Stock Annex: Roundnose grenadier (*Coryphaenoides rupestris*) in subareas 6-7, and in Divisions 5.b and 12.b (Celtic Seas and the English Channel, Faroes grounds, and western Hatton Bank)

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Roundnose grenadier
Working Group:	Working Group on Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP)
Created:	9 April 2014
Authors:	Lionel Pawlowski, and Pascal Lorance
Last updated:	07 May 2019
Last updated by:	Bruno Almón

A. General

A.1. Stock definition

ICES WGDEEP has in the past proposed four assessment units of roundnose grenadier in the NE Atlantic (Figure 1):

- Skagerrak (3.a)The Faroe–Hatton area;
- Celtic sea (Divisions 5.b and 12.b, Subareas 6, 7);
- Mid-Atlantic Ridge 'MAR' (Divisions 10.b, 12.c, Subdivisions 5.a1, 12.a1, 14.b1);
- All other areas (Subareas 1, 2, 4, 8, 9, Division 14.a, Subdivisions 5.a2, 14.b2).

Roundnose grenadier is widely distributed in the North Atlantic. Its area stretches from Norway to northwest Africa in the east to the Canadian-Greenland coasts and the Gulf of Mexico in the west, and from Iceland in the north to the areas south of the Azores in the south (Parr, 1946; Andriyashev, 1954; Leim and Scott, 1966; Zilanov *et al.*, 1970; Geistdoerfer, 1977; Gordon, 1978; Parin *et al.*, 1985; Pshenichny *et al.*, 1986; Sauskan, 1988; Eliassen, 1983). Aggregations of this species are found on the continental slope of Europe and Canada, on the MAR seamounts, in the Faroe-Hatton area (banks Hatton, Rockall, Louzy, Bill Baileys, etc.) and in the Skagerrak and Norwegian fjords.

Some studies have allowed observing fish in all maturity stages in all the distribution area (Allain, 2001; Kelly *et al.*, 1996, 1997; Shibanov, 1997; Vinnichenko *et al.*, 2004), therefore allowing for several populations to exist.

No genetic results are available to validate the hypothetical stock structure presented above. Several authors also consider that roundnose grenadier is a poor swimmer and is therefore unlikely to make extended migrations. No pattern in seasonal density variation has been observed from surveys or from fisheries. However, there are no data available to indicate whether or not individuals move around during their lifespan.

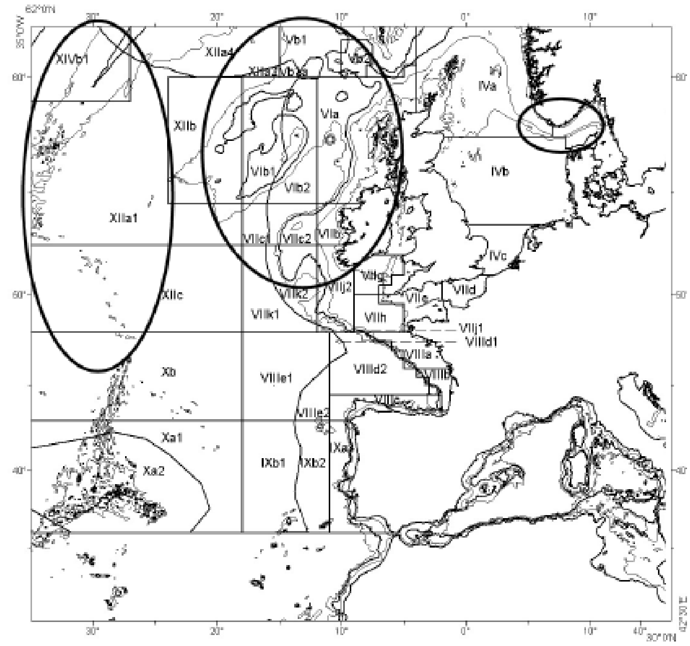

Figure 1. Areas of the main fisheries for roundnose grenadier, Skagerrak, west of the British Isles and Mid-Atlantic Ridge. The isobaths displayed are 100, 200, 1000 and 2000 m (from Lorance *et al.*, 2008).

The current perception is based on what is believed to be natural restrictions to the dispersal of all life stages. The Wyville Thomson Ridge may separate populations further south on the banks and slopes off the British Isles and Europe from those distributed to the north along Norway and in the Skagerrak. Considering the general water circulation in the North Atlantic, populations from the Icelandic slope may be separated from those distributed to the west of the British Isles.

It has been postulated that a single population occurs in all the areas south of the Faroese slopes, including also the slopes around the Rockall Trough and the Rockall and Hatton Banks but the biological basis for this remains hypothetical.

Published results on length (11.5–12.5 cm pre-anal fin length, PAFL) and age (9–14 years) at first maturity of females to the West of British Isles and in the Skagerrak (Allain, 2001; Bergstad, 1990; Kelly *et al.*, 1996; 1997) do not seem to clearly discriminate these two groups, although they are most likely to be demographically different unit.

Some studies have detected genetic differentiation in at least parts of the species range and indicating the presence of distinct populations within the species (Logvinenko *et al.*, 1983; Duschenko, 1989).

In 2007, WGDEEP examined the available evidence of stock discrimination in this species based on length distribution, commercial catch, cpue, age, maturity, reproduction. Length distribution, catch and cpue data were considered too aggregated or too dependent on external factors (e.g. fleet dynamics, depth) to be usable to discriminate stocks. Analyses on age data on longevity were unable to conclude if the differences of longevity from one region to another were local changes or the effect of exploitation.

New genetic studies are likely to become available in the forthcoming months. Preliminary results were presented in the ICES symposium "Issues confronting the Deep Oceans" (Horta, Azores, 27–30 April 2009). Microsatellite DNA was used to characterize the large-scale population structure from samples spanning over the entire North Atlantic. Samples of ca. 800 individuals were analysed for eight microsatellite loci. Roundnose grenadier was found to display a trend of increasing genetic differentiation with distance among samples. In absolute terms the amount of genetic differentiation among roundnose grenadier samples was considerably higher than in other deep-sea fish species, such as Greenland halibut (Knutsen *et al*., 2007) and tusk (Knutsen *et al*., submitted) over comparable distances. The gene flow appeared restricted also among relatively closely situated localities (less than 500 km) (Knutsen *et al*., 2009). If these preliminary results are confirmed, the current stock structure used for assessment and primarily based upon bathymetry and hydrology will need revision towards a structuring at smaller spatial scale.

A.2. Fishery

The majority of landings of roundnose grenadier from this area are taken by bottom trawlers. To the west of the British Isles, in Divisions 5.b, 6.a, 6.b2 and Subareas 7, French trawlers catch roundnose grenadier in a multispecies deep-water fishery. The Spanish trawl fleet operates further offshore along the western slope of the Hatton Bank in ICES Divisions 6.b1 and 12.b.

French trawlers began to land increasing amounts of roundnose grenadier, from the west of Scotland in 1987 (Charuau *et al*., 1995). Landings of these species have been reported separately in French landings statistics since 1989 (Lorance *et al*., 2001). The quantities landed in 1987 and 1988 are not known with accuracy but they are believed to be less compared with landings in the 1990s.

The activity of the Spanish fishery in international waters is poorly known. New information on landings data in Division 6.b and Subarea 12 from the Spanish fisheries for the years 2005, 2007 and 2008 have been made available. These newly obtained data are from the freezer fleet operating mostly in those regions. Data from 2006 are incomplete and of no use for stock assessment. The main problem associated to Spanish official landing data for roundnose grenadier is the uncertainty regarding their accuracy. The disagreement between observer catch data and official landings data suggests that catches of this species might be reported as corresponding to several species. Roughhead grenadier is mostly absent from observer data despite recorded annual catches above 1000 tonnes in 2005 and 2007. Similarly, roughsnout grenadier is absent from observer data although apparently between 1300 and 4800 tonnes where landed in the years 2005, 2007 and 2008. Gunther´s grenadier was recorded by the observers but not in the logbooks. The distribution of the catch and effort are poorly known. Effort directed at deep-water species increased from 1989 to 1996 (Lorance and Dupouy, 2001). In 1995 an effort regulation was introduced but was not a constraint to this fleet. TACs and a new effort regulation was introduced in 2003 (Council Regulation (EC) No 2347/2002 of 16 December 2002) and the fishery has reduced. Part of the fishing time of the licensed fleet is expended on the shelf mainly in the Celtic Sea.

A.3. Ecosystem aspects

Roundnose grenadier is a slow-moving species, which prefers grounds with slow currents. Vertical diurnal migrations are also observed, the pattern of which depends on feeding (Savvatimsky, 1969) and water circulation and meteorological processes (Shibanov and Vinnichenko, 2007).

There is no direct evidence of long distance migrations made by adult fish. The distribution and dispersal of the eggs and larval stages is poorly known, except in the Skagerrak (Bergstad and Gordon, 1994). Juveniles grenadier of 2–8 cm pre-anal length were caught in the midwater by 120–840 m over bottoms of 1200–3200 m along Greenland slope, on the Mid-Atlantic Ridge, Hatton Bank, in the Irminger and Labrador Seas suggesting that some passive migrations of juveniles in the open ocean occurs (Vinnichenko and Khlivnoy, 2007).

In the Skagerrak (ICES Division 3.a), available information indicates that roundnose grenadier spawn in the late autumn (Bergstad, 1990a). Eggs (diameter 2.4–2.6 mm), postlarvae and pelagic juveniles have been caught with plankton net from 150 to 550 m. The newly hatched larvae appear very primitive and the pelagic phase is extensive. The mean size of larvae, assumed to belong to the same cohort sampled repeatedly in the same year, increased from February to October, when they attained a demersal stage of life cycle (Bergstad and Gordon, 1994). To the west of the British Isles, females with maturing ovaries have been observed from February to December, but they were more abundant from May to October and spawning appears to extend at least from May to November (Kelly *et al*., 1996; Allain, 2001). Studies in Icelandic waters indicate year-round spawning, with no obvious peaks (Magnússon *et al*., 2000). There appear thus to be differences in the timing of spawning between areas, perhaps reflecting varying environmental conditions. Roundnose grenadier is a batch spawner with a fecundity of 4000–70 000 oocytes per batch (Allain, 2001).

There is a lack of knowledge of the distribution and dispersal of the eggs and larval stages, except in the Skagerrak (Bergstad and Gordon, 1994), and so the biological basis for the current hypothetical population structure must await the results from future studies of genetics and otolith microchemistry. To date, only a single study of whole otolith microchemistry of roundnose grenadier from a wide area of the Atlantic (Mid-Atlantic Ridge, Reykjanes Ridge, Hatton Bank, Porcupine Seabight, Rockall Trough, Skagerrak and two Norwegian fjords) has been carried out using solution-based, inductively coupled, plasma mass spectrometry (SO-ICPMS) (Gordon *et al*., 2001). Discriminant analysis of eight elements separated samples from the Norwegian fjords and the Skagerrak from those from the NE Atlantic areas. Differences between samples from six areas of the Atlantic (Hatton Bank, Rockall Trough, Porcupine Seabight, Mid-Atlantic Ridge, and Reykjanes Ridge) were small, and elemental concentrations overlapped. Therefore, this study supports the view that populations in the NE Atlantic are separate from the Norwegian fjords and the Skagerrak, but does not demonstrate any difference in populations between the Mid-Atlantic Ridge and the remainder of the NE Atlantic.

Studies about the feeding habits of the Roundnose Grenadier in nearby areas have been going on during the past years. The results of these investigations may be available in the coming years, adding valuable information that may help explain the distribution patterns of the species. So far, preliminary results suggest that they feed mostly on small invertebrates, mainly copepods, which is consistents with the vertical migration patterns observed in the Roundnose grenadier.

B. Data

B.1. Commercial catch

Landings time-series data per ICES areas are available.

Landings data by ICES statistical rectangle are available from France, Norway and UK (England and Wales and Scotland). No other country provided data by rectangle. Landings by ICES division are available from other countries.

Catch in Subarea 12 are allocated to Division 12.b (western Hatton Bank) or 12.a,c (Mid-Atlantic Ridge) according to knowledge of the fisheries from WG members. For each country, the time-series of landings are checked and revised if needed according to StatLand data. StatLand reports landings in Subarea 12 consistently with what this working group did in the past.

Catch and discards by haul are available from observer programmes. From the French observer programme, total catch, landings and discards and catch, landings and discards of roundnose grenadier are available on a haul by haul basis for 2004–2006.

Discard data (quantities and length distribution) are also available from the on-board observation of the French fishery, 2004–ongoing, from French on-board observations on French vessels in 1997–1998 and from Scottish observers on board of French vessels, 1997–2001. The length distributions of discards from all these observations seem quite consistent.

Based on EU observer programme 2004–2005, about 30% by weight and 50% by number of the catch of roundnose grenadier is discarded, because of small size. This figure is higher than in previous sampling where the discarding rate in the French fisheries was estimated slightly above 20% from sampling in 1997-1998 (Allain *et al.*, 2003). The change may come from a combination of changes in the depth distribution of the fishing effort and a decrease in the abundance of larger fish as visible in the landings. The modal discarded length has remained constant.

The mode of the length distribution of the discards from the Spanish fleet in Divisions 6.b and 12.b is slightly smaller, probably because of different sorting habits in relation to different markets. It is therefore important that length distribution of the landings and discards are provided to the working group by all fleets exploiting the stock. Larger variations in discards levels have been reported between species and between observers and vessels.

Misreporting or underreporting is not known to have been a problem in the French trawling fleet. Concerns have been repeatedly expressed that misreporting could occur in international waters (NEAFC regulatory area). There are also been regular complains from the French Industry that IUU fish was landed in France and was pulling the prices down. This seems to have disappeared in recent years. Misreporting is not an issue that scientists have the power to inquire and this should stay in hand on management and regulation authorities to monitor misreporting. No quantitative data on misreporting is available.

The landings data were however considered uncertain in Division 12.b, because unreported landings may occur in international waters. In addition to this, all national landings data were not reported by new ICES divisions and some landings were allocated to divisions according to knowledge of the fisheries from the working group. Lastly significant unallocated landings occurred in 2005. This has led the working group to remove in 2008, 12.b from the exploratory assessments although the stock definition consider the Faroe–Hatton area, Celtic Sea catches (Divisions 5.b and 12.b, Subareas 6, 7) belonging to the same stock.

B.2. Biological data

Size–frequency data (and corresponding weight data) for roundnose grenadier are available for French catches for every year since 1990. Historic length–frequency series from sampling onboard French trawlers by French and Scottish observer is presented in Figures 2 and 3.

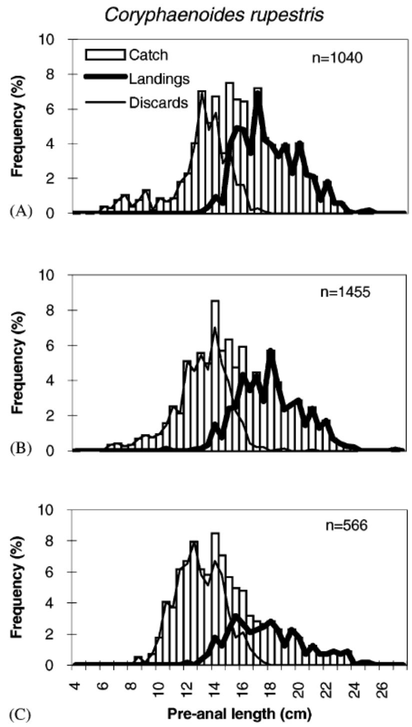

Figure 2. Length distribution of the discards and landings of roundnose grenadier in 1996–1997 by depth, A) 800–1000 m, B) 1000–1200 m, C) 1200–1400 m, sampled on board French vessels, (re-drawn from Allain, 2003).

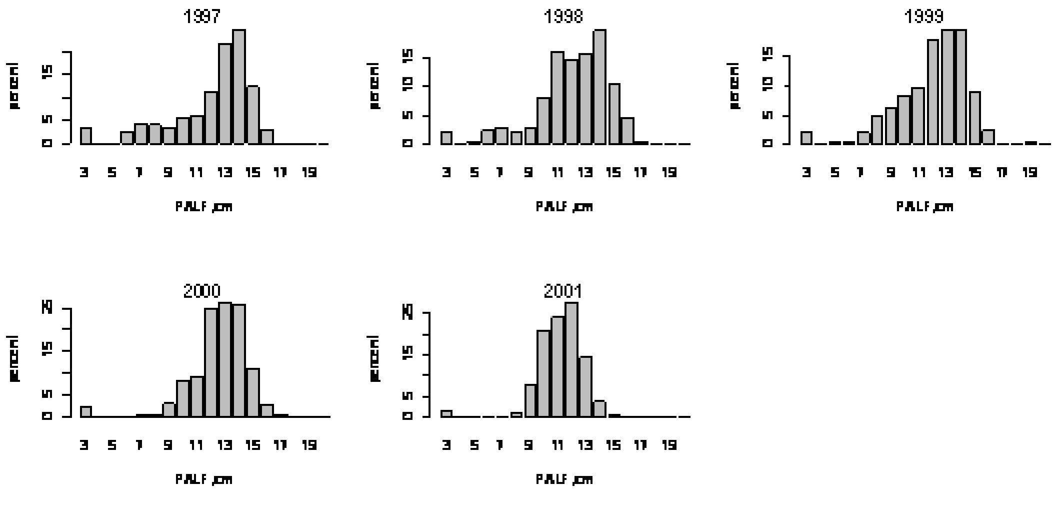

Figure 3. Length distribution of the discards of the French fleet, sampled on board French vessels by Scottish observers, 1997–2001.

Age estimates were available from France. This dataset may be heterogeneous, because three different readers estimated the age over these different years and also because measuring the fish on board may lead to different age–length relationship than measuring the landed fish that may have lost water for some days in ice. Large discrepancies between readers were observed in a recent otolith reading exchange and workshop (ICES, 2007a).

Age composition of the French landings has been routinely estimated since 2001. Formerly age–length keys (ALK) were derived from a cruise in 1999 and from sampling on board of commercial trawler in 1996–1997 (Lorance *et al*., 2001; 2003). Preliminary analysis of the length-at-age data demonstrated that ALK is very stable over years. ALK for years 1999 and 2001–2004 were very similar, the ALK for 2005 appeared different and the change was ascribed to a change of the reader.

These data are based upon ALK from age estimates in 1996, 1999 and 2002–2005. Otoliths from 1996 and 1999 were collected respectively on board of commercial trawlers and during a scientific cruise; otoliths for 2002–2005 were routinely sampled from the landings.

No new data on maturity and natural mortality has been collected in recent years. Natural mortality was previously estimated from catch curves and an estimated M=0.1 was used by the Working Group since 2002. It should be kept in mind than this estimate is based on limited data.

B.3. Surveys

Only one cruise relevant to roundnose grenadier is currently carried out on a yearly basis by FRS (Scotland). Stock indicators were derived from this survey (Neat and Burns, in press) but have not yet been formally integrated into stock assessment.

Another cruise has been carried out since 2006 on the RV Celtic explorer every year during autumn. The surveys aim to collect biological data on the main deep-water fish species and invertebrates along the continental slope in Subareas 6 and 7 north. Fishing tows were carried out at four depths, 500 m, 1000 m, 1500 m and 1800 m in three distinct areas. The effective fishing time, from when the net touched the bottom, was set at two hours. Tows were carried out along the depth contour. At each station the entire catch was sorted to species level and weighed. Full biological sampling, i.e. length, weight, sex, maturity, and age, was carried out on specific commercial species. Additional biological sampling, without age, was carried out on an *ad-hoc* basis on other species.

B.4. Commercial cpue

Time-series of French fishing effort are available based upon logbook data (1987–2009). Following their requirement under the Data Collection Regulation (DCF), VMS data (starting back from 2003) are made available from 2010. Lpues data based upon French tallybooks are available from 2000 based upon a voluntary participation of fishermen. These data are used in the working group as indicators of trends and also in the assessment.

Time-series of fishing effort of past years can be improved from tallybooks. In EU logbooks, fishing operations (individual tows and lines and net setting) carried out in the same day and rectangle are cumulated. For the French trawling fleet, tallybooks of haul by haul data were provided by the industry and allowed for better account of all factors in lpues (Lorance *et al*., 2009). Applied to all fleets such data would allow effort to be properly handled. Electronic logbooks are under development on French vessels and data will be reported haul by haul including depth. It should be noted that this improvement is particular to deep-water fisheries where depth may vary a lot in a single statistical rectangle. Therefore haul by haul data and fishing depth are much more crucial in deep-water fisheries than in shelf fisheries were most of the depth information is conveyed by the statistical rectangle.

VMS data also allows for improvement of effort data as is allows for some particular uses such as estimating the fishery footprint and fine scale changes in effort distribution. Nevertheless, data such as tallybooks provided to Ifremer by the industry includes all the effort information (tow duration, depth, location) coupled with catch, while using VMS requires assumptions to identify fishing and steaming activities and coupling catch to VMS data is an unresolved issue.

Overall the knowledge of the fleet activity at sea is reliable in Division 5.b and Subareas 6 and 7, the situation is poorer in Divisions 6.b and 12.b. Distribution of catch and effort at the resolution of ICES rectangle has been available, from France, Ireland and UK (ICES, 2006; ICES, 2007b).

The French fleet is known based upon the licensing scheme since 2003. Before this time, catch composition was used to identify which vessels were fishing in the deep water. Therefore, composition of the fleet, number of vessels can be considered available since the early 1980s.

B.5. Other relevant data

No other source of data is used in the assessment.

C. Historical stock development

Past assessments

Based upon what is believed to be natural restrictions to the dispersal of all life stages, the area of this stock is considered to include Divisions 5.b and 12.b and Subareas 6 and 7. Due to uncertainties in the catch in Division 12.b, assessment has been restrained to 5.b, 6, 7. Therefore only a portion of the regions of this stock has been assessed in 2008 and 2009.

Given the lack of data, assessments have only been exploratory until 2009. Exploratory assessments focused on integrating discard data into the assessment (WGDEEP, 2008) and rebuilding catch at the beginning of the fishery (WGDEEP, 2009; Pawlowski and Lorance, 2009). The assessment model used was the Separable VPA. The main criticisms against the use of this model were the short time-series of available data and the uncertainties around the age- and length-based approach for this species.

The Bayesian Surplus Production model, Multiyear Catch Curve model and other indicators of trends are currently used for assessment until the next Benchmark Workshop.

Bayesian surplus production model

In 2010, WKDEEP considered the Bayesian Surplus Production Model as the most parsimonious short-term approach. Such an approach can be informative on relative trends such as changes in exploitation biomass and depletion. However, interpreting absolute levels are inappropriate with the current data.

Multiyear catch curve model

A Multiyear catch curve (MYCC) model developed as part of the EU-DEEPFISHMAN project, returns realistic trends in total mortality Z per year. Absolute level may have to interpret with caution. Nevertheless, this model should be used further, to derive an indicator of total mortality and to explore the stock dynamic. Input data are age distribution of the landings or of the catch (landings and discards) per year. The model was run on age 25–46+ (fully recruited stock). The model requires some parameter to be fixed.

M=0.1 (depending on model setting)

Coefficient of variations of the recruitment (CVrec= 0.1)

Coefficient of variations of the landings or catch (CVo=0.1 : CV of observations

Other indicators of trends

Biological indicators such as trends in mean length, ratio of mature/immature provide valuable insights of the state of stocks. Information from length distribution of landings and discards in addition to information on fishing depths are useful indicators of trends in the fishery and in the population structures.

Lpues data based upon French tallybooks were used as indicators of trends and also in the assessment until 2017. Catch rates from surveys are used to check the consistency of the analysis on the commercial cpues.

Biomass indices are based upon Marine Scotland Deepwater Scicence Survey covering 2000 and onwards. Length distribution and individual weight are used to compute biomass indices that have been in use for the assessment until 2018.

Stock assessment parameters

Assessment Model used: Surplus Production Model (based on Pella Tomlinson biomass dynamic model)

Software used: FLBayes package version 1.4, FLCore 1.99-91, R 2.9.2 (URL: http://code.google.com/p/wgdeep-rng/)

Model Options chosen:

Initial parameters

Age-at-maturity: 11 (variance 0.1)

Longevity: 50 (variance 0.1)

Priors for Q (logQ.mean = 0, loqQ.var = 100)

Priors for K (K.mean = log(100000) , K.var = 1)

Priors for r (r.mean = mean(log(r.mc)), r.var = mean(var(r.mc)))

sigma.shape = 2

sigma.rate = 1

Input data types and characteristics:

Landings data are used from 1988 in 5.b, 6, 7 and 12.b when available.

Lpues from French tallybooks from 2000 (past lpues may be included when data will be available). Lpues are provided by region and are combined. The weight of each region is the proportion between the local and the total landings.

Lpues from Spanish data in 12.b from 2002.

D. Short-term projection

Short term projections are done using the surplus production model for set catch levels and various management scenarios.

E. Medium-term projections

No projections are performed.

F. Long-term projections

No projections are performed.

G. Biological reference points

- B_{MSY} and H_{MSY} are outputs from the model.

- MSY $B_{trigger}$ is equals to half B_{msy}.

H. Other issues

Landings and effort data in Division 12.b should be included into the assessment if they become reliable. A separate assessment for Division 12.b should be carried out separately from the one for Division 5.b, and Subareas 6, 7.

As the performance of this model is dependent on the length of the time-series, separate exploratory runs may be performed to evaluate the effects of new datasets or datapoints.

Because discarding is no longer allowed for this species (ref), all catch should be landed in the forthcoming years and will be integrated into the assessment.

New stock identity results are likely to become available in the next few years and should be considered to evaluate the assessment area.

I. References

Allain V. 2001. Reproductive strategies of three deep-water bentho-pelagic fishes from the Northeast Atlantic Ocean. Fisheries Research 51: 165–176.

Allain V, Biseau A, Kergoat B. 2003. Preliminary estimates of French deep-water fishery discards in the Northeast Atlantic ocean. Fisheries Research 60: 185–192.

Allain V, Lorance P. 2000. Age estimation and growth of some deep-sea fish from the Northeast Atlantic ocean. Cybium 24: 7–16.

Andriyashev A. P. 1954. The North sea's fish. Moscow. AN USSR:568 (in Russian).

Bergstad OA. 1990. Distribution, population structure, growth and reproduction of the roundnose grenadier *Coryphaenoides rupestris* (Pisces: Macrouridae) in the deep waters of the Skagerrak. Marine Biology 107: 25–39.

Bergstad OA, Gordon JDM. 1994. Deep-water ichthyoplankton of the Skagerrak with special reference to *Coryphaenoides rupestris* Gunnerus, 1765 (Pisces, Macrouridae) and Argentina silus (Ascanius, 1775) (Pisces, Argentinidae). Sarsia 79: 33–43.

Charuau A., Dupouy H., Lorance P. 1995, French exploitation of the deep-water fisheries of the North Atlantic. In: Hopper A.G. (Ed.) Deep-water fisheries of the North Atlantic oceanic slope, Series E: Applied Sciences, Kluwer Academic Publishers, Dordrecht/Boston/London, 337–356.

Dushchenko V. V. 1989. On intraspecific structure of roundnose grenadier (*Coryphaenoides rupestris* G.) from the North Atlantic. Abstract of Biology science candidate dissertation. M:22. (in Russian).

Eliassen J.E. 1983. Distribution and abundance of roundnose grenadier (*Coryphaenoides rupestris*, Gadiformes, Macrouridae) in northern and mid Norway//ICES CM1983/G:43:24.

Geistdoerfer P. 1977. Contribution a la biologie de *Coryphaenoides rupestris*. Repartition et reproduction dans l'Atlantique nord-est// ICES C.M. 1977/F:45:6.

Gordon JDM. 1978. Some notes of the biology of the Roundnose Grenadier *Coryphaenoides rupestris* to the west of Scotland// ICES C.M. 1978/G:40:13.

Gordon, JDM, Swan SC, Geffen AJ,Morales-Nin B. 2001. Otolith microchemistry as a means of identifying stocks of deep-water demersal fishes (OTOMIC). Northwest Atlantic Fisheries Organization (NAFO) Scientific Council Meeting, Varadero (Cuba), NAFO Scientific Council Research Document 01/100 Serial No. N4488.

ICES. 2006. Report of the Working Group on the Biology and Assessment of Deep-sea Fisheries Resources. ICES CM2006/Assess:28.

ICES. 2007a. Report of the Workshop on Age Reading of Roundnose Grenadier (WKARRG), 4–7 September 2007, Boulogne-sur-mer, France. ICES CM 2007/ACFM:36. 50 pp.

ICES. 2007b, Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP), 8–15 May 2007. International Council for the Exploration of the Sea. ICES CM 2008/ACOM 14. 471p.

ICES. 2008, Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP), 3–10 March 2008. International Council for the Exploration of the Sea. ICES CM 2008/ACOM 14. 486p.

ICES. 2009. Report of the Working Group on the Biology and Assessment of Deep-Sea Fisheries Resources (WGDEEP), 9–16 March 2009. International Council for the Exploration of the Sea. ICES CM 2008/ACOM 14. 504p.

Kelly CJ, Connolly PL, Bracken JJ. 1996. Maturity, oocyte dynamics and fecundity of the roundnose grenadier from the Rockall Trough. Journal of Fish Biology 49: 5–17.

Kelly CJ, Connolly PL, Bracken JJ. 1997. Age estimation, growth, maturity and distribution of the roundnose grenadier from the Rockall Trough. Journal of Fish Biology 50: 1–17.

Knutsen, H., Jorde, P. E., Albert, O. T., Hoelzel, A. R., Stenseth, N. C. 2007. Population genetic structure in the North Atlantic Greenland halibut (*Reinhardtius hippoglossoides*): influenced by oceanic current systems? Canadian Journal of Fisheries and Aquatic Sciences 64(6), 857–866.

Knutsen, H., Jorde, P. E., Sannaes, H., Hoelzel, A. R., Bergstad, O. A., Stefanni, S., Johansen, T., Stenseth, N. C. 2009. Bathymetric barriers promoting genetic structure in the deep-water demersal fish tusk (*Brosmebrosme*). Molecular Ecology 18(15), 3151–3162.

Knutsen H., Jorde P.E., Skogen M., Stenseth N.C. 2009. Large-scale population structure in roundnose grenadier. ICES International Symposium, Issues confronting the deep oceans, Horta, Azores, 27–30 April 2009.

Leim AH, Scott WB. 1966. Fishes of the Atlantic coast of Canada. Ottawa: 220–221.

Logvinenko BM, Nefedov GN, Massal'skaya LM., Polyanskaya IB. 1983. A population analysis of rock grenadier based on the genetic polymorphism of non-specific esterases and myogenes. Can Trans Fish Aquat Sci No. 5406: 16pp.

Lorance P., Dupouy H., Allain V. 2001, Assessment of the roundnose grenadier (*Coryphaenoides rupestris*) stock in the Rockall Trough and neighbouring areas (ICES Subareas V–VII). Fisheries Research 51, 151–163.

Lorance P., Garren F., Vigneau J. 2003. Age estimation of roundnose grenadier (*Coryphaenoides rupestris*), effects of uncertainties on ages. Journal of Northwest Atlantic Fishery Science 31:387–399.

Lorance P., Large P.A., Bergstad O.A., Gordon J.D.M. 2008. Grenadiers of the Northeast Atlantic – Distribution, biology, fisheries, and their impacts, and developments in stock assessment and management.In: Grenadiers of the world oceans: biology, stock assessment and fisheries, Bethesda, MS, USA, American Fisheries Society Symposium 63, 365–397.

Lorance P., Pawlowski L., Trenkel V. 2009. Standardizing blue ling LPUE from industry haul by haul data using generalised additive models, Journal of Marine Science. *Submitted.*

Magnússon J, Magnússon JV, Jakobsdottir KB. 2000. Deep-sea fishes. Icelandic contributions to the deep-water research project, EC FAIR Project CT 95-0655, 1996–1999.

Neat F., Burns F. In press. Stable abundance, but changing size structure in grenadier fishes (*Macrouridae*) over a decade (1998–2008) in which deep-water fisheries became regulated. Deep Sea Research I.

Parin, NV, Neyma VG, Rudyakov YA. 1985. To the problem of waters biological productivity in the High Sea areas of underwater elevations. In: Biological grounds of the fishery development of the High Sea areas. Selected papers. Nauka. Moscow: 192–203 (in Russian).

Parr AE. 1946. The Macrouridae of the Western North Atlantic and Central American seas//Bulletin of the Bingham Oceanogr. Collect. Yale Univers., - v. X, art. 1. p. 1–101.

Pawlowski L., Lorance P. 2009. Effect of discards on roundnose grenadier stock assessment in the Northeast Atlantic. *Aquat. Living Resour.* 22 (2009). DOI: 10.1051/alr/2009040.

Pshenichny, BP., Kotlyar AN, Glukhov AA. 1986. Fish resources of thalassobathyal Atlantic Ocean. In: Biological resources of the Atlantic Ocean. Moscow, Nauka:230–252 (in Russian).

Savvatimsky, PI. 1969. Roundnose grenadier of the North Atlantic. PINRO, Murmansk, 72 (in Russian).

Sauskan VI. 1988. Commercial fish of the Atlantic Ocean. Agropromizdat, Moscow: 165–166 (in Russian).

Shibanov VN. 1997. Biological foundation of roundnose grenadier (*Coryphaenoides rupestris* Gunnerus, 1765) fishery in the North Atlantic. Candidate Dissertation in Biological Sciences. Murmansk, PINRO:156 (in Russian).

Shibanov VN, Vinnichenko VI. 2007. Biology and fishery of roundnose grenadier (*Coryphaenoides rupestris* Gunnerus 1765) in the North Atlantic. In press.

Vinnichenko VI, Khlivnoy BN, Orlov AM. 2004. Biology and distribution of the deep-water fish on the Northeast Atlantic underwater elevations. Fishery economy. Water biological resources, their condition and use: Obzornaya informacjiya/ VNIERH. Moscow. 1:46 (in Russian).

Vinnichenko VI, Khlivnoy BN. 2007. New data on distribution of young roundnose grenadier (*Coryphaenoides rupestris*) in the North Atlantic. In press.Walters, C. 2003. Folly and fantasy in the analysis of spatial catch rate data. Canadian Journal of Fisheries and Aquatic Sciences, 60, 1433–1436.

Zilanov VK, Troyanovsky FM, Shepel LI. 1970. Some biology features, search and fishery characteristics of the roundnose grenadier in the North Atlantic. In: Materials of the Northern Basin. Murmansk. 16:3–21 (in Russian).