Information provided is based on daily fishing vessel reports, materials collected during research surveys and data collected by observers on board fishing vessels (WGDEEP 2020, WD23).

No new data was provided for 2021.

13.8 Age composition

No new data available to WGDEEP, but recent literature provided information on age composition and growth parameters for *M. berglax* in the Norwegian Sea shelf edge in ICES subareas 1 and 2, based on pooled length at age data from slope surveys 2009-2018 (Bergstad *et al.*, 2021).

Age was derived from otolith readings. Where data was suitable, age distributions showed that sampled individuals consisted mainly of 5 to 25 years old, but older individuals (up to 30 years old) were also common. The oldest specimens recorded were around 50 years old. Estimated parameters of the von Bertalanffy growth functions were L_{inf} : 27.36 cm PAFL; K: 0.11 year⁻¹; t_0 : -0.02 year for females; and L_{inf} : 22.85 cm PAFL; K: 0.13 year⁻¹; t_0 : -0.74 year for males.

13.9 Weight-at-age

No new data available.

13.10 Maturity and natural mortality

Maturity data was last available for 2019, provided by the Russian investigations in the Norwegian Sea (ICES divisions 2.a and 2b) (WGDEEP 2020, WD23).

Deep-water fish catches were taken by bottom and pelagic trawls of 16-135 mm mesh size. The biological samples were collected according to the methods employed at PINRO (Anon., 2004). Mass measurement was based on the total length (hereinafter referred to as 'length'). Maturity stages were assigned using the following maturity scale: II – immature, III – maturing, IV – pre-spawning, V – spawning, VI – post-spawning, VI-VII – postspawning recovery.

8-76 cm long roughhead grenadier was observed in by-catches of bottom fishing and research trawls, the mean length of the studied individuals was 39.5 cm, while 27-49 cm long roughhead grenadier prevailed (Fig. 13.3). In November-December, mainly immature individuals were recorded in catches. Among the sampled individuals, there were also males with maturing sex products, as well as individuals of both sexes at the stage of post-spawning recovery (Fig. 13.4). Research vessel survey and cpue

13.10.1 Research vessel survey

The Icelandic autumn groundfish survey IS-SMH is the main source of fishery-independent data for *M. berglax* in Icelandic waters. Further, data can be compiled from several other older surveys of exploratory nature.

The IS-SMH survey covers Icelandic shelf and slope at depths from 20–1500 m. It is a stratified systematic survey with standardized fishing methods. Small-meshed bottom trawls (40 mm in the codend) equipped with rock-hopper are towed at a speed of 3.8 knots for a predetermined distance of 3 nautical miles (See the stock annex for greater silver smelt for a detailed description of methodology).

The Greenlandic annual bottom trawl survey is the main source for fishery-independent data for roughhead grenadier in Subarea ICES Subarea 14.b.2 (Greenland waters). This survey is depth stratified covering depths from 400–1500 m using Alfredo trawl towed at a speed between 2.5–3.0 knots with a 30 min bottom time (tows of at least 15 min are accepted). Survey period span from 1998 to present with no survey in 2001, 2017, 2018, 2020 and 2021.

Norway conducts a long-term monitoring survey of deep-water species on the shelf-break and upper slope off Norway and Spitsbergen (between 68 and 80° N in ICES subareas 1 and 2), since the mid-1990s. An analysis of the fisheries-independent time series (1997–2020) suggests that roughhead grenadier is widely distributed between 500–800 m deep. Trends in abundance is more variable, showing a decline in the northern areas, but such trend was not detected towards the southern parts of the Norwegian shelf-edge, suggesting that distribution extends southwards beyond the sampling area (Bergstad *et al.*, 2021). Biomass indices varied without trends in the survey period. A considerable temporal variation in recruitment is reported by Bergstad *et al.* (2021), which can be linked to the seasonal variability in food supply (Priede, 2017).

13.10.2 CPUE

The data available to WGDEEP only allow an estimation of non-standardised CPUE for the Spanish fleet operating in subareas 6, 12 and 14 in 1996–2015.

13.11 Data analyses

Length distributions from ICES Subarea 14.b.2 show that from 1998 to 2016 a single mode around 19 cm (total length) dominated the survey and from 2010 to 2016 a second and smaller mode around 29 cm (total length) is also evident (Fig. 13.1). From this survey, it is shown that the highest biomass and abundance in Subarea 14.b.2 is equally distributed between three depth strata of 601–800 m, 801–1000 m and 1001–1500 m (Table 13.10). Survey biomass index appears stable from 2008 until 2016 (Fig. 13.2).

13.12 Benchmark assessments

There has been no benchmark for this stock.

13.13 Management considerations

Only landings are available and the time-series considered reliable is restricted to 1992–2001. Years 2002–2015 are not considered because catches reported in some divisions are significantly larger than the historical landings and there are major doubts about the certainty of these catches

(ICES, 2014). Information from scientific on-board observers and exploratory surveys in subareas 6, 12 and 14 indicates that the species occurs at low density over these fishing grounds.

Available biological data (length or age composition, weight-at-age, maturity, mortality) does not allow to assess changes in stock status.

The population structure of roughhead grenadier in the Northeast Atlantic is poorly known. The species occurs at small abundance in some areas, mostly to the North of 60°N. Available literature suggests a significant gene flow of the roughhead grenadier *Macrourus berglax* across the North Atlantic (Coscia *et al.*, 2018), in contrast to the depth-dependent genetic structure found in *Coryphaenoides rupestris* (Gaither *et al.*, 2018).

Literature based mostly on survey data from Canadian waters indicates that this is a long-lived, slow-growing species, of low fecundity and vulnerable to overfishing (see Devine and Haedrich, 2008 and references therein; Gonzalez-Costas, 2010). Age estimations from otoliths have found specimens of up to 23 years (Savvatimsky, 1984) and the species has been classified as of concern due to a decline of >90% of the survey index within Canadian waters over a period of 15 years (COSEWIC, 2007).

Whilst roughhead grenadier continue to occur as a bycatch, the proportions reported remain relatively low. There is very limited data available for this species, and some of the reported landings data are considered to be species misreporting. Thus, no expansion of current fisheries should be permitted until adequate data are collected from the exploited population to identify stock structure and conduct an appropriate assessment.

13.14 References

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13.15 Tables and Figures

Table 13.1. Official landings (t) of roughhead grenadier (*Macrourus berglax*) in Subareas 1 and 2.

Year	Germany	Norway	Russia	France	Spain	TOTAL
1988						
1989						
1990	9	580				589
1991		829				829
1992		424				424
1993		136				136
1994						0
1995				1		1
1996				3		3
1997		17		4		21
1998		55				55
1999				<0.5		0
2000		35	13	<0.5		48
2001		74	20	<0.5		94
2002		28	1	<0.5		29
2003		47	30			77
2004		78	1			79
2005		64	13	<0.5		77
2006		74	4	<0.5		78

Year	Germany	Norway	Russia	France	Spain	TOTAL
2007		44	5			49
2008		49	6			55
2009		51	2			53
2010		39	6			45
2011		29				29
2012		54				54
2013		34	1	1		36
2014						
2015	0	26	17	0	+	43
2016		38	62			100
2017	0	41	9	+	0	50
2018 ¹	0	89	0	+	0	89
2019 ¹	0	141	1	< 0.5	0	142
2020 ¹	0	148	5	< 0.5	0	153
2021 ¹	0	121	***	0.1	0	121

¹—preliminary statistics.

Table 13.2. Official landings (t) of roughhead grenadier (*Macrourus berglax*) in Subareas 3 and 4.

Year	France	Ireland	Norway	UK (Scot.)	TOTAL
1991					
1992			7		7
1993					
1994					
1995					
1996	4				4
1997	5				5
1998	1				1
1999	< 0.5				
2000	< 0.5	1	3	< 0.5	4
2001	< 0.5	1	9		10

Year	France	Ireland	Norway	UK (Scot.)	TOTAL
2002	< 0.5		3	< 0.5	3
2003	< 0.5		2		2
2004	< 0.5		< 0.5	1	1
2005	1		38	< 0.5	39
2006	< 0.5				< 0.5
2007					0
2008					0
2009					0
2010				< 0.5	< 0.5
2011	2				2
2012	1			< 0.5	1
2013	1				1
2014					0
2015	+	0	+	0	+
2016	< 0.5		< 0.5		< 1
2017	< 0.5		< 0.5		< 1
2018 ¹	< 0.5	0	< 0.5	0	< 0.5
2019 ¹	< 0.5	0	0	0	< 0.5
2020 ¹	< 0.5	0	0	0	< 0.5
2021 ¹	0.1	0	0	0	0.1

¹—preliminary statistics.

Table 13.3. Official landings (t) of roughhead grenadier (*Macrourus berglax*) in 5.a.

Year	Iceland	Norway	TOTAL
1995			
1996	15		15
1997	4		4
1998	1		1
1999			
2000	2		2

Year	Iceland	Norway	TOTAL
2001	1		1
2002	4		4
2003	33		33
2004	3		3
2005	5		5
2006	7		7
2007	2		2
2008	< 0.5		
2009	5		5
2010	22		22
2011	21		21
2012	16		16
2013	16		16
2014			
2015	20		20
2016	20		20
2017	40 ¹		40 ¹
2018 ²	20	< 0.5	20
2019 ²	28		28
2020 ²	44		44
2021 ²	31	25	56

¹—revised catch data. ²—preliminary statistics.

Table 13.4. Official landings (t) of roughhead grenadier (*Macrourus berglax*) in Division 5.b.

Year	France	Norway	UK (Scot.)	Russia	TOTAL
1997	6				6
1998	9				9
1999	99				99
2000	1				1
2001	2	2			4

Year	France	Norway	UK (Scot.)	Russia	TOTAL
2002	3		< 0.5		3
2003	12				12
2004	9		1		10
2005	6				6
2006	10				10
2007	3			2	5
2008	1			2	3
2009					0
2010		1			1
2011					0
2012	2		1		3
2013	2				2
2014	< 0.5				0
2015	1	+	0	0	1
2016					0
2017	< 0.5	< 0.5			0.5
2018 ¹	1	4	0	0	5
2019 ¹	< 0.5	< 0.5	0	0	< 1
2020 ¹	< 0.5	0	0	0	< 0.5
2021 ¹	0.4	0.5	0	0	0.9
¹ —preliminary statistics.					

Table 13.5. Official landings (t) roughhead grenadier (*Macrourus berglax*) in Subareas 6 and 7.

Year	UK (E+W)	France	Norway	UK (Scot.)	Spain	Ireland	Russia	Lithuania	TOTAL
1988									
1989									
1990									
1991									
1992									
1993	18								18

¹—preliminary statistics.

Table 13.6. Official landings (t) roughhead grenadier (*Macrourus berglax*) in Subarea 12.

Country	Norway	France	Spain	Russia	Lithuania	TOTAL
1999						
2000	7	< 0.5				7
2001	10	< 0.5				10
2002	7		1136			1143
2003	2	< 0.5	223			225
2004	27	< 0.5	725			752
2005		< 0.5	2200	5		2205
2006		< 0.5	968	8		976
2007			420			420
2008			252			252
2009	6		2826			2832
2010			580			580
2011			441			441
2012			526		4	530
2013			210			210
2014			164			164
2015			53			53
2016	< 0.5		31			31
2017						0
2018 ¹	0	0	0	0	0	0
2019 ¹			0			0
2020 ¹			0			0
2021 ¹	0	0	0	0	0	0

¹—preliminary statistics.Table 13.7. Official landings (t) of roughhead grenadier (*Macrourus berglax*) in Subarea 14.

Country	Greenland	Norway	Russia	Spain	UK (E+W)	Germany	TOTAL
1993	18	34					52
1994	5						5

Country	Greenland	Norway	Russia	Spain	UK (E+W)	Germany	TOTAL
1995	2						2
1996							0
1997							0
1998		6					6
1999		14					14
2000							0
2001		26					26
2002		49	4				53
2003		33					33
2004		46	9				55
2005	20	30	10				60
2006	4	1	3				8
2007	4	6	9				19
2008	12		3				15
2009	4	3			1		8
2010	12	1	13	1500	1		1527
2011	2		27	1516			1545
2012	14	16	18	2687			2735
2013			32	803			835
2014	62		11	450			523
2015	38	68	0	12			121
2016	74	73	8	4			159
2017	93	88 ¹	17				198 ¹
2018 ²	89	97	16	0	0		202
2019 ²	1	76	5	0			82
2020 ²	18	19	0	0	0	9	46
2021 ¹	45	101	0	0	0	0	146

¹—revised catch data. ²—preliminary statistics.

Table 13.8. Average discard rate (discarded catch / total catch) 1996–2015, estimated from data collected by scientific observers on board commercial trawlers.

Year	6.b	12.a	12.b	14.b
1996			0.00	0.00
1997				
1998	0.42		0.56	
1999				
2000		1.00	0.41	0.12
2001	0.94		0.40	0.00
2002	0.79		0.50	1.00
2003	0.65		0.00	0.00
2004	1.00		0.97	
2005				
2006	0.33		0.00	
2007				
2008	0.00		0.04	
2009			0.00	
2010			0.17	
2011				0.13
2012				
2013	1.00		1.00	1.00
2014				
2015	NA	NA	NA	NA
Mean	0.79	1.00	0.37	0.51

Table 13.9. Roughhead grenadier in the Northeast Atlantic. Landings inside and outside the NEAFC Regulatory Area (RA) as estimated by ICES. Landings in tonnes.

Year	Inside the NEAFC RA	Outside the NEAFC RA	Total landings	Proportion inside the NEAFC RA (%)
2016	4	373	377	1
2017	0	294	294	0
2018	0	330	330	0
2019	0	259	259	0

Year	Inside the NEAFC RA	Outside the NEAFC RA	Total landings	Proportion inside the NEAFC RA (%)
2020 ¹	0	247	247	0
2021 ¹	0	330	330	0

¹—preliminary statistics.

Table 13.10. Biomass (t) and abundance (in numbers) with SE of roughhead grenadier expressed as mean catch per km² and total biomass by Q-subarea and depth stratum in ICES subarea 14.b.2 in 2016. Q-subareas encompass Q1-Q5 (see Nielsen *et al.* 2019) for which area and number of survey hauls in 2016 are listed.

Subarea	Depth strata	Area	Hauls	Biomass			Abundance		
				Mean/km ²	Biomass	SE	Mean/km ²	Abundance	SE
Q1	401-600	6975	12	0.0305	212.9	91.5	28.1	195794	91854
Q2	401-600	1246	5	0.6579	819.7	466.7	615.6	766985	379861
	601-800	1475	7	1.3791	2034.7	746.6	844.3	1245641	356006
	801-1000	1988	10	0.9196	1828.5	503.4	676.8	1345717	458547
	1001-1500	6689	7	0.2539	1698.3	612.7	298.0	1993532	768271
Q3	401-600	9830	11	0.0106	104.2	61.5	12.6	124283	84253
	601-800	3788	14	0.0121	45.7	18.6	7.9	30040	11284
	801-1000	755	6	0.0171	12.9	8.6	12.7	9610	6398
Q5	401-600	1819	3	0.0032	5.9	5.9	4.4	7970	7970
	601-800	257	6	0.0486	12.5	4.1	53.3	13700	2996
	801-1200	256	5	0.1387	35.5	7.9	285.6	72993	15673
	1201-1400	986	9	0.1037	102.2	29.0	147.4	145251	36288
	1401-1500	615	5	0.0672	41.3	14.1	87.7	53912	24270
All		36679	100	0.1896	6954.2	1191	163.7	6005430	1044

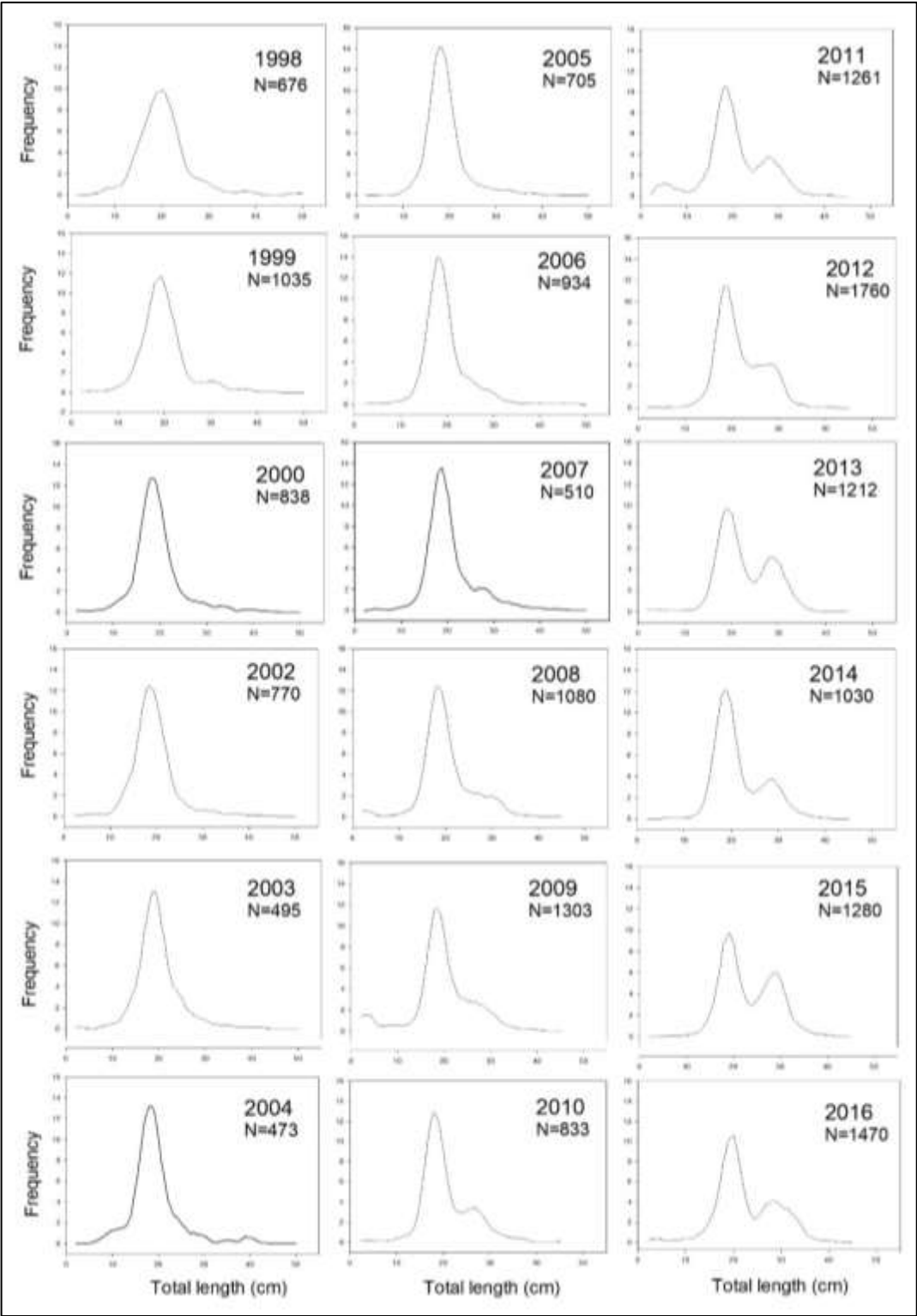


Figure. 13.1. Length frequency distribution of roughhead grenadier for years 1998-2016 in ICES subarea 14b2 (east Greenland). No survey in 2001, and since 2017.

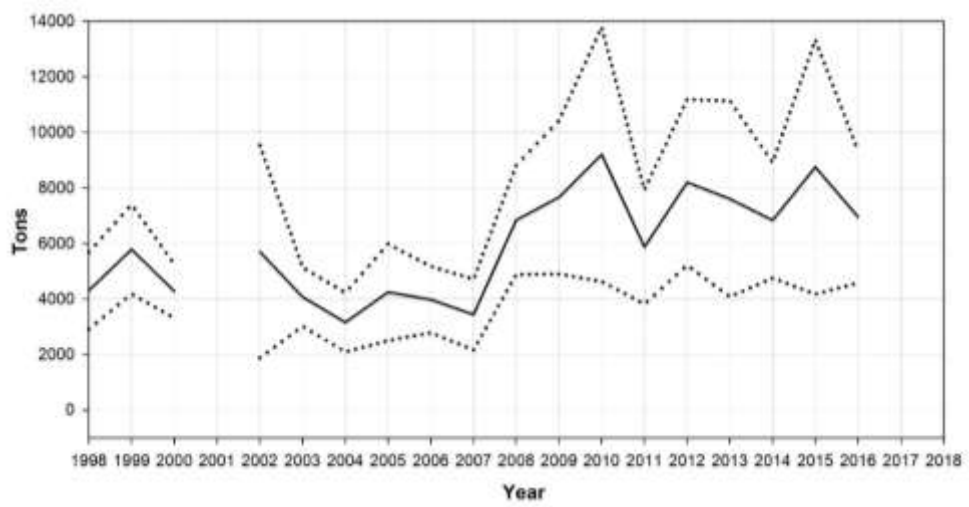


Figure 13.2. Estimated index biomass (solid line) of roughhead grenadier in ICES 14.b.2 plotted with +/- 2*SE. No survey in 2001, and since 2017.

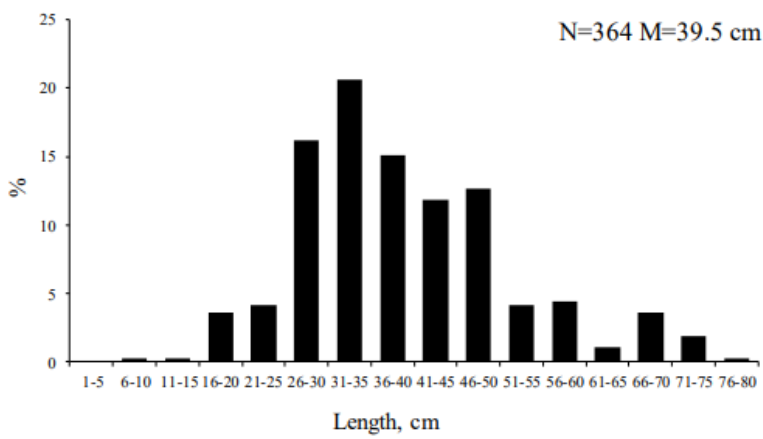


Figure 13.3. Length composition of roughhead grenadier in the Norwegian Sea (subareas 2a and 2b) in 2019.

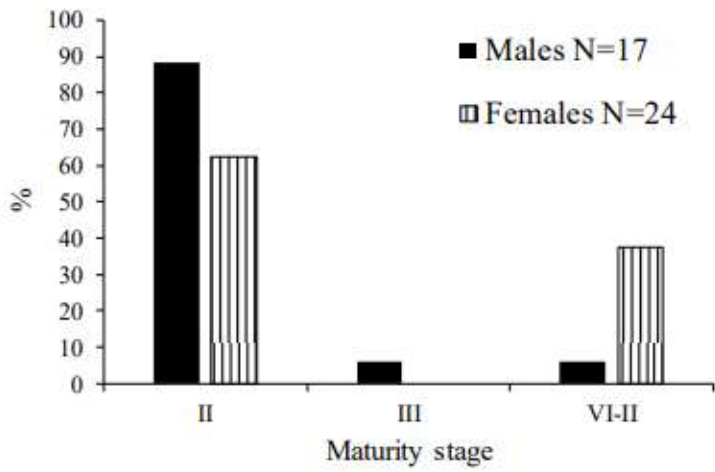


Figure. 13.4. Maturity of roughhead grenadier in the Norwegian Sea (subareas 2a and 2b) in November-December 2019.