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Fish investigations in the Barents Sea Winter 2018

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Preface

Annual catch quotas and other regulations of the Barents Sea fisheries are set through negotiations between Norway and Russia. Assessment of the state of the stocks and quota advices are given by the International Council for the Exploration of the Sea (ICES). Their work is based on survey results and international landings statistics. The results from the demersal fish winter surveys in the Barents Sea are an important source of information for the annual stock assessment.

The development of the survey started in the early 1970s and focused on acoustic measurements of cod and haddock. Since 1981 it has been designed to produce both acoustic and swept area estimates of fish abundance. Some development has taken place since then, both in area coverage and in methodology. The development is described in detail by Jakobsen *et al*. (1997), Johannesen *et al*. (2009) and Appendix 2. At present the survey provides the main data input for several projects at the Institute of Marine Research, Bergen:

- monitoring abundance of the Barents Sea demersal fish stocks
- mapping fish distribution in relation to climate and prey abundance
- monitoring food consumption and growth
- estimating predation mortality caused by cod

This report presents the main results from the surveys in January-March 2018. The surveys were performed with the Norwegian research vessels “Helmer Hanssen” and “Johan Hjort” and Russian research vessel “Fritjof Nansen”. Annual survey reports since 1981 are listed in Appendix 1, and names of scientific participants are given in Appendix 3.

1 Introduction

The Institute of Marine Research (IMR), Bergen, has performed acoustic measurements of demersal fish in the Barents Sea since 1976. Since 1981 a bottom trawl survey has been combined with the acoustic survey. Typical effort of the combined survey has been 10-14 vessel-weeks, and about 350 bottom trawl hauls have been made each year. Most years three vessels have participated from about 1 February to 15 March.

The purpose of the investigations is presently:

- Obtain acoustic abundance indices by length and age for cod and haddock
- Obtain swept area abundance indices by length (and age) for cod, haddock, redfish, Greenland halibut and blue whiting
- Map the geographical distribution of those fish stocks
- Estimate length, weight and maturity at age for cod and haddock
- Collect stomach samples from cod, for estimating predation by cod. Results from analysis of cod stomach samples from the 2018 survey were not available when this report was finalized. Results of such analyses for the period 1984-2017 are given in the 2017 survey report.
- Map the distribution of maturing/prespawning capelin

Data and results from the survey are used both for stock assessments in the ICES Arctic Fisheries Working Group AFWG and by several research projects at IMR and PINRO.

From 1981 to 1992 the survey area was fixed (strata 1-12, main areas ABCD in Fig. 2.1). Due to warmer climate and increasing stock size in the early 1990s, the cod distribution area increased. Consequently, in 1993 and further in 1994 the survey area was extended to the north and east (strata 13-23, main areas D'ES in Fig. 2.1) to obtain a more complete coverage of the younger age groups of cod, and since then the survey has aimed at covering the whole cod distribution area in open water. For the same reason, the survey area was extended further northwards in the western part in 2014 (strata 24-26 in Fig. 2.1). In many years since 1997 Norwegian research vessels have had limited access to the Russian EEZ, and in 1997, 1998, 2007 and 2016 the vessels were not allowed to work in the Russian EEZ. In 1999 a rather unusually wide ice-extension partly limited the coverage. Since 2000, except in 2006, 2007 and 2017, Russian research vessels have participated in the survey and the coverage has been better, but for various reasons not complete in most years. In 2008-2015 Norwegian vessels had access to major parts of the Russian EEZ. The coverage was more complete in these years, especially in 2008, 2011 and 2014. Table 3.6 summarizes degree of coverage and main reasons for incomplete coverage in the Barents Sea winter 1981-2018.

2 Methods

2.1 Acoustic measurements

The method is explained by Dalen and Smedstad (1979, 1983), Dalen and Nakken (1983), MacLennan and Simmonds (1991) and Jakobsen et al. (1997). The acoustic equipment has been continuously improved. Since the early 1990s Simrad EK500 echo sounder and Bergen Echo Integrator (BEI, Knudsen 1990) were used. The Simrad EK60 echo sounder replaced the EK500 on R/V “Johan Hjort” in 2005 and on R/V “Helmer Hanssen” since the 2008 survey. The latest R/V “G.O. Sars” has used EK60 since it replaced R/V “Sarsen” (former R/V “G.O. Sars”) in 2004. The Large Scale Survey System (LSSS, Korneliussen *et al*. 2016) replaced BEI on R/V “G.O. Sars” and R/V “Johan Hjort” in 2007 and on R/V “Helmer Hanssen” since the 2008 survey. On the Russian vessels EK 500 was used from 2000 to 2004 and ER60 since 2005. The new Simrad EK80 echo sounder has been used on R/V “G.O. Sars” since 2017 and on R/V “Johan Hjort” since 2018.

In the mid-1990s the echo sounder transducers were moved from the hull to a retractable centreboard, on R/V “Johan Hjort” since the 1994 survey, on R/V “Sarsen” (former R/V “G.O. Sars”) since 1997, on the latest R/V “G.O. Sars in 2004 and on R/V “Helmer Hanssen” since the 2008 survey. This latter change has largely reduced the signal loss due to air bubbles in the close to surface layer. None of the Russian vessels have retractable centreboards.

On the Norwegian vessels, acoustic backscattering values (s_A = nautical area scattering coefficient NASC) are stored at high resolution in LSSS. After scrutinizing and allocating the values to species or species groups, the values are stored with 10 m vertical resolution and 1 nautical mile (NM) horizontal resolution. The procedure for allocation by species is based on:

- composition in trawl catches (pelagic and demersal hauls)
- the appearance of the echo recordings
- inspection of target strength distributions
- inspection of target frequency responses

For each trawl catch the relative s_A-contribution from each species is calculated (Korsbrekke 1996) and used as a guideline for the allocation. In these calculations, the fish length dependent catching efficiency of cod and haddock in the bottom trawl (Aglen and Nakken 1997) is taken into account. There is no reason to believe that trawl catches give an accurate representation of species composition in the sea, so the calculated s_A-contribution from the trawl hauls are used as a guidance only.

The new Sea2Data software StoX has been applied to estimate acoustic indices with CVs for cod and haddock. Acoustic estimates for the period 1994-2017 were re-estimated using StoX (Mehl *et al*. 2018). The main difference between the SAS based BEAM Program (Totland and Godø 2001) used until 2017 and StoX acoustic abundance estimation is that in BEAM the survey area is divided into rectangles, and for each rectangle an average acoustic density (s_A) is calculated, while in StoX transects are defined within each stratum (Figure 2.1) as primary sampling units (PSUs) and used to calculate acoustic density (Jolly and Hampton 1990).

The survey area is divided into eight Main Areas (A, B, C, D, E, S and N, Fig 2.1) and 26 strata. In 2014, the investigated area was enlarged by three new strata in northwest, 24-26 (Main Area N, Fig. 2.1). Within each stratum, the acoustic course tracks are divided into transects, separated by the trawl stations in the stratum since the course tracks run through the net of fixed bottom trawl stations in the bottom trawl survey. An area of about 2 nautical miles around each station is not included in the transects. For the time series 2004-2017 this was done by first running a R-script tagging all the transects and then the transects were inspected and edited manually in StoX if necessary. Minimum length of a transect is 4 nautical miles. In this process miles with obvious errors in the s_A-values, e.g. bottom contribution, were removed from the transects.

For each transect and stratum, an arithmetic mean s_A is calculated for the demersal zone (less than 10 m above bottom) and the pelagic zone (more than 10 m above bottom).

The conversion of mean NASC (m^2 nmi^{-2}) to density of fish followed a standard procedure where all trawl stations within a stratum with a catch of more than 5 individuals were assigned to each PSU. If less than 3 trawl stations had been carried out in a stratum, stations in neighbouring strata were assigned to the PSUs such that at least 3 stations were assigned to each PSU.

The combined length distribution (*d*) was calculated for each transect (PSU (*j*)) as:

$$d_{l,j} = \sum_{s=1}^{s} d_{l,s,j}$$

where $d_{l,s,j}$ is density (number by 1 NM tow distance) by 1 cm length group (*l*) for the stations (*s*) assigned to PSU (*j*).

The trawl catches are normalised to 1 NM towing distance and adjusted for length dependent catch efficiency (Aglen and Nakken 1997, Dickson 1993a,) using the parameters given in the text table below:

Species	α	β	l_{min}	l_{max}
Cod	5.91	0.43	15 cm	62 cm
Haddock	2.08	0.75	15 cm	48 cm

The areal density of fish (ρ) (n per nmi^2) by length group *l* by transect *j* was calculated as

$$\rho_{j,l} = \frac{\mathrm{NASC}_{j,l}}{\sigma_l}$$

where $\mathrm{NASC}_{j,l}$ is the mean nautical area scattering coefficient by transect (*j*) and length group (*l*) and σ_l is the acoustic backscattering cross-section for a fish of length *l*.

$NASC_{j,l}$ is calculated as:

$$NASC_{j,l} = NASC_j \frac{\sigma_{l,p}}{\sum_l \sigma_{l,p}}$$

where $\sigma_{l,p}$ is the acoustic backscattering cross-section for a fish of length *l* multiplied with the proportion (*p*) of a fish of length *l* in the total length distribution and $NASC_j$ is the mean nautical area scattering coefficient in transect *j*.

The acoustic backscattering cross-section (m^2) for a fish of length *l* is calculated as

$$\sigma_l = 4\pi 10^{\left(\frac{TS_l}{10}\right)}$$

where the target strength, *TS*, for a fish of length *l* (cm) is calculated as

$$TS_l = m \log_{10}(l) + a$$

Where *m* and *a* are constants. For cod and haddock we applied

$$TS = 20 \log(l) - 68 \text{ (Foote, 1987),}$$

The fish abundance (*N*) by length group (*l*) for stratum *k* is:

$$N_{k,l} = \rho_{k,l} A_k\,,$$

where *A* is stratum area and the mean density of fish of length group *l* and stratum *k* is:

$$\rho_{k,l} = \frac{1}{n_k} \cdot \sum_{k=1}^{n_k} w_{kj} \rho_{kj,l}$$

where $w_{kj} = L_{kj} / \overline{L}_k$ (j= 1,2, n_k) are the lengths of the n_k sample transects.

Estimates by length are converted to estimates by age using available age-length data from all selected (filtered) stations in the stratum, weighted by station density. The total biomass is estimated by multiplying the numbers at age by weight at age. The abundance by stratum is then summed for defined main areas (Figure 2.1).

2.2 Swept area measurements

All vessels were equipped with the standard research bottom trawl Campelen 1800 shrimp trawl with 80 mm (stretched) mesh size in the front. Prior to 1994 a cod-end with 35-40 mm (stretched) mesh size and a cover net with 70 mm mesh size were mostly used. Since this mesh size may lead to considerable escapement of 1-year-old cod, the cod-ends were in 1994 replaced by cod-ends with 22 mm mesh size. At present a cover net with 116 mm meshes is mostly used.

The trawl is now equipped with a rockhopper ground gear (Engås and Godø 1989). Until and including 1988 a bobbins gear was used, and the cod and haddock indices from the period 1981-1988 have since been recalculated to 'rockhopper indices' and adjusted for length dependent catch efficiency and/or sweep width (Godø and Sunnanå 1992, Aglen and Nakken 1997). The sweep wire length is 40 m, plus 12 m wire for connection to the doors.

In the Norwegian Barents Sea shrimp survey (Aschan and Sunnanå 1997) the Campelen trawl has been rigged with some extra floats (45 along the ground rope and 18 along the under belly and trunk, all with 20mm diameter) to reduce problems on very soft bottom. This rigging has been referred to as "Tromsø rigging". When the shrimp survey was terminated 2004 and later merged with the Barents Sea Ecosystem survey in 2005, improved shrimp data were also requested from the winter survey, and the "Tromsø rigging" was used in parts of the shrimp areas in 2004 (11 stations) and 2005 (9 stations). In 2006-2014 "Tromsø rigging" was used for nearly all bottom trawl stations taken by Norwegian vessels in the winter survey, while since 2015 "Tromsø rigging" has not been applied.

Vaco doors (6 m^2, 1500kg), were previously standard trawl doors on board the Norwegian research vessels. On the Russian vessels and hired vessels V-type doors (ca 7 m^2) have been used. In 2004, R/V "Johan Hjort" and R/V "G.O. Sars" started using a V-type door for bottom trawling (Steinshamn W-9, 7.1m^2, 2050 kg), the same type as used on the Russian research vessels. In 2010 the V-doors were replaced by 125" Thyborøn trawl doors. R/V "Helmer Hanssen" has used Thyborøn trawl doors since the 2008 survey. To achieve constant sampling width of a trawl haul independent of e.g. depth and wire length, a 10-15 m rope "locks" the distance between the trawl wires 80-150 m in front of the trawl doors on the Norwegian vessels. This is called "strapping". The distance between the trawl doors is then in most hauls restricted to the range 48-52 m regardless of depth (Engås and Ona 1993, Engås 1995). Strapping was first attempted in the 1993 survey on board one vessel, in 1994 it was used on every third haul and in 1995-1997 on every second haul on all vessels. Since 1998 it has been used on all hauls when weather conditions permitted. Strapping is not applied on the Russians vessels, but the normal distance between the doors is about 50 m (D. Prozorkevich, pers. comm.).

Standard tow duration is now 15 minutes (until 1985 the tow duration was 60 min. and from 1986 to 2010 30 min.). Trawl performance is constantly monitored by Scanmar trawl sensors, i.e., distance between the doors, vertical opening of the trawl and bottom contact control. In 2005-2008 sensors monitoring the roll and pitch angle of the doors were used due to problems with the Steinshamn W-9 doors. The data is logged on files, but have so far not been used for further evaluation of the quality of the trawl hauls.

At the start of the survey at least two of the trawls on the Norwegian vessels should go through a “sea test”. The purpose of the test is to check that the geometry of the trawl is within the specified limits and that the trawl performance is satisfactory, especially that the bottom contact is stable. It is further checked that the trawl sensors operate as they should.

The positions of the trawl stations are pre-defined. When the swept area investigations started in 1981 the survey area was divided into four main areas (A, B, C and D, Fig 2.1) and 35 strata.

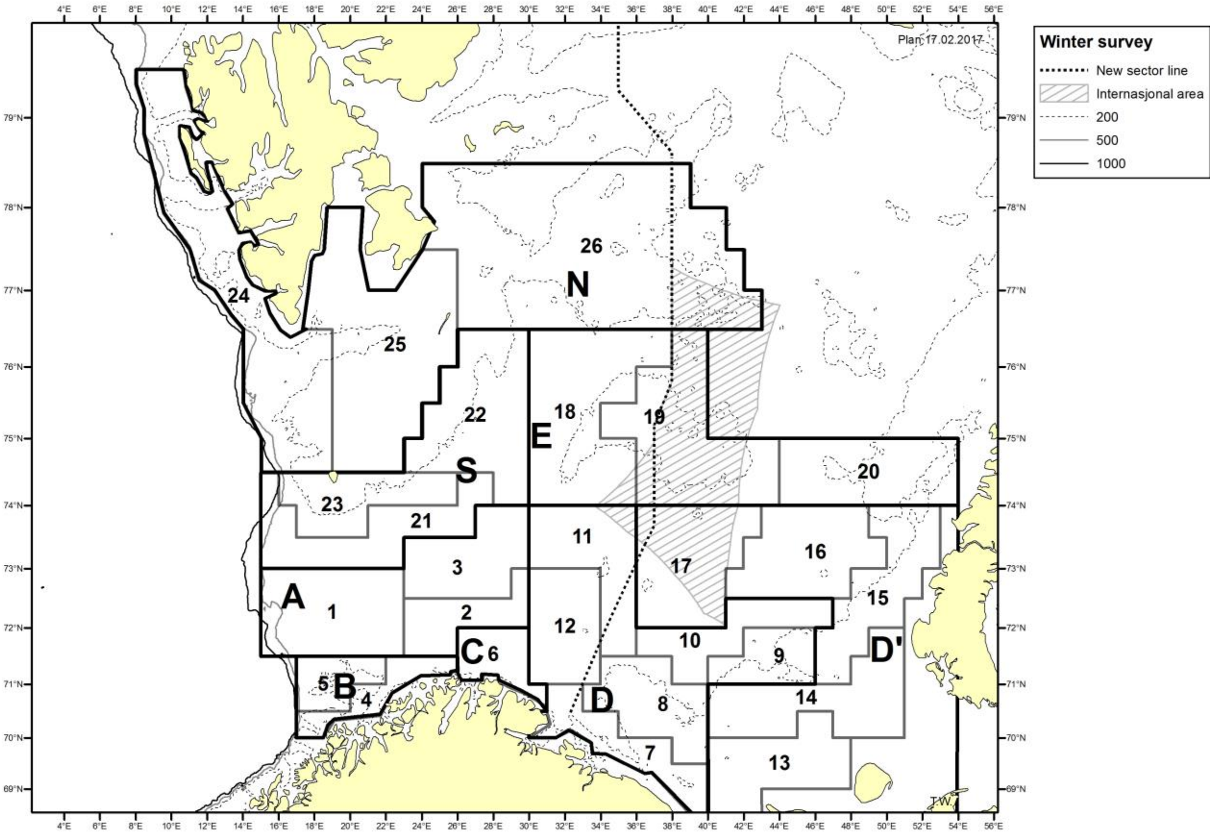

Figure 2.1. Strata (1-23) and main areas (A,B,C,D,D’,E and S) used for swept area estimations and acoustic estimations with StoX. Additional strata (24-26, main area N) are covered since 2014, but not included in the standard time series.

During the first years, the number of trawl stations in each stratum was set based on expected fish distribution to reduce the variance, i.e., more hauls in strata where high and variable fish densities were expected to occur. During the 1990s trawl stations were spread out more evenly, yet the distance between stations in the most important cod strata is shorter (16 or 20 NM) compared to the less important strata (24, 30 or 32 NM). Considerable amounts of young cod were now distributed outside the initial four main areas, and in 1993 the investigated area was therefore enlarged by areas D’, E, and the ice-free part of Svalbard (S) (Fig. 2.1 and

Table 3.5), 28 strata altogether. In the 1993-1995 survey reports, the Svalbard area was included in area A' and the western part of area E (west of 30°E). Since 1996 a revised strata system with 23 strata has been used (Figure 2.1). The main reason for reducing the number of strata was the need for enough trawl stations in each stratum to get reliable estimates of density and variance. In 2014 the investigated area was enlarged by three new strata in northwest, 24-26 (main area N, Fig. 2.1). However, the data are due to few years so far not included in the standard time series of standard abundance indices used in the assessments.

Swept area fish density estimation

Swept area fish density estimates ($\rho_{s,l}$) by species (*s*) and length (*l*) were estimated for each bottom trawl haul by the equation:

$$\rho_{s,l} = \frac{f_{s,l}}{a_{s,l}}$$

$\rho_{s,l}$ number of fish of length *l* per n.m.^{2} observed on trawl station *s*

$f_{s,l}$ estimated frequency of length *l*

$a_{s,l}$ swept area:

$$a_{s,l} = \frac{d_s \cdot EW_l}{1852}$$

d_s towed distance (nm)

EW_l length dependent effective fishing width:

$$EW_l = \alpha \cdot l^{\beta} \text{ for } l_{\min} < l < l_{\max}$$

$$EW_l = EW_{l_{\min}} = \alpha \cdot l_{\min}^{\beta} \text{ for } l \le l_{\min}$$

$$EW_l = EW_{l_{\max}} = \alpha \cdot l_{\max}^{\beta} \text{ for } l \ge l_{\max}$$

The parameters are given in the text table below:

Species	α	β	$l_{\min}$	$l_{\max}$
Cod	5.91	0.43	15 cm	62 cm
Haddock	2.08	0.75	15 cm	48 cm

The fishing width was previously fixed to 25 m = 0.0135 nm. Based on Dickson (1993a,b), length dependent effective fishing width for cod and haddock was included in the calculations in 1995 (Korsbrekke *et al*., 1995). Aglen and Nakken (1997) have adjusted both the acoustic and swept area time series back to 1981 for this length dependency based on mean-length-at-age information. In 1999, the swept area 1983-1995 time series was recalculated for cod and haddock using the new area and strata divisions (Bogstad *et al.* 1999).

For redfish, Greenland halibut and other species, a fishing width of 25 m was applied, independent of fish length.

The new Sea2Data software StoX has been applied to estimate swept area indices with CVs for cod, haddock, golden redfish, beaked redfish, Norway redfish, Greenland halibut and blue whiting. Swept-area estimates for the period 1994-2016 was re-estimated using StoX (Mehl *et al*. 2016), and so was length and weight at age for cod and haddock. All estimates for 2017 and updated estimates for 2016 and 2014-15 strata 24-26 was re-estimated with StoX version 2.3, Rstox 1.5 and updated input data downloaded from DataSet Explorer: http://tomcat7.imr.no:8080/DatasetExplorer/v1/html/main.html.

The main difference between the SAS based Survey Program previously used (years 1981-1993 of the time-series, see earlier reports for results and method details) and StoX swept area estimation is in the use of the age-length data. StoX does not use age-length keys (ALK) in the traditional sense with ALKs estimated for large areas. Missing age information is imputed from known age-length data within station. If age information is still missing StoX searches within strata, or lastly within all strata. If no age is available for a length group, the abundance estimate is presented as unknown age. StoX does also allow for uncertainty estimation by bootstrapping primary sampling units (PSUs).

2.3 StoX input, filters and settings

StoX version 2.5 and Rstox 1.8 was used for acoustic, swept-area, length and weight at age and CV estimations for 2018 (http://www.imr.no/forskning/prosjekter/stox/en). R for Windows version 3.4.3 was used in the R calls (https://www.r-project.org/).

In **FilterAcoustic, FreqExpr** was set to **frequency=38000 or frequency=37879**. In **NASCExpr, acocat** was **31** for cod and **30** for haddock.

In **NASC and LayerType** was set to **DepthLayer**.

Under **FilterBiotic** and **FishStationExpr**, in the acoustic estimations was applied: **fs.getLengthSampleCount('TORSK') > 5** for cod and **fs.getLengthSampleCount('HYSE') > 5 for haddock** and **fishstationtype !~ ['1', '2', '3']**, filtering out stations with less than six specimen and stations with experiments, (see Johnsen et al. 2016 and Mjanger et al. 2017 for more info about filters and codes).

In the swept area estimations was used: **FilterBiotic** and **FishStationExpr**, **gear** =~['3270','3271'] and **gearcondition** < 3 and **trawlquality** =~['1','3'] and **fishstationtype** != 2. In **DefineStrata**, **vintertokt_barentshavny.txt** was used as basis for strata definition. Nodes for strata towards north and east have been adjusted to reduce the strata according to coverage and ice border in each year.

In **StratumArea** and **AreaMethod**, **Accurate** was applied.

Under **StationLengthDist** and **LengthDistType**, **NormalLengthDist** was used, and under **RegroupLengthDis**t and **LengthInterval**, **1.0** is applied in the acoustic estimations and **5.0** in the swept area estimations.

Under **Catchability** and **Catchability Method**, **LengthDependentSweepWidth** was used for cod and haddock with the parameters given above.

In the swept area estimates, for **SweptAreaDensity, LengthDependent** was use, and for **SweepWidthMethod, Predetermined** was applied for cod and haddock and **Constant** with **SweepWidth 25 m** for the other species.

In the acoustic estimates, for **BioStationAssignment** and **AssignmentMethod**, **Stratum** was used. **EstLayers** was set to **1~PEL 2~BOT**.

Under **BioStationWeighting** and **WeightingMethod, SumWeightedCount** was used.

In **AcusticDensity**, **m** was set to **20** and a to **-68**.

Under **SuperIndAbundance** and **AbundWeightMethod**, **StationDensity** was used, with **LengthDist** set to **RegroupLengthDist**.

2.4 Estimation of variance.

The acoustic and swept area survey indices are presented together with an estimate of uncertainty (coefficient of variation; CV). These estimates were obtained by using StoX with a stratified bootstrap routine treating each transect as the primary sampling unit. In addition, a bootstrap routine for all trawl stations by strata was carried out within each run.

The estimated CV (Standard Deviation · 100/mean) is estimated from 500 iterations and is strongly dependent on the choice of estimator for the indices. A CV of 20% or less could be viewed as acceptable in a traditional stock assessment approach if the indices are unbiased (conditional on a catchability model). Values above this indicate a highly uncertain index with little information regarding year class strength.

2.5 Sampling of catch and age-length keys.

Sorting, weighing, measuring and sampling of the catch are done according to instructions given in Mjanger *et al*. (2017). Since 1999 all data except age are recorded electronically by Scantrol Fishmeter measuring board, connected to stabilized scales. The whole catch or a representative sub sample of most species was length measured on each station.

At each trawl station age (otoliths) and stomach were sampled from one cod per 5 cm length-group. In 2007-2009, all cod above 80 cm were sampled, and in 2010 all above 90 cm, limited to 10 per station. The stomach samples were frozen and analysed after the survey. Haddock and Greenland halibut otoliths were also sampled from one specimen per 5 cm length-group.

Regarding the redfish species *Sebastes norvegicus* and *S. mentella*, otoliths for age determination were sampled from two fish in every 5-cm length-group on every station. Table 3.3 gives an account of the sampled material.

2.6 Raising of indices

In 1997, 1998 and 2007 only the Norwegian EEZ (NEZ) and parts of the Svalbard area (S) was covered. The swept-area indices for cod, haddock, golden redfish, beaked redfish and Greenland halibut has therefore been raised to also represent the Russian EEZ (REZ) (Mehl *et al*. 2016).

In 2006, there was not a complete coverage in southeast due to restrictions. The observations in the partially covered strata 7 were extrapolated to the full strata, and the observations in the partially covered strata 13 were extrapolated to the same area as covered in 2005. In 2012 the coverage was incomplete in the eastern areas, and the cod and haddock swept area estimates within the covered area were raised by the "index ratio by age" observed for the same area in 2008-2011 (ICES 2012). The scaling factor ("index ratio") for estimating adjusted total from <Total – area D'> was the average ratio by age for Total/(Total – area D') in the years 2008-2011 (Aglen et al. 2012).

In 2017, the Norwegian vessel was not allowed to operate south of 70º 10' N and west of 41º 00 º E, and no Russian vessel participated in the survey. Only a small part of strata 7 was covered, and strata 13, 15, 17 and 20 were not covered. The cod, haddock, Greenland halibut and beaked redfish swept area estimates and cod and haddock acoustic estimates within the covered area were raised following the same procedure as for 2012. The scaling factor for estimating adjusted total from <Total –strata 7 > was the average ratio by age for Total/(Total – (strata 7+13+15+17+20)) swept area indices in the years 2014-2016.

3 Survey operation and material

Table 3.1 presents the vessels participating in the survey in 2018 and IMR trawl station series numbers, and Figure 3.1 shows survey tracks, trawl stations and ice cover.

Table 3.1. Vessel participation by period and trawl station series numbers by vessel for the winter survey in 2018.

	Period	Series no.
Johan Hjort	28.01-12.03	70001-70220
Helmer Hanssen	20.01-27.02	70301-70540
Fritjof Nansen	08.02-11.03	00001-00118

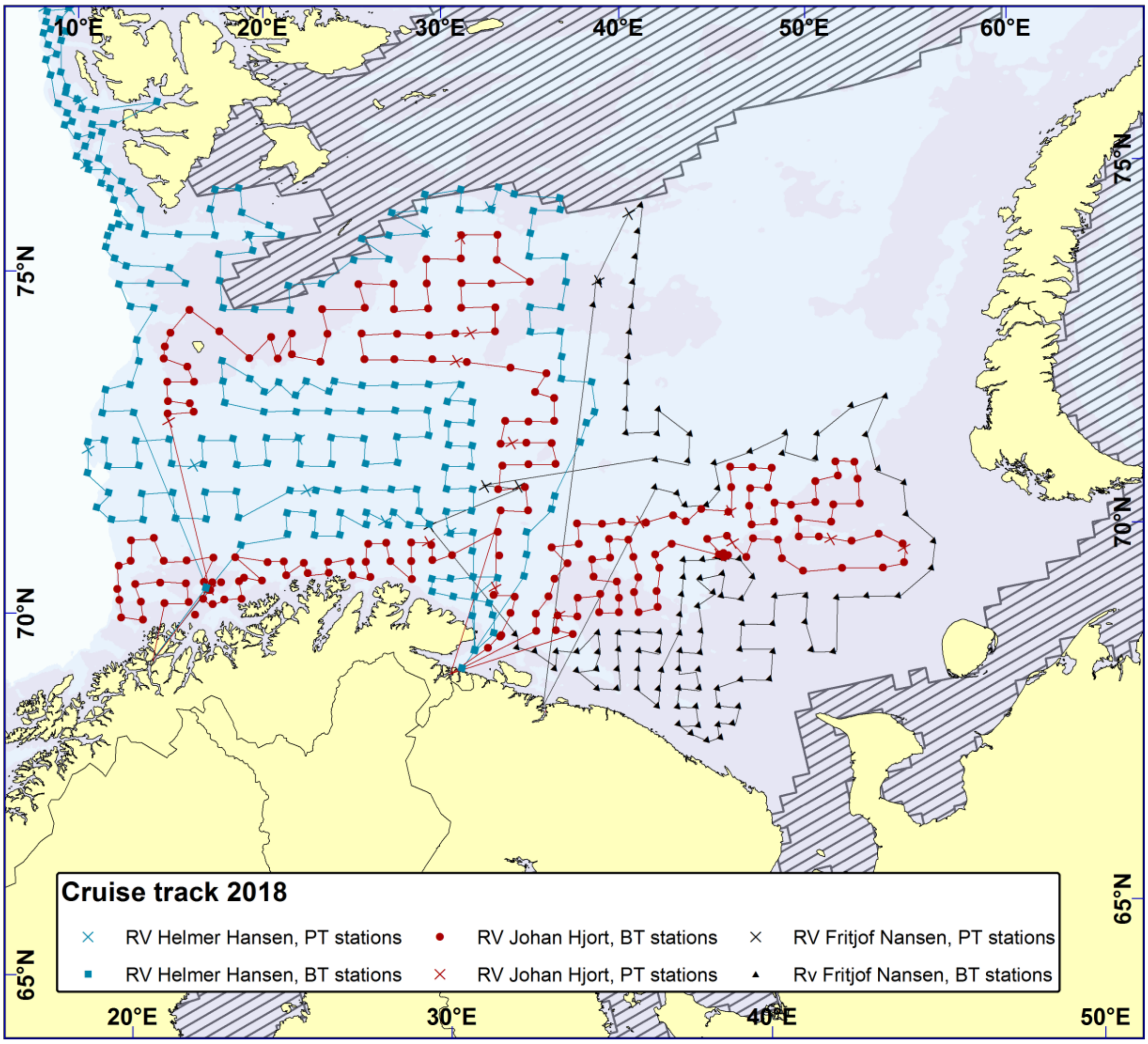

Figure 3.1. Survey tracks and all trawl stations in the winter survey 2018. Data source for the ice cover: ftp://sidads.colorado.edu/DATASETS/NOAA/G02135/north/monthly/shapefiles/shp_extent/02_Feb/

Table 3.2 presents the number of swept area trawl stations, other bottom trawl stations and pelagic trawl stations taken in the different main areas. For the calculation of swept area indices to be used in the assessments, only the successful pre-defined bottom trawl stations within the standard strata system (strata 1-23) were used. The number of stations in the new strata 24-26 are also given.

Table 3.2. Number of trawl stations by main area in the Barents Sea winter 2018. B_1= swept area bottom trawl (quality=1 and condition<3), B_2=other bottom trawl, P=pelagic trawl, N=trawl stations in new strata.

Main area	**Trawl type**	
A	B_1 B_2 P	46 8 1
B	B_1 B_2 P	33 9 5
C	B_1 B_2 P	19 1 2
D	B_1 B_2 P	172 14 11
D'	B_1 B_2 P	56 - 1
E	B_1 B_2 P	34 - 4
S	B_1 B_2 P	57 1 1
Inside standard strata system	B_1 B_2 P	417 33 25
N	B_1 B_2 P	87 1 9
Outside strata system	B_2	6
Total	B_1+B_2 P	544 34

Table 3.3 gives an account of the sampled length- and age material from bottom hauls and pelagic hauls.

Table 3.3. Number of fish measured for length (L) and age (A) in the Barents Sea winter survey 1994-2018.

	Cod		Haddock		Golden redfish	Beaked redfish	Greenland halibut	Blue whiting
Year	**L**	**A**	**L**	**A**	**L**	**L**	**L**	**L**
1994	57290	3400	40608	1808	3157	12389	525	
1995	66264	3547	37775	1692	3785	9622	583	
1996	61559	3304	34497	1416	2510	10206	587	
1997	35381	2381	30054	1003	5429	10997	675	
1998	39044	2843	12512	859	1739	9664	649	
1999	22971	2321	12752	926	1266	6677	397	
2000	31543	2871	25881	1426	1161	8739	546	
2001	36789	2998	30921	1657	1173	7323	499	
2002	45399	3730	58464	2057	1143	6660	688	
2003	59573	2857	54838	1883	1102	4654	657	
2004	40851	3175	51705	1874	1438	5507	459	
2005	33582	3216	67921	2060	835	5166	832	
2006	19319	2683	23611	1899	728	3356	962	
2007	16556	2954	26610	2023	798	4544	973	4657
2008	26844	3809	50195	2490	897	8568	1020	1350
2009	22528	3486	40872	2433	455	9205	807	891
2010	30209	4085	35881	2367	429	8564	984	626
2011	26913	3959	29180	2260	286	6885	607	105
2012	17139	3020	33524	1854	574	5721	354	2441
2013	14525	2451	19142	1671	479	6087	263	1091
2014	22624	4501	35940	2586	563	9310	444	1846
2015	25401	3795	18483	2038	395	8933	541	1991
2016	16636	3368	25423	2067	614	8668	425	2396
2017	12402	2851	15689	1955	576	8898	448	4799
2018	42462	5178	43294	3307	1211	11500	548	1443

The coverage of the most northern and most eastern strata differs from year to year. The areas of these strata are therefore calculated according to the coverage each year. Table 3.4 gives the area covered by the survey every year since 1981. In that table "Extrapolated area" reflects the size of areas where some kind of extrapolations/adjustments have been made to take account of incomplete coverage (see also section 2.6). Table 3.5 summarizes the degree of coverage and main reasons for incomplete coverage in the whole period.

Table 3.4. Area (NM^2) covered in the bottom trawl surveys in the Barents Sea winter 1981-2018, 1994-2018 are StoX estimates.

	Main Area									**Extra-polated area**
Year	**A**	**B**	**C**	**D**	**D'**	**E**	**S**	**N**	**Total excluding N**	
1981-92	23299	8372	5348	51116	-	-	-		88135	
1993	23929	8372	5348	51186	23152	8965	16690		137642	
1994	27180	9854	5165	53394	36543	11417	17557		161110	
1995	26797	9854	5165	53394	58605	13304	24783		191904	
1996	26182	9854	5165	53394	54047	5738	11809		166190	
1997[1]	27785	9854	5165	23964	2670	0	18932		88371	56200
1998[1]	27785	9854	5165	23964	5911	3829	23931		100440	51100
1999	27785	9854	5165	43230	8031	5742	18737		118545	
2000	27173	9854	5165	52314	29438	14207	25053		163204	
2001	26609	9854	5165	53394	29694	15777	24157		164652	
2002	26594	9854	5165	53394	21914	15757	24689		157369	
2003	26621	9897	5165	52072	23947	6259	23400		147361	
2004	27785	9854	5165	53394	42731	4739	20760		164428	
2005	27785	9854	5165	53394	39104	19931	24648		179883	
2006[2]	27785	9854	5165	53394	35302	13872	24691		170064	18100
2007[1]	27785	9854	5165	23911	8498	20822	27858		123894	56700
2008	27785	9854	5165	53394	23792	18873	26313		165176	
2009	27785	9854	5165	53394	31978	15739	27858		171774	
2010	27785	9854	5165	53394	17882	18562	27858		160501	
2011	27785	9854	5165	53394	33432	16835	27858		174324	
2012[2]	27785	9854	5165	53394	9917	17289	27858		151263	16700
2013	27785	9854	5165	53394	58183	21118	27858		203358	
2014[3]	27785	9854	5165	53394	54800	29897	27858	58048	208754	
2015[3]	27785	9854	5165	53394	45449	26541	27858	47263	196047	
2016[3]	27785	9854	5165	53526	29266	20342	27630	54387	173568	
2017[2,3]	27785	9854	5165	45493	12223	18524	27858	38786	146903	37460
2018[3]	27785	9854	5165	53394	45193	23095	27630	44186	192117	

[1]REZ not covered

[2]REZ not completely covered (Strata 7 and 13 in 2006, Area D' in 2012 and strata 7, 13, 15, 7 and 20 in 2017).

[3] Additional northern areas (N) covered, not included in total and standard survey index calculations.

Table 3.5. Barents Sea winter surveys 1981-2018. Main Areas covered, and comments on incomplete coverage.

Year	Coverage	Comments
1981-1992	ABCD	
1993-1996	ABCDD'ES	
1997	Norwegian EEZ (NEZ), S	Not allowed access to Russian EEZ (REZ)
1998	NEZ, S, minor part of REZ	Not allowed access to most of REZ
1999	ABCDD'ES	Partly limited coverage due to westerly ice extension
2000	ABCDD'ES	Russian participation starts
2001-2005	ABCDD'ES	Russian vessel covered where Norwegians had no access
2006	ABCDD'ES	No Russian vessel, not allowed access to Murman coast
2007	NEZ, S	No Russian vessel, not allowed access to REZ
2008	ABCDD'ES	Russian vessel covered where Norwegians had no access
2009	ABCDD'ES	Reduced Norwegian coverage of REZ due to catch handling
2010	ABCDD'ES	Reduced Norwegian coverage of REZ due to bad weather
2011	ABCDD'ES	Russian vessel covered where Norwegians had no access
2012	ABCDD'ES	No Norwegian coverage of REZ due to vessel problems
2013	ABCDD'ES	No Norwegian coverage of REZ due to vessel shortage
2014	ABCDD'ESN	Strata 24-26 (N) covered for the first time
2015	ABCDD'ESN	Slightly reduced/more open coverage due to bad weather
2016	ABCDD'ESN	No access to REZ, Russian vessel covered most of REZ
2017	ABCDD'ESN	No Russian vessel, not allowed access to southwestern REZ
2018	ABCDD'ESN	Russian vessel covered where Norwegians had no access

4 Total echo abundance of cod and haddock

Table 4.1 presents the time series of total echo abundance (mean s_A multiplied by strata area and summed over all strata) of cod and haddock in the investigated areas.

Table 4.1. Cod and haddock. Total echo abundance in the Barents Sea winter 1994-2018 (m^2 reflecting surface · 10^{-3}) estimated by StoX. Observations outside main areas A-S are not included.

	StoX		
Year	**Cod**	**Haddock**	**Sum**
1994	5282	3898	9180
1995	3671	2948	6619
1996	2789	1248	4037
1997[1]	1355	832	2187
1998[1]	2254	543	2797
1999	1517	771	2288
2000	2833	1534	4367
2001	2158	1488	3646
2002	1976	2247	4223
2003	3717	3570	7287
2004	1174	2087	3261
2005	1370	2519	3889
2006	1116	2541	3657
2007[1]	675	2311	2986
2008	3510	6195	9705
2009	2452	5300	7752
2010	3526	5939	9465
2011	2967	3715	6682
2012	3478	4182	7660
2013	5026	3604	9656
2014	4847	2915	7762
2015	5245	2161	7406
2016	2879	1587	4466
2017[1]	2139	2588	4732
2018	3537	2851	6388

[1] not scaled for uncovered areas

Since 1993 the acoustic values have been split between the two species during the scrutinizing. The values for cod have showed an increasing trend since the late 2000s, with a peak in 2013-2015. Total echo abundance was 40% lower in 2016 compared to 2015 and decreased further from 2016 to 2017, while there was an increase of more than 50% from 2017 to 2018. The values for haddock increased gradually from the end of the 1990s to 2008, decreased gradually to less than one third of the 2008 value in 2016 but increased considerably in 2017.

5 Distribution and abundance of cod

5.1 Acoustic estimation

Surveys in the Barents Sea at this time of the year mainly cover the immature part of the cod stock. Most of the mature cod (age 7 and older) have started on their spawning migration southwards out of the investigated area, and are therefore to a lesser extent covered. There are indications that a higher proportion than normal spawned along Finnmark in some of the previous years, e.g. 2004-2006. Thereby a higher proportion of the spawners might have been covered by the survey these years.

Table 5.1 shows the acoustic indices for each age group by main areas in 2018. A rather high proportion of the 1 year olds was found in the extended area (N). The time series (1994-2018) is presented in Table 5.2. The estimates have been variable and increasing in later years, with a peak in biomass in 2013, and this may partly be explained by variable and not complete coverage of the distribution area towards north and east in several years. As cod grow older it gets a more south-westerly distribution during winter, it so to say "grows" into the incomplete survey. This is especially evident for the strong 2004 and 2005 year-classes, which as 6-11 year olds stand out as the strongest in the time series. Of more recent year-classes 2011 seems to be strong. 2014 seemed strong at age 1, while at age 2 it appears rather moderate. Table 5.4 shows indices for strata 24-26 in 2014-2018.

Table 5.4 presents estimated coefficients of variation (CV) for cod age groups 1-15 in 1994-2018. These estimates were obtained by using StoX with a stratified bootstrap routine treating each transect as the primary sampling unit. In addition, a bootstrap routine for all trawl stations by strata was carried out within each run. The estimated CV (Standard Deviation · 100/mean) is estimated from 500 iterations and is strongly dependent on the choice of estimator for the indices. A CV of 20% or less could be viewed as acceptable in a traditional stock assessment approach if the indices are unbiased (conditional on a catchability model). Values above this indicate a highly uncertain index with little information regarding year class strength. In all years, CVs for age groups older than 10 years are above what could be considered as acceptable.

Table 5.1. COD. Abundance indices (numbers in millions) for the main areas of the Barents Sea from acoustic survey winter 2018 estimated by StoX software.

	Age group																
Area	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15+**	**Total**	**Biomass ('000 t)**
A	58.8	6.31	8.19	21.0	7.70	10.0	15.25	9.69	1.36	1.80	0.15	0.13	0.03	0	0	140.4	151.8
B	1.77	0.67	1.22	3.55	3.98	8.05	9.34	13.8	4.69	2.91	0.72	1.28	1.09	0	0.11	53.1	236.6
C	5.22	0.46	0.84	1.96	1.12	1.22	1.81	0.86	0.34	0.14	0.08	0.05	0.08	0	0	14.2	23.0
D	619.4	54.8	28.9	48.8	14.1	12.8	11.6	6.33	2.02	1.53	0.37	0.57	0.30	0.14	0.13	801.8	197.8
D'	402.8	75.8	24.6	28.6	10.5	10.42	9.27	2.76	0.75	0.20	0.03	0.06	0.05	0	0	565.7	111.7
E	273.9	69.6	18.9	14.7	3.08	2.16	1.89	0.69	0.15	0	0	0	0	0		385.1	35.7
S	130.2	13.6	10.7	15.4	6.21	7.19	6.96	1.05	0.74	0.08	0.03	0.05	0.01	0	0.01	192.1	61.2
ABCD	685.1	62.2	39.2	75.3	26.9	32.1	38.0	30.6	8.41	6.36	1.32	2.04	1.50	0.14	0.25	1009.5	609.1
AS	1492.0	221.2	93.3	134.0	46.7	51.9	56.1	35.1	10.0	6.65	1.38	2.14	1.55	0.14	0.25	2152.4	817.7
N	514.2	50.6	16.2	16.7	6.96	4.35	8.64	0.99	0.76	0.25	0.08	0.12	0.01	0	0	619.9	76.1
Total	2006.2	271.8	109.5	150.7	53.6	56.2	64.8	36.1	10.8	6.89	1.46	2.25	1.56	0.14	0.25	2772.3	893.8

Table 5.2. COD. Abundance indices (numbers in millions) from acoustic surveys in the Barents Sea standard area winter 1994-2018 estimated by StoX software.

	Age group																Biomass
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15+**	**Total**	**('000 t)**
1994	823.5	586.9	307.2	384.4	207.0	68.0	12.1	3.53	2.55	0.81	1.11	0.11	0.12	0	0	2397.4	1053.8
1995	2106.6	217.9	143.0	138.0	198.3	67.0	16.1	2.46	0.90	0.32	0.53	0.16	0	0	0	2891.2	669.3
1996	1748.9	261.1	110.0	89.5	115.0	83.3	23.0	2.20	0.27	0.08	0.05	0.05	0.06	0.01	0	2433.4	509.2
1997[1]	2832.9	842.9	209.2	49.2	51.5	43.1	24.9	5.73	1.00	0.23	0.22	0	0	0.03	0	4060.9	358.6
1998[1]	2633.1	555.8	444.5	210.8	46.6	44.4	28.6	16.90	1.85	0.46	0.16	0	0.02	0	0.07	3983.2	572.9
1999	351.1	227.0	151.6	133.3	51.8	12.0	7.02	3.98	1.54	0.32	0.02	0.01	0.01	0	0	939.6	265.4
2000	142.4	248.1	301.1	168.8	147.1	49.0	12.1	4.48	2.85	0.80	0.18	0.12	0.03	0	0	1077.0	546.7
2001	348.3	50.8	179.0	162.3	81.1	44.0	11.3	1.73	0.47	0.18	0.10	0	0	0	0.01	879.4	436.9
2002	18.4	208.8	62.4	105.5	98.0	53.4	20.2	2.96	0.30	0.53	0.12	0	0	0	0.02	570.6	430.7
2003	1399.7	52.0	307.0	120.6	121.8	118.7	39.1	9.32	1.84	0.33	0.07	0	0.07	0.05	0	2170.5	756.7
2004	147.1	111.2	33.3	85.2	33.5	28.5	18.0	5.35	1.15	0.36	0.06	0.01	+	0	0	463.8	245.5
2005	438.2	123.2	129.8	34.9	69.1	21.2	15.0	4.95	0.95	0.27	0.04	0.06	0.05	0.03	0	837.7	263.5
2006[2]	369.5	158.3	64.4	54.5	18.6	29.7	9.57	4.83	1.22	0.19	0.11	0.22	0	0	0	711.2	226.4
2007[1]	88.9	53.7	63.9	35.7	32.7	9.68	18.8	6.57	2.74	0.51	0.24	0.09	0.04	0	0	313.6	239.2
2008	48.5	91.9	196.1	292.0	116.0	73.7	21.1	14.1	2.62	0.72	0.05	0.02	0.01	0	0	856.8	819.8
2009	195.5	23.2	104.6	191.6	139.7	40.9	14.1	4.70	4.38	0.48	0.13	0.02	0.01	0	0	719.4	543.8
2010	696.1	41.8	21.8	86.9	161.8	153.8	46.2	14.4	3.87	2.86	0.91	0.11	0.14	0.09	0.01	1230.9	890.2
2011	248.5	88.7	39.1	28.7	65.4	106.6	102.4	19.4	6.71	1.49	1.07	0.28	0.13	0.10	0.02	708.5	790.0
2012[3]	508.1	45.3	87.8	47.6	35.1	70.9	135.8	60.3	8.19	5.19	1.26	0.66	0.45	0.01	0.10	1006.7	961.8
2013	293.3	82.4	59.1	85.4	70.6	50.2	100.0	129.9	57.0	5.37	3.98	1.63	0.70	0.21	0.05	939.8	1511.9
2014	582.2	154.2	234.0	115.9	96.0	68.4	37.7	84.7	55.3	24.1	2.46	1.51	0.17	0.04	0.16	1456.8	1336.6
2015	1183.0	107.6	110.2	188.0	119.5	130.2	84.9	33.8	51.7	23.0	6.27	0.57	0.14	0.04	0.01	2038.9	1374.6
2016	106.2	111.5	35.2	61.6	101.2	64.5	49.2	23.1	11.9	16.3	7.37	2.25	0.69	0.25	0.09	591.4	806.1
2017[3]	381.5	42.8	80.6	33.0	37.6	58.0	33.0	22.3	10.3	3.81	3.00	3.15	0.59	0.20	0.10	710.0	610.3
2018	1492.0	221.2	93.3	134.0	46.7	51.9	56.1	35.1	10.0	6.65	1.38	2.14	1.55	0.14	0.25	2152.4	817.7

[1]Indices raised to also represent the Russian EEZ. [2] Not complete coverage in southeast due to restrictions, strata 7 area set to default and strata 13 as in 2005.
[3]Indices raised to also represent uncovered parts of the Russian EEZ.

Table 5.3. COD. Abundance indices (numbers in millions) for new strata 24-26 from acoustic surveys in the Barents Sea winter 2014-2018 estimated by StoX software.

	Age group																
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15+**	**Total**	**Biomass ('000 t)**
2014	1112.5	54.0	54.5	11.7	14.6	7.31	2.26	4.73	2.98	0.27	0.02	0	0	0	0	1264.9	103.4
2015	589.7	88.3	25.2	49.0	12.7	11.2	5.34	1.08	3.40	1.16	0.77	0.05	0	0	0	787.9	122.4
2016	104.9	84.6	18.0	14.6	16.8	2.47	2.94	1.86	0.30	0.67	0.17	0.02	0.01	0	0	247.3	60.2
2017	31.1	28.7	26.5	5.44	5.68	4.13	1.54	0.65	0.24	0.05	0.28	0.04	0	0	0	104.4	40.1
2018	514.2	50.6	16.2	16.7	6.96	4.35	8.64	0.99	0.76	0.25	0.08	0.12	0.01	0	0	619.9	76.1

Table 5.4. COD. Estimates of coefficients of variation (%) for acoustic abundance indices. Barents Sea standard area winter 1994-2018.

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1994	33	40	29	12	7	10	12	18	20	29	27	73	97	-
1995	14	20	11	9	7	9	11	21	25	31	55	48	-	-
1996	10	15	14	11	11	10	13	15	29	43	61	60	111	117
1997[1]	33	22	13	12	11	9	9	13	25	55	74	-	-	118
1998[1]	24	17	10	8	10	9	8	10	21	44	57	-	97	-
1999	22	23	17	15	10	11	11	13	25	58	114	121	107	-
2000	31	26	17	10	7	10	17	21	22	42	72	68	110	-
2001	13	15	11	9	10	9	13	22	32	35	77	-	-	-
2002	18	16	10	6	7	10	15	17	32	78	72	-	-	-
2003	26	31	15	13	8	8	13	17	20	40	59	-	99	94
2004	17	16	13	10	10	10	9	13	16	45	58	95	125	-
2005	26	50	19	14	14	14	12	20	26	24	62	90	49	91
2006[2]	21	15	13	10	10	11	15	15	23	37	57	68	-	-
2007[1]	32	27	14	13	11	17	19	21	24	29	40	46	94	-
2008	18	24	15	16	13	10	16	14	20	44	75	65	100	-
2009	21	20	26	22	18	17	13	14	19	32	45	71	112	0
2010	36	17	19	25	16	12	11	12	17	22	28	86	74	70
2011	13	27	12	11	11	10	9	15	28	29	35	39	66	86
2012[2]	36	14	53	11	19	19	17	13	19	35	33	55	52	81
2013	12	24	15	9	21	25	21	18	22	41	49	59	75	111
2014	13	10	11	12	12	8	11	13	15	19	33	53	58	95
2015	17	24	16	16	12	20	18	20	24	25	50	64	71	82
2016	21	15	13	12	11	15	15	16	23	23	29	47	58	87
2017[2]	15	21	13	9	10	11	14	11	18	34	43	55	66	108
2018	10	11	8	8	10	11	10	14	16	23	26	36	50	56

[1]REZ not covered

[2] REZ partly covered

5.2 Swept area estimation

Figures 5.1 - 5.4 show the geographic distribution of bottom trawl catch rates (number of fish per NM^2, for cod size groups < 20 cm, 20-34 cm, 35-49 cm and ≥ 50 cm. As in previous years, a high proportion of the smallest cod (less than 35 cm) were found in the eastern part of the survey area within the Russian EEZ and near the northern borders of the standard strata system (strata 1-23). In 2018, a higher proportion of cod < 20 cm was found in the extended survey area (strata 24-26) compared to 2017, 61% of the number of cod < 20 cm found in the standard survey area was found in the extended area. Mehl *et al*. (2013, 2014, 2015, 2016, 2017) found that since 2009 more of the largest cod had been found in the north-western part of the survey area (main areas S and N), and this trend is confirmed by the 2018 estimates.

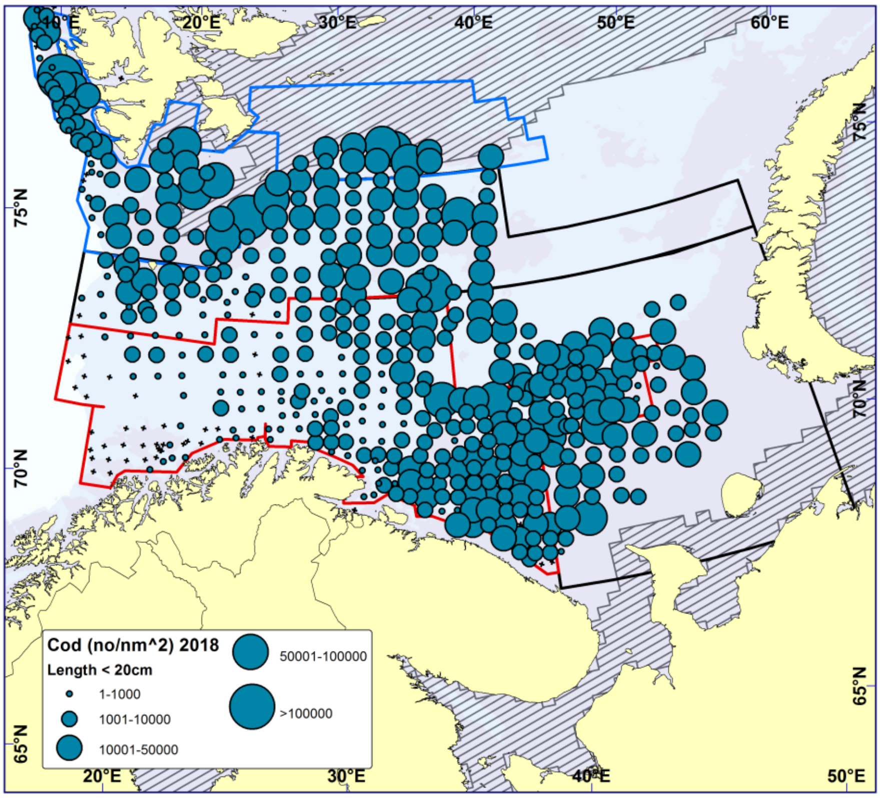

Figure 5.1. COD < 20 cm. Distribution in valid bottom trawl catches winter 2018 (number per nm^2). Black crosses indicate zero catches.

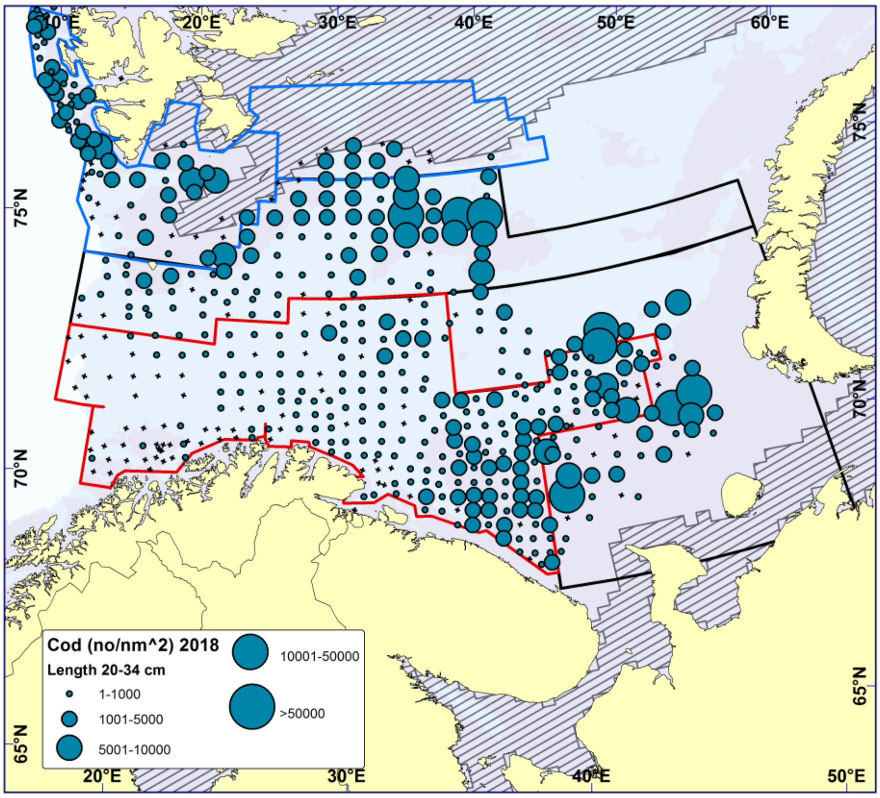

Figure 5.2. COD 20-34 cm. Distribution in valid bottom trawl catches winter 2018 (number per nm^2). Black crosses indicate zero catches.

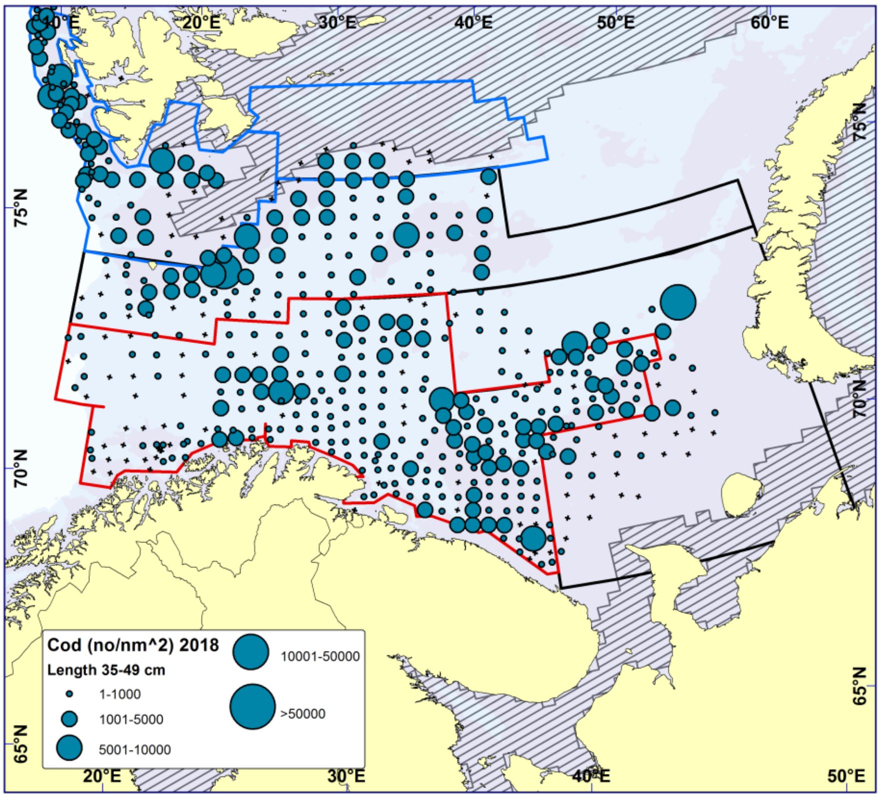

Figure 5.3. COD 35-49 cm. Distribution in valid bottom trawl catches winter 2018 (number per nm^2). Black crosses indicate zero catches.

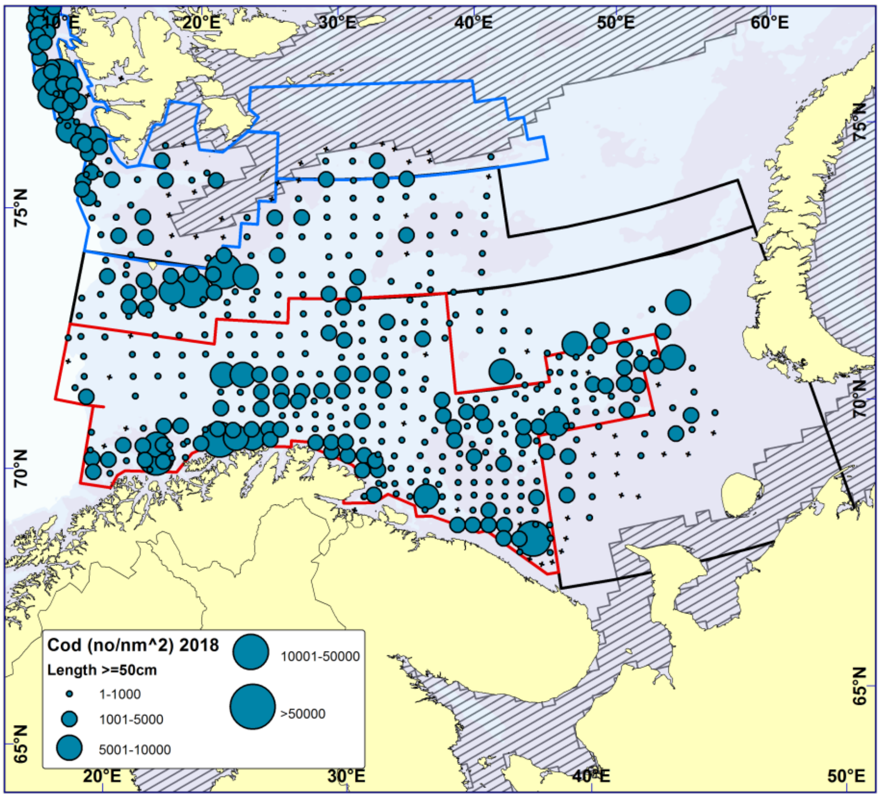

Figure 5.4. COD ≥ 50 cm. Distribution in valid bottom trawl catches winter 2018 (number per nm^2). Black crosses indicate zero catches.

Table 5.5 presents the distribution of the indices by main areas and age and the time series 1994-2018 is shown in Table 5.6. The bottom trawl indices have fluctuated somewhat due to the same reasons as for the acoustic indices, and the 2004 and 2005 year-classes stand out as the strongest in the time series. The 2009, 2011 and 2014 year-classes seemed to be strong as 1-year olds, but have later been reduced to average level or below. A considerable amount of cod was found in the extended survey area (Table 5.3), on average over all age groups about 49% of the amount found in the standard survey area by numbers and about 23% by biomass. Tables 5.7 present swept area abundance indices by age for new strata 24-26 in 2014-2018.

Table 5.8 presents estimated coefficients of variation (CV) for cod age groups 1-15 in 1994-2018. Estimates are based on a stratified bootstrap approach with 500 replicates (with trawl stations being primary sampling unit). A CV of 20% or less could be viewed as acceptable in a traditional stock assessment approach if the indices are unbiased (conditional on a catchability model). Values above this indicate a highly uncertain index with little information regarding year class strength. In all years, CVs for age groups older than 10 years are above what could be considered as acceptable.

Table 5.5. COD. Abundance indices from bottom trawl hauls for main areas of the Barents Sea winter 2018 (numbers in millions).

	Age group															Biomass
Area	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15+**	**Total**	**(‘000 t)**
A	23.8	3.9	4.0	15.9	3.80	5.6	8.62	3.42	0.86	0.45	0.13	0.22	0.03	0	0	70.8	80.3
B	0.86	0.33	0.53	1.97	1.35	4.55	4.25	6.26	2.25	2.44	0.18	1.21	0.70	0.00	0.27	27.1	122.7
C	5.14	0.51	0.65	1.98	1.17	1.31	1.67	0.66	0.29	0.16	0.09	0.04	0.09	0	0	13.8	22.2
D	455.7	53.6	26.2	39.2	10.6	11.3	9.78	5.70	1.74	1.51	0.37	0.55	0.30	0.13	0.10	616.7	176.8
D'	563.1	203.6	26.6	40.5	13.2	15.3	11.7	5.04	1.32	0.73	0.26	0.13	0.05	0	0	881.5	170.0
E	429.3	111.4	30.5	22.1	6.44	3.58	2.59	1.07	0.23	0	0	0	0	0	0	607.2	56.6
S	208.3	21.5	19.06	27.0	9.55	14.0	14.8	1.76	0.79	0.12	0.10	0.11	0.02	0	0.02	317.2	111.3
ABCD	485.5	58.3	31.4	59.1	16.9	22.7	24.3	16.0	5.14	4.56	0.78	2.00	1.11	0.13	0.39	728.4	402.0
AS	1686.2	394.8	107.6	148.7	46.1	55.7	53.4	23.9	7.48	5.42	1.13	2.24	1.19	0.13	0.4	2534.3	739.9
N	1024.9	106.2	32.7	34.2	15.8	8.09	19.9	1.82	1.96	0.56	0.15	0.24	0.02	0	0	1246.6	166.7
Total	2711.0	501.0	140.3	182.9	61.9	63.7	73.3	25.7	9.4	5.97	1.28	2.48	1.21	0.13	0.4	3780.9	906.5

Table 5.6. COD. Abundance indices (numbers in millions) from bottom trawl surveys in the Barents Sea standard area winter 1994-2018.

	Age group																
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15+**	**Total**	**Biomass ('000 t)**
1994	1044.5	545.5	296.8	307.6	152.6	46.8	8.13	2.59	1.32	0.55	0.52	0.11	0.05	0	0	2407.0	760.2
1995	5343.8	540.2	280.4	242.1	252.3	77.1	17.9	2.33	1.13	0.55	0.59	0.19	0	0	0	6758.7	937.5
1996	5908.3	778.6	164.0	116.7	140.7	111.2	24.8	2.79	0.37	0.16	0.08	0.08	0.05	0.02	0	7247.9	725.4
1997[1]	5122.8	1413.7	315.4	69.2	75.0	60.7	26.8	4.95	0.63	0.68	0.46	0.00	0.00	0.00	0.00	7090.2	502.4
1998[1]	2512.1	492.5	355.2	167.4	31.7	26.4	17.5	8.26	0.79	0.52	0.65	0.00	0.35	0.00	0.04	3613.4	405.9
1999	479.7	353.6	189.6	181.9	61.3	12.8	6.83	5.19	0.98	0.27	0.02	0.03	0.02	0	0	1292.2	324.2
2000	128.2	242.8	247.5	130.0	112.0	27.0	4.73	1.82	1.23	0.36	0.10	0.03	0.02	0	0	895.8	364.7
2001	715.8	77.6	182.0	194.5	81.6	38.0	9.58	1.19	0.45	0.19	0.04	0	0	0	0.01	1300.9	433.8
2002	34.2	416.2	118.0	137.7	108.6	46.5	14.5	2.19	0.34	0.19	0.05	0	0	0	0.02	878.5	448.5
2003	3021.4	61.2	380.8	125.4	95.2	66.6	17.9	4.72	1.02	0.16	0.04	0	0.02	0.02	0	3774.3	546.9
2004	321.3	236.3	65.5	186.1	53.6	43.2	30.9	6.92	1.66	0.29	0.08	0.01	0.01	0	0	945.8	417.2
2005	846.8	216.4	244.8	54.8	102.7	22.4	16.4	3.80	0.88	0.30	0.04	0.02	0.03	0.04	0	1509.5	357.9
2006[2]	676.9	283.8	115.6	114.0	28.1	43.3	14.0	5.19	1.34	0.22	0.21	0.08	0	0	0	1282.6	332.2
2007[1]	584.2	369.9	365.8	127.3	68.9	13.7	23.6	6.85	2.20	0.40	0.31	0.08	0.00	0.00	0.00	1563.2	459.2
2008	69.0	103.3	192.5	300.0	115.6	40.8	18.0	8.29	1.86	0.35	0.02	0.02	0.01	0	0	850.0	694.5
2009	389.4	35.5	124.3	196.1	218.0	58.2	17.5	8.44	5.27	0.50	0.18	0.03	0.03	0	0	1053.4	740.3
2010	1031.5	96.5	37.0	114.9	155.5	144.5	39.8	11.2	3.70	1.64	0.57	0.05	0.02	0.03	0.02	1637.0	831.1
2011	615.3	225.6	85.4	50.7	129.9	138.0	103.1	16.7	4.34	1.17	0.79	0.20	0.17	0.04	0.02	1371.4	890.1
2012[3]	728.4	124.8	83.1	70.3	36.4	93.9	136.3	49.6	9.38	2.33	0.87	0.60	0.47	0.02	0.05	1336.6	901.6
2013	439.1	147.2	70.3	119.8	64.0	41.0	65.0	76.2	33.6	2.21	2.83	0.41	0.35	0.06	0.03	1062.0	958.1
2014	499.8	148.8	180.6	85.1	67.9	47.8	32.6	46.9	31.7	9.36	1.01	0.97	0.15	0.04	0.07	1153.0	789.0
2015	1295.0	196.8	125.4	170.2	135.7	99.8	71.2	27.4	52.8	17.0	2.86	0.72	0.10	0.07	0.04	2194.8	1220.0
2016	212.3	232.9	53.4	112.3	151.3	109.0	66.1	26.6	12.8	15.0	6.43	0.96	0.50	0.17	0.14	1000.0	979.3
2017[3]	471.5	71.0	116.1	39.7	48.7	56.6	27.8	18.9	7.63	3.01	2.22	3.49	0.53	0.17	0.06	867.5	540.9
2018	1686.2	394.8	107.6	148.7	46.1	55.7	53.4	23.9	7.48	5.41	1.13	2.24	1.19	0.13	0.39	2534.3	739.9

[1]Indices raised to also represent the Russian EEZ. [2] Not complete coverage in southeast due to restrictions, strata 7 area set to default and strata 13 as in 2005
[3]Indices raised to also represent uncovered parts of the Russian EEZ.

Table 5.7. COD. Abundance indices (numbers in millions) for new strata 24-26 from bottom trawl surveys in the Barents Sea winter 2014-2018.

	Age group																**Biomass ('000 t)**
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15+**	**Total**	
2014	748.1	43.0	48.6	10.1	20.4	9.27	1.32	5.43	4.64	0.30	0.03	0	0	0	0	891.1	116.8
2015	348.8	147.0	19.1	56.4	12.4	14.1	5.43	1.59	2.22	1.27	0.41	0.05	0	0	0	608.8	132.5
2016	102.7	77.4	37.6	23.6	37.2	4.30	6.17	2.73	0.50	1.24	0.30	0.02	0.02	0	0	293.7	108.9
2017	181.9	52.4	58.1	20.6	33.4	31.0	9.20	7.25	0.58	0.23	0.33	0.05	0	0	0	395.0	183.6
2018	1024.9	106.2	32.7	34.2	15.8	8.09	19.9	1.82	1.96	0.56	0.15	0.24	0.02	0	0	1246.6	166.7

Table 5.8. COD. Estimates of coefficients of variation (%) for swept area abundance indices. Barents Sea standard area winter 1994-2018.

	Age group														
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1994	11	17	13	8	7	8	13	21	23	25	22	67	66	-	-
1995	8	14	11	12	10	10	12	23	33	27	43	39	-	-	-
1996	7	12	19	10	12	10	13	13	25	44	51	42	59	106	-
1997[1]	27	28	16	14	13	10	9	14	21	55	70	-	-	-	-
1998[1]	8	12	15	11	11	10	8	10	17	48	61	-	95	-	68
1999	18	28	17	14	8	10	14	29	22	62	105	94	91	-	-
2000	12	18	13	8	8	9	13	10	14	32	59	61	84	-	-
2001	11	14	17	14	9	10	13	23	25	35	59	-	-	-	-
2002	14	24	25	8	9	12	9	15	25	40	70	93	-	-	-
2003	25	33	26	18	7	7	9	11	15	39	56	65	65	-	-
2004	13	15	17	14	11	12	15	14	16	35	39	100	95	-	-
2005	9	15	26	16	16	14	12	11	17	23	60	66	43	50	-
2006[2]	12	13	14	26	17	12	20	12	17	27	54	76	-	-	-
2007[1]	26	21	15	25	7	9	14	17	19	19	33	49	84	-	-
2008	9	16	17	23	33	10	35	14	26	23	74	83	97	-	-
2009	10	9	18	12	19	14	17	25	22	26	34	62	97	-	-
2010	33	9	11	18	13	11	22	13	24	21	27	64	57	57	97
2011	7	30	11	15	16	11	9	11	26	19	49	38	58	64	99
2012[2]	46	13	65	12	14	19	20	12	24	19	23	31	48	80	92
2013	10	18	16	19	12	10	11	10	18	22	55	35	59	102	99
2014	16	10	12	12	10	10	17	13	10	17	27	34	60	132	80
2015	7	24	9	9	14	13	30	21	42	20	20	34	95	82	87
2016	9	10	9	12	9	20	22	10	14	28	21	31	30	54	57
2017[2]	8	10	8	9	15	10	16	18	13	22	23	27	45	35	97
2018	08	18	9	11	12	14	9	13	16	33	21	40	46	43	44

[1] REZ not covered

[2] REZ partly covered

5.3 Growth and survey mortalities

Tables 5.90 and 5.10 present the time series for mean length (1994-2018) and mean weight (1994-2018) at age for the standard area. There have only been moderate fluctuations, but with a decreasing trend for older fish (8+) in later year. The same pattern is reflected in the annual weight increments (Table 5.11). In 2017 weight and yearly weight increment increased, especially for fish older than six years, and decreased again in 2018. A higher proportion of mature cod in the southwestern area in 2017 may have caused this.

Table 5.12 gives the time series of survey based mortalities (log ratios between survey indices of the same year class in two successive years) since 1994. These mortalities are influenced by natural and fishing mortality, age reading errors, and the catchability and availability (coverage) at age for the survey. In the period 1994-1999 there was an increasing trend in the survey mortalities. The trend appears most consistent for the age groups 3-7 in the swept area estimates. Most later surveys show lower mortalities, but there are some fluctuations for the same reasons as mentioned for the acoustic and swept area indices. Presumably the mortality of the youngest age groups (ages 1-3) is mainly caused by predation, while for the older age groups the fishery mainly causes it. Before 2001 the survey mortalities for age 4 and older were well above the mortalities estimated in the ICES stock assessment. Decreasing survey catchability at increasing age could be one reason for this. Another possible reason could be that the assessment does not include all sources of mortality, like discards, unreported catches, or poorly quantified predation. The low survey mortalities in the most recent years, even with "impossible" negative values, could partly be caused by fish gradually "growing into" the covered area at increasing age. In 2017, the estimated mortalities increased to the same high levels as observed before 2001, while in 2018 estimated mortalities were negative for ages 2-7. The 2017 coverage in area D' and E was not complete, and the indices were raised (extrapolated) by the "index ratio by age" observed for the same area in 2014-2016. However, in 2018 the coverage was even better than in 2014-2016, and the 2017 indices may have been underestimated compared to 2018.

The observed mortality rates in the acoustic investigations have been more variable, and the rates in 2017 were lower than in 2016 and mainly negative in 2018. This might be caused by changes in fish behaviour and how available the fish is for acoustic registration.

Table 5.9 COD. Length (cm) at age from bottom trawl surveys in the Barents Sea standard area winter 1994-2018. + indicates few samples.

Age/ Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1994	11.3	17.9	30.2	44.6	55.1	65.5	73.8	78.5	87.5	97.9	97.7	100.8	122.1	-
1995	12.2	18.0	28.8	42.1	54.0	63.7	75.7	80.2	83.9	99.1	+	109.0	-	-
1996	12.1	18.9	28.7	40.6	49.3	60.9	71.7	84.8	92.2	92.2	99.5	104.6	108.7	121.0
1997[1]	10.9	15.9	26.8	39.9	49.5	59.2	69.9	81.6	91.8	+	+	-	-	-
1998[1]	9.8	18.0	29.3	40.0	50.9	58.9	67.7	76.7	87.4	+	+	-	+	-
1999	12.0	18.3	29.0	39.9	50.4	59.4	70.4	78.5	88.7	88.4	+	+	+	-
2000	12.9	20.7	28.4	39.7	51.5	61.4	70.5	76.2	84.8	81.8	99.7	+	+	-
2001	11.6	22.6	33.0	41.1	52.2	63.3	70.2	77.7	86.0	96.2	103.8	-	-	-
2002	12.0	19.5	28.6	43.6	52.1	62.0	71.3	79.5	91.0	89.3	102.3	-	-	-
2003	11.4	18.0	28.9	39.4	53.4	61.7	70.6	80.8	89.1	90.6	104.5	-	105.8	111.6
2004	10.6	18.4	31.7	40.6	51.7	61.6	68.6	79.7	90.9	88.5	91.7	+	+	-
2005	11.2	18.3	29.5	43.5	51.1	60.3	71.0	79.6	88.9	96.2	109.4	+	+	+
2006	12.0	19.5	30.9	42.1	53.6	60.2	66.4	76.5	84.5	98.8	93.2	96.3	-	-
2007[1]	13.1	21.0	29.4	40.2	53.1	62.9	68.7	76.6	87.6	94.9	102.4	+	-	-
2008	12.1	22.4	33.1	43.2	51.7	64.1	69.0	81.3	88.4	94.6	108.9	+	+	-
2009	11.2	21.2	32.1	42.6	53.1	61.7	76.5	81.8	89.3	97.9	99.9	+	+	-
2010	11.2	18.2	31.5	42.7	52.4	60.7	70.6	80.4	88.5	96.2	102.7	+	+	+
2011	11.9	19.4	29.5	41.9	51.0	60.7	68.1	78.3	85.9	95.2	101.3	111.1	111.7	119.0
2012	10.6	18.4	29.7	41.0	52.4	58.0	66.5	75.7	86.0	91.4	106.2	113.4	119.7	+
2013	11.2	19.2	31.0	41.0	51.6	62.1	69.7	76.5	81.1	95.2	92.2	110.7	110.7	+
2014	9.8	17.3	29.1	40.1	51.8	59.5	70.3	77.0	81.9	87.1	96.7	98.1	110.5	+
2015	10.5	16.2	30.0	39.9	51.2	60.5	69.0	77.6	80.1	88.9	95.4	101.4	+	+
2016	12.2	18.5	29.9	40.6	50.0	60.6	68.3	76.7	85.6	86.0	90.0	92.6	111.8	122.2
2017	12.4	21.8	31.4	42.3	51.9	60.8	69.7	79.5	85.9	90.6	96.3	91.9	106.9	108.7
2018	11.2	18.6	31.9	42.2	51.1	61.5	68.9	77.6	83.7	87.9	97.0	98.8	100.1	105.8

[1)] Adjusted lengths, REZ not covered

Table 5.10. COD. Weight (g) at age from bottom trawl surveys in the Barents Sea standard area winter 1994-2018. + indicates few samples.

Age/ Year	1	*2*	3	4	5	6	7	8	9	10	11	12	13	14
1994	12	55	260	796	1463	2372	3477	4624	6782	8420	8530	13516	20786	-
1995	15	53	239	656	1341	2194	3628	4577	5315	8907	+	12176	-	-
1996	15	62	232	632	1079	1979	3327	5479	7655	8192	9760	13013	13614	14650
1997[1]	13	46	181	592	1097	1785	2917	4928	7290	+	+	-	-	-
1998[1]	8	50	256	608	1184	1749	2601	4040	6383	+	+	-	+	-
1999	14	58	231	588	1178	1827	2994	4123	6343	7326	+	+	+	-
2000	16	74	210	558	1210	1961	3042	3842	5384	5727	9960	+	+	-
2001	14	106	336	642	1288	2233	3090	4332	5727	8571	11022	-	-	-
2002	14	67	233	747	1225	2065	3189	4577	7472	6431	11645	-	-	-
2003	13	59	229	586	1313	2013	2982	4725	6511	7552	12467	-	12885	16112
2004	10	59	276	607	1142	1946	2618	4139	6684	6988	7957	+	+	-
2005	13	61	245	724	1145	1857	2953	4224	6418	8607	12488	+	+	+
2006	13	69	280	663	1413	1965	2599	4244	5783	10131	8620	10735	-	-
2007[1]	17	71	226	638	1370	2270	2918	4254	6556	8727	11130	+	-	-
2008	15	90	336	799	1410	2449	3144	5218	6793	9494	12918	+	+	-
2009	13	84	294	704	1293	2030	4061	5082	6884	9504	9614	+	+	-
2010	11	64	307	702	1297	2031	3165	4736	6501	9016	10417	+	+	+
2011	15	65	247	667	1129	1940	2725	4003	5914	8233	9888	13213	13814	+
2012	13	62	251	609	1278	1673	2480	3772	5923	7783	12298	14876	17868	+
2013	11	65	264	591	1201	2064	2804	3839	4814	8433	8759	15101	14729	+
2014	8	49	238	592	1234	1776	2849	3942	4946	6181	8368	9212	12578	+
2015	10	47	242	574	1250	1971	2760	4077	4621	6901	8096	11366	+	+
2016	13	54	239	602	1063	1952	2701	3855	5553	6034	6963	8061	15330	21950
2017	16	92	287	739	1253	2017	3092	4645	6088	7403	9186	8413	12416	14916
2018	12	66	305	687	1237	2074	2867	4180	5536	6793	9222	10497	11164	12268

1) Adjusted weights, REZ not covered

Table 5.11. COD. Yearly weight increment (g) from bottom trawl surveys in the Barents Sea standard area winter 1994-2018.

Year\Age	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10
1994-95	41	184	396	545	731	1256	1100	691	2125
1995-96	47	179	393	423	638	1133	1851	3078	2877
1996-97	31	119	360	465	706	938	1601	1811	-
1997-98	37	210	427	592	652	816	1123	1455	-
1998-99	50	181	332	570	643	1245	1522	2303	943
1999-00	60	152	327	622	783	1215	848	1261	-616
2000-01	90	262	432	730	1023	1129	1290	1885	3187
2001-02	53	127	411	583	777	956	1487	3140	704
2002-03	45	162	353	566	788	917	1536	1934	80
2003-04	46	217	378	556	633	605	1157	1959	477
2004-05	51	186	448	538	715	1007	1606	2279	1923
2005-06	56	219	418	689	820	742	1291	1559	3713
2006-07	58	157	358	707	857	953	1655	2312	2944
2007-08	73	265	573	772	1079	874	2300	2539	2938
2008-09	69	204	368	494	620	1612	1938	1666	2711
2009-10	51	223	408	593	738	1135	675	1419	2132
2010-11	54	183	360	427	643	694	838	1178	1732
2011-12	47	186	362	611	544	540	1047	1920	1869
2012-13	52	202	340	592	786	1131	1359	1042	2510
2013-14	38	173	328	643	575	785	1138	1107	1367
2014-15	39	193	336	658	737	984	1228	679	1955
2015-16	44	192	360	489	702	730	1095	1476	1413
2016-17	79	233	500	651	954	1140	1944	2233	1850
2017-18	50	213	400	498	821	850	1088	891	705

Table 5.12. COD. Survey mortality from surveys in the Barents Sea standard area winter 1994-2018.

	Age							
Year	**1-2**	**2-3**	**3-4**	**4-5**	**5-6**	**6-7**	**7-8**	**8-9**
	Acoustic investigations							
1994-95	1.08	1.24	0.78	0.66	1.04	1.34	1.75	1.67
1995-96	2.04	1.15	0.86	0.62	1.03	1.21	1.79	1.95
1996-97	1.72	0.59	0.59	0.36	0.84	1.21	1.64	1.39
1997-98	0.94	0.01	0.03	0.20	0.39	0.32	0.49	0.86
1998-99	2.41	1.44	1.49	1.40	1.41	1.66	1.88	2.83
1999-00	0.48	0.22	-0.06	-0.39	-0.01	0.07	0.31	0.31
2000-01	0.88	0.47	0.36	0.72	1.28	1.35	1.93	2.24
2001-02	1.07	-0.08	0.21	0.52	0.50	0.79	1.37	1.25
2002-03	-1.22	-0.34	-0.50	-0.14	-0.12	0.32	0.85	0.46
2003-04	2.78	0.60	1.18	1.32	1.54	1.91	1.76	1.86
2004-05	0.28	-0.16	0.00	0.39	0.60	0.64	1.40	1.77
2005-06	0.76	0.40	0.74	0.78	0.90	0.65	1.17	1.10
2006-07	2.18	0.99	0.76	0.67	0.53	0.60	0.57	0.76
2007-08	0.25	-1.23	-1.34	-1.33	-0.83	-0.86	0.14	0.48
2008-09	0.81	-0.63	0.16	0.80	1.39	1.71	1.42	1.19
2009-10	1.69	-0.13	0.40	0.02	-0.17	-0.24	-0.10	0.40
2010-11	1.36	0.23	0.18	0.42	0.48	0.43	0.95	1.12
2011-12	1.68	-0.07	-0.11	-0.26	0.15	-0.16	0.31	0.50
2012-13	2.15	0.13	0.45	-0.30	-0.32	-0.21	0.02	0.09
2013-14	1.22	-0.69	-0.61	-0.07	0.08	0.32	0.11	0.67
2014-15	1.60	0.38	0.36	0.00	-0.07	-0.21	0.60	0.12
2015-16	2.25	1.13	0.49	0.47	0.62	0.65	1.30	0.31
2016-17	1.08	0.28	0.01	0.19	0.36	0.54	0.67	0.47
2017-18	0.55	-0.78	-0.51	-0.35	-0.32	0.03	-0.06	0.80
	Bottom trawl investigations							
1994-95	0.66	0.67	0.20	0.20	0.68	0.96	1.25	0.83
1995-96	1.93	1.19	0.88	0.54	0.82	1.13	1.86	1.84
1996-97	1.43	0.90	0.86	0.44	0.84	1.42	1.61	1.49
1997-98	2.34	1.38	0.63	0.78	1.04	1.24	1.18	1.84
1998-99	1.96	0.95	0.67	1.00	0.91	1.35	1.22	2.13
1999-00	0.68	0.36	0.38	0.48	0.82	1.00	1.32	1.44
2000-01	0.50	0.29	0.24	0.47	1.08	1.04	1.38	1.40
2001-02	0.54	-0.42	0.28	0.58	0.56	0.96	1.48	1.25
2002-03	-0.58	0.09	-0.06	0.37	0.49	0.95	1.12	0.76
2003-04	2.55	-0.07	0.72	0.85	0.79	0.77	0.95	1.04
2004-05	0.40	-0.04	0.18	0.59	0.87	0.97	2.10	2.06
2005-06	1.09	0.63	0.76	0.67	0.86	0.47	1.15	1.04
2006-07	0.60	-0.25	-0.10	0.50	0.72	0.61	0.71	0.86
2007-08	1.73	0.65	0.20	0.10	0.52	-0.27	1.05	1.30
2008-09	0.66	-0.19	-0.02	0.32	0.69	0.85	0.76	0.45
2009-10	1.40	-0.04	0.08	0.23	0.41	0.38	0.45	0.82
2010-11	1.52	0.12	-0.32	-0.12	0.12	0.34	0.87	0.95
2011-12	1.60	-0.14	0.19	0.33	0.32	0.01	0.73	0.58
2012-13	1.60	0.57	-0.37	0.09	-0.12	0.37	0.58	0.39
2013-14	1.08	-0.20	-0.19	0.57	0.29	0.23	0.33	0.88
2014-15	0.93	0.17	0.06	-0.47	-0.39	-0.40	0.17	-0.12
2015-16	1.72	1.30	0.11	0.12	0.22	0.41	0.98	0.76
2016-17	1.09	0.70	0.30	0.84	0.98	1.37	1.25	1.25
2017-18	0.18	-0.42	-0.25	-0.15	-0.13	0.06	0.15	0.93

6 Distribution and abundance of haddock

6.1 Acoustic estimation

Like for cod it is expected that the survey best covers the immature part of the stock. This time of the year a large proportion of the mature haddock (age 6 and older) are on its spawning migration south-westwards out of the investigated area. In some earlier years, e.g. 2004 and 2005, concentrations of mature haddock have been observed pelagically rather far above bottom along the shelf edge. The bottom trawl sampling poorly covers these concentrations. There are indications that the distribution of age groups 1 and 2 in some years are concentrated in coastal areas not well covered by the survey. This occurred in the late 1990s and will have strongest effect on poor year-classes. In the later surveys, small haddock have been widely distributed, and the strong year-classes have been found unusually far to the north. Favourably hydrographic conditions and/or density dependent mechanisms might cause this. However, it is difficult to separate the two factors. Table 6.1 shows the acoustic abundance indices by age within the main areas. As in most of the previous years the highest abundance was observed in main area D. The time series (1994-2018) are presented in Table 6.2. The strong 2004-2006 year-classes can be followed through the time series. In later years, the 2009, 2011, and 2013-2017 year-classes seem to be fairly strong.

Table 6.3 shows indices for strata 24-26 in 2014-2018. The contribution from main area N was rather low in all years, except from age 1 in 2018, when 41% of the number of haddock < 20 cm found in the standard survey area was found in the extended area.

Table 6.4 presents estimated coefficients of variation (CV) for haddock age groups 1-14 in 1994-2018. These estimates were obtained by using StoX with a stratified bootstrap routine treating each transect as the primary sampling unit. In addition, a bootstrap routine for all trawl stations by strata was carried out within each run. The estimated CV (Standard Deviation · 100/mean) is estimated from 500 iterations and is strongly dependent on the choice of estimator for the indices. A CV of 20% or less could be viewed as acceptable in a traditional stock assessment approach if the indices are unbiased (conditional on a catchability model). Values above this indicate a highly uncertain index with little information regarding year class strength. In most years, CVs for age groups older than 7 years are above what could be considered as acceptable.

Table 6.1. HADDOCK. Abundance indices (numbers in millions) for the main areas of the Barents Sea from acoustic survey winter 2018 estimated by StoX software.

	Age group																
Area	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15+**	**Total**	**Biomass ('000 t)**
A	583.7	88.2	24.6	12.9	26.87	3.2	7.06	0.74	1.05	0.05	3.42	1.37	1.28	0	0	754.3	116.6
B	173.0	21.1	5.68	5.50	6.55	0.77	1.90	0.12	0.22	0.26	0.05	0.23	0.02	0	0	215.4	30.7
C	105.8	7.8	1.24	1.22	2.32	0.13	0.38	0.17	0.08	0.06	0.16	0	0	0.01	0	119.4	9.7
D	824.7	433.5	90.2	34.9	23.48	1.4	2.70	1.11	0.83	0.83	1.35	0.89	0.11	0.14	0	1416.1	151.1
D'	199.9	171.8	28.9	4.44	0.85	0.01	0.09	0.07	+	0.05	0.01	0.02	0.01	0	0	406.2	34.0
E	68.5	9.53	0.88	0.11	+	0	0	0	0	0	0	0	0	0	0	79.0	2.4
S	119.2	27.2	7.27	1.28	0.62	0.21	0.64	0.11	0.04	0.05	0.01	0.06	+	0	0	156.7	11.3
ABCD	1687.2	550.6	121.7	54.5	59.2	5.51	12.0	2.13	2.17	1.18	4.98	2.49	1.41	0.14	0	2505.2	308.1
AS	2074.8	759.2	158.7	60.3	60.7	5.73	12.8	2.30	2.22	1.28	5.00	2.56	1.42	0.15	0	3147.1	355.8
N	855.7	46.4	11.7	2.57	3.48	1.15	2.97	0.45	0.33	0.25	0.54	0.39	0.38	0	0	926.4	54.6
Total	2930.5	805.6	170.5	62.9	64.2	6.88	15.7	2.76	2.55	1.53	5.54	2.95	1.80	0.15	0	4073.5	410.3

Table 6.2. HADDOCK. Abundance indices (numbers in millions) from acoustic surveys in the Barents Sea standard area winter 1994-2018 estimated by StoX software.

	Age group																Biomass
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15+**	**Total**	**('000 t)**
1994	887.8	188.0	348.7	626.6	121.4	8.55	0.70	0.33	0.61	0.48	1.46	0.16	0	0	0	2184.8	643.5
1995	1198.2	88.6	41.5	121.5	395.4	47.6	2.80	0.05	0.12	0.03	0.00	0.54	0.14	0	0	1896.4	508.8
1996	132.6	94.5	30.0	22.1	68.7	143.7	5.67	0.94	0	0.01	0	0.02	0.04	0	0.0	498.2	248.3
1997[1]	508.9	26.5	57.3	22.2	15.5	56.1	62.8	4.68	0.07	0	0	0.01	0.05	0.06	0	754.1	217.2
1998[1]	211.0	151.0	33.8	58.8	24.2	7.70	14.1	20.7	1.44	0.02	0.04	0	0	0	0.12	522.8	152.1
1999	653.4	30.1	83.7	21.6	22.1	6.17	1.55	3.88	2.72	0.03	0	0.02	0	0	0	825.3	107.9
2000	1063.0	404.8	36.4	75.5	14.0	12.6	1.57	0.53	2.01	0.69	0.17	0.13	0.02	0	0	1611.5	189.8
2001	753.0	266.1	233.5	40.2	41.4	2.20	1.61	0.16	0.09	0.14	0.28	0.09	0.09	0	0.02	1338.8	206.5
2002	1315.2	267.9	255.2	201.8	18.5	11.7	1.59	0.29	0.03	0.13	0.26	0.09	0.05	0	0	2072.7	298.2
2003	2743.7	362.3	203.7	184.6	136.0	12.3	6.01	0.26	0.14	0.26	0.34	0.09	0.07	0	0	3649.8	444.5
2004	529.0	466.5	151.0	101.8	107.8	57.7	7.62	1.15	0.29	0.04	0.05	0.05	0.04	0.08	0	1423.2	323.0
2005	2276.5	144.0	221.3	115.7	57.4	56.7	12.7	0.38	0.32	0.01	0	0	0	0	0	2885.0	306.0
2006[2]	2091.1	624.8	56.3	123.8	47.4	19.3	13.6	3.23	0.08	0.15	0	0.03	0	0	0.09	2979.9	297.9
2007[1]	2015.7	953.5	209.3	46.1	80.6	28.9	10.00	5.05	2.26	0.30	0.18	0.00	0.00	0.00	0.05	3352.0	406.0
2008	778.4	1753.5	812.4	303.0	90.0	74.1	7.41	12.8	1.63	0.14	0.16	0.18	0	0	0	3833.8	920.4
2009	443.9	209.1	883.7	630.0	266.6	38.9	14.6	1.26	0.34	0.66	0.66	0	0.05	0	0	2489.0	865.4
2010	1559.4	86.0	128.1	631.0	604.0	167.0	12.1	2.94	0.96	0.99	0.10	0.06	0	0	0	3192.6	1035.9
2011	428.5	288.3	54.2	84.2	313.0	292.2	54.9	1.72	0.96	0.23	0	0.21	0.07	0	0	1518.4	712.1
2012[3]	1583.4	94.5	191.6	48.8	88.1	310.6	172.5	30.1	0.52	0.34	0.02	0.13	0	0	0	2520.8	814.6
2013	292.7	407.2	67.3	146.8	35.4	53.0	223.8	102.7	14.1	0.25	0	0	0	0	0	1343.2	759.6
2014	1703.7	109.0	324.5	38.2	107.9	22.4	33.8	84.5	35.3	1.46	0.50	0	0	0.01	0	2461.4	566.4
2015	1521.9	224.4	23.6	171.5	25.5	39.4	8.32	21.1	17.3	6.83	0.42	0.15	0	0	0	2060.5	339.5
2016	1260.3	105.4	68.5	11.8	56.0	11.8	16.6	6.86	15.5	11.9	2.43	0.48	0	0.03	0.02	1567.5	258.3
2017[3]	3263.8	323.2	79.9	62.8	4.4	32.2	5.84	7.01	1.50	6.43	5.48	2.01	0.44	0	0	3795.1	308.6
2018	2074.8	759.2	158.7	60.3	60.7	5.73	12.8	2.30	2.22	1.28	5.00	2.56	1.42	0.15	0	3147.1	355.8

[1]Indices raised to also represent the Russian EEZ. [2] Not complete coverage in southeast due to restrictions, strata 7 area set to default and strata 13 as in 2005
[3]Indices raised to also represent uncovered parts of the Russian EEZ.

Table 6.3. HADDOCK. Abundance indices (numbers in millions) for new strata 24-26 from acoustic surveys in the Barents Sea winter 2014-2018 estimated by StoX software.

	Age group																
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15+**	**Total**	**Biomass ('000 t)**
2014	135.0	0.88	10.3	0.92	0.81	0.80	0.96	1.84	1.31	0.20	0.02	0	0	0	0	153.0	17.9
2015	71.2	22.2	0.71	17.9	1.10	6.77	0.90	1.31	4.01	3.03	0.14	0	0.09	0	0	129.4	48.2
2016	15.7	1.77	3.32	0.26	3.67	0.70	0.71	0.62	1.75	0.83	0.33	0	0	0	0	29.7	16.1
2017	80.1	8.20	1.23	2.28	0.40	2.60	0.40	0.92	0.29	0.64	0.61	0.33	0	0	0	98.0	18.1
2018	855.7	46.4	11.7	2.57	3.48	1.15	2.97	0.45	0.33	0.25	0.54	0.39	0.38	0	0	926.4	54.6

Table 6.4. HADDOCK. Estimates of coefficients of variation (%) for acoustic abundance indices. Barents Sea standard area winter 1994-2018.

	Age group													
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1994	11	12	10	9	12	21	44	53	39	55	31	103	-	-
1995	16	22	24	15	10	15	34	128	85	114	-	55	90	-
1996	20	27	31	23	16	15	22	44	-	120	-	98	108	-
1997[1]	12	17	14	16	16	12	14	33	53	-	-	121	63	74
1998[1]	14	15	15	13	14	21	17	15	50	107	109	-	-	-
1999	19	24	21	28	22	23	32	34	26	118	-	123	-	-
2000	9	9	21	12	18	17	28	45	30	39	72	102	104	-
2001	17	16	16	25	16	30	35	65	66	96	62	94	86	-
2002	8	10	12	10	16	16	29	51	111	69	60	53	71	-
2003	11	11	11	9	15	25	38	80	106	90	76	102	107	-
2004	37	23	23	30	33	17	21	26	45	65	65	86	64	66
2005	10	16	11	15	12	16	19	59	76	104	-	-	-	-
2006[2]	12	10	27	20	12	15	20	33	66	67	-	78	-	-
2007[1]	9	7	9	12	12	15	21	29	40	52	88	-	-	-
2008	13	10	10	10	21	24	29	62	94	263	84	137	-	-
2009	14	13	9	11	14	19	19	43	79	48	-	107	-	-
2010	15	17	10	10	9	13	27	34	49	49	108	92	-	-
2011	15	13	16	12	11	10	15	40	58	94	-	84	115	-
2012[2]	16	28	16	35	24	20	20	27	86	50	105	68	-	-
2013	14	13	22	11	22	16	13	15	26	59	-	-	-	-
2014	13	19	12	20	18	17	16	15	15	44	79	-	-	109
2015	14	17	24	13	23	21	27	23	20	55	64	65	-	-
2016	11	15	15	19	12	14	15	19	17	15	30	43	-	70
2017[2]	6	9	15	13	22	16	22	23	34	29	24	36	67	-
2018	8	8	9	13	17	29	22	29	34	30	27	28	54	81

[1] REZ not covered
[2] REZ partly covered

6.2 Swept area estimation

Figures 6.1 - 6.4 show the geographic distribution of bottom trawl catch rates (number of fish per NM^2) for haddock size groups < 20 cm, 20-34 cm, 35-49 cm and ≥ 50 cm. Like in previous years (Mehl *et al*. 2013, 2014, 2015, 2016, 2017), the distribution extends further to the north and to the east than what was usual in the 1990s. To a certain degree, one can follow the high densities through the size groups, especially the northern and eastern distributions.

Table 6.5 presents the indices for each age group by main areas. The time series (1994-2018) are shown in Table 6.6. As with the acoustic indices, the strong 2004-2006 year-classes dominates bottom trawl indices. Overall, this survey tracks both strong and poor year-classes fairly well. In later years, the 2009, 2011 and 2013-2017 year-classes are stronger than the 2007, 2008, 2010 and 2012 year-classes. Compared to cod a lower proportion of haddock was found in the extended survey area (Table 6.7). This difference is most pronounced for the young ages. The extended area represents about 26% of the numbers in the standard area and about 16 % of the biomass.

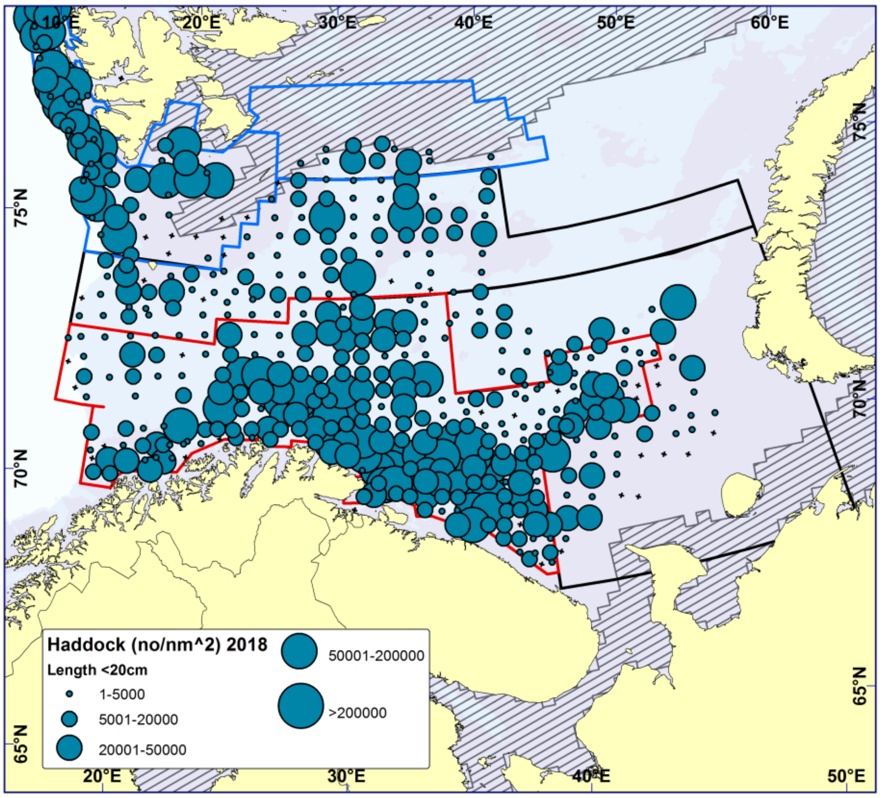

Figure 6.1. HADDOCK < 20 cm. Distribution in valid bottom trawl catches winter 2018 (number per nm^2). Black crosses indicate zero catches.

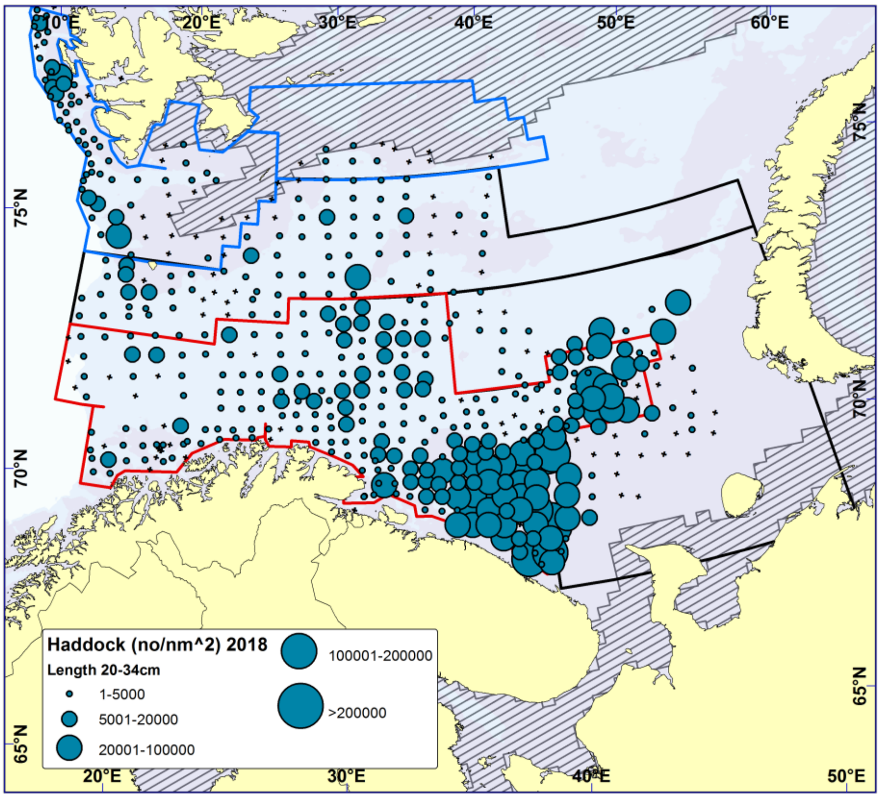

Figure 6.2. HADDOCK 20-34 cm. Distribution in valid bottom trawl catches winter 2018 (number per nm^2). Black crosses indicate zero catches.

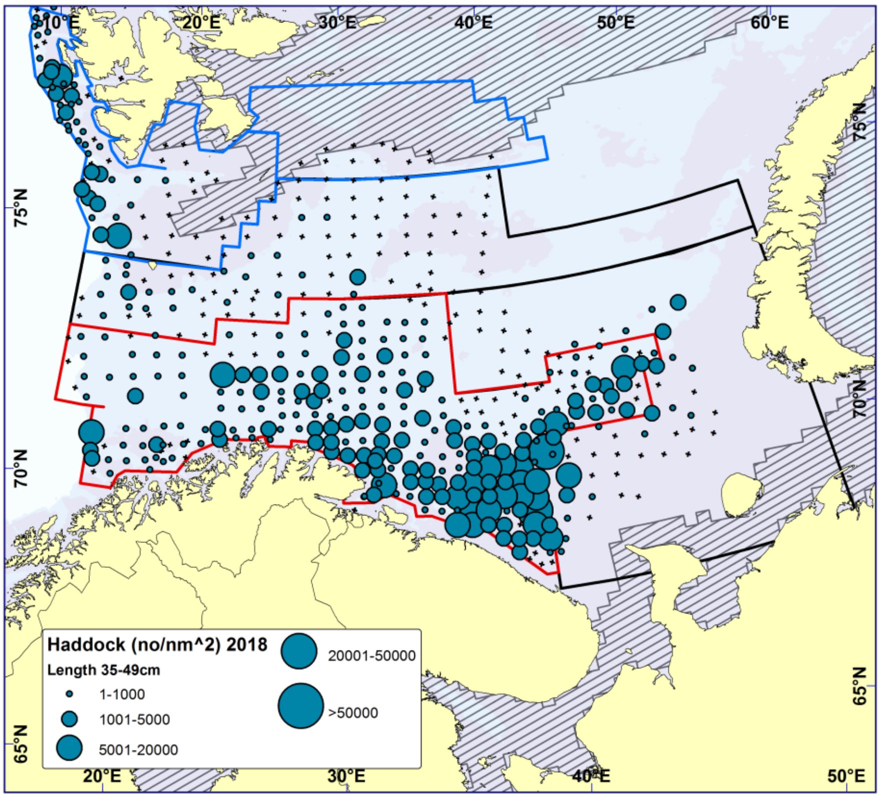

Figure 6.3. HADDOCK 35-49 cm. Distribution in valid bottom trawl catches winter 2018 (number per nm^2). Black crosses indicate zero catches.

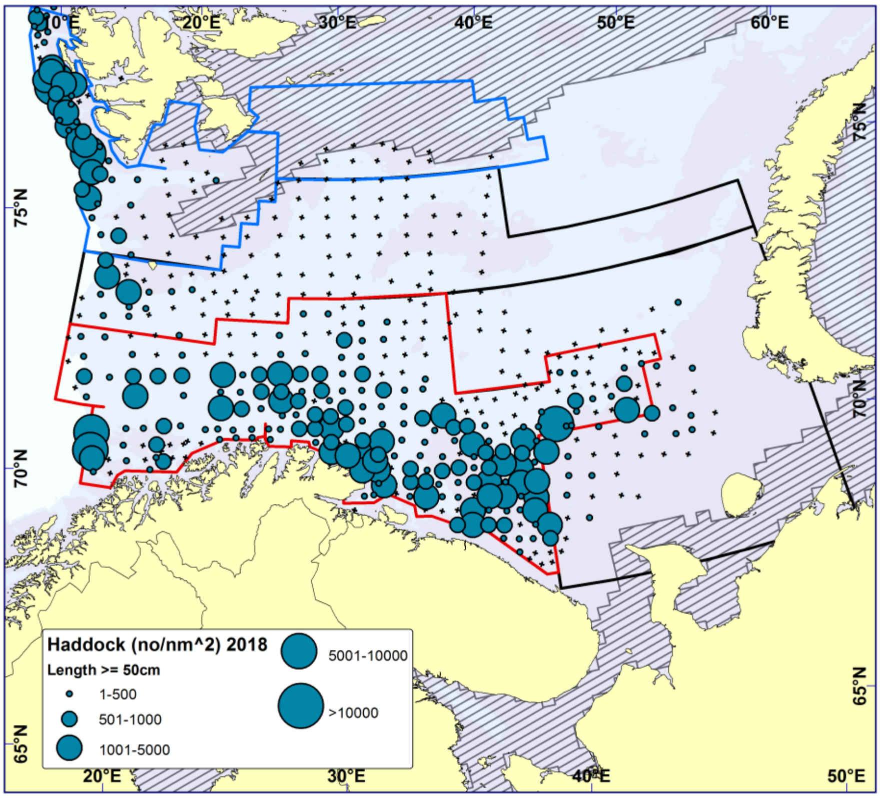

Figure 6.4. HADDOCK ≥ 50 cm. Distribution in valid bottom trawl catches winter 2018 (number per nm^2). Black crosses indicate zero catches.

Table 6.8 presents estimated coefficients of variation (CV) for haddock age groups 1-14 in 1994-2018. Estimates are based on a stratified bootstrap approach with 500 replicates (with trawl stations being primary sampling unit). A CV of 20% or less could be viewed as acceptable in a traditional stock assessment approach if the indices are unbiased (conditional on a catchability model). Values above this indicate a highly uncertain index with little information regarding year class strength. In most years, CVs for age groups older than 7 years are above what could be considered as acceptable.

Table 6.5. HADDOCK. Abundance indices from bottom trawl hauls for main areas of the Barents Sea winter 2018 (numbers in millions).

	Age group																**Biomass ('000 t)**
Area	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15+**	**Total**	
A	344.3	59.0	12.8	5.5	12.46	1.4	2.03	0.63	0.56	0.02	1.04	0.85	0.53	0	0	441.1	52.7
B	125.2	14.2	3.46	4.48	5.12	0.85	3.21	0.00	0.08	0.21	0.00	1	0	0	0	157.3	27.4
C	204.9	15.8	2.19	1.98	5.04	0.33	0.54	0.21	0.25	0.03	0.49	0	0	0.02	0	231.8	19.3
D	1209.5	820.8	171.7	61.7	36.1	2.5	4.39	1.61	1.05	0.98	2.34	1.53	0.18	0.12	0	2314.6	259.4
D'	424.5	610.4	114.8	8.16	2	0.13	0.84	0.27	0.07	0.06	0.07	0.23	0.11	0	0	1161.2	112.7
E	206.6	43.9	2.94	0.09	0	0	0	0	0	0	0	0	0	0	0	253.6	8.7
S	175.3	44.1	13.33	2.12	0.74	0.31	0.94	0.03	0	0.02	0.00	0.25	0	0	0	237.1	17.4
ABCD	1883.9	909.8	190.2	73.6	58.7	5.13	10.2	2.45	1.94	1.24	3.88	2.97	0.71	0.13	0.0	3144.9	358.8
AS	2690.3	1608.3	321.2	84.0	61.0	5.57	11.9	2.75	2.01	1.33	3.95	3.46	0.82	0.13	0.0	4796.8	497.6
N	1141.1	66.1	17.9	3.20	5.03	2.27	3.66	0.90	0.54	0.36	0.72	0.48	0.56	0	0	1242.8	78.0
Total	3831.3	1674.4	339.2	87.2	66.0	7.84	15.6	3.65	2.55	1.68	4.67	3.94	1.38	0.13	0.0	6039.6	575.6

Table 6.6. HADDOCK. Abundance indices (numbers in millions) from bottom trawl surveys in the Barents Sea standard area winter 1994-2018.

	Age group															Total	Biomass ('000 t)
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15+**		
1994	593.5	220.9	315.2	427.9	48.3	3.39	0.14	0.17	0.16	0.14	0.45	0.04	0	0	0	1610.4	402.5
1995	1392.8	182.1	57.6	163.0	338.4	28.8	1.87	0.03	0.04	0.04	0	0.25	0.11	0	0	2165.1	435.7
1996	295.5	245.0	55.5	32.5	161.0	250.9	18.3	1.11	0	0.01	0	0.03	0.03	0	0	1059.9	453.3
1997[1]	1068.7	93.5	80.9	39.6	18.2	61.4	87.3	3.22	0.08	0	0	0	0.03	0.02	0	1452.8	284.5
1998[1]	239.2	196.0	21.2	36.1	12.8	3.24	8.15	5.94	0.56	0.03	0.02	0	0	0	0.05	523.3	85.2
1999	1186.4	79.8	57.1	15.6	9.36	2.87	0.86	1.30	0.74	0.01	0	0.02	0	0	0	1354.2	85.5
2000	817.0	429.8	24.1	35.8	6.91	4.05	0.65	0.01	0.81	0.24	0.03	0.03	0.01	0	0	1319.5	123.3
2001	1215.5	450.0	291.8	26.1	22.7	1.73	0.78	0.06	0.06	0.05	0.16	0.10	0.02	0	0.01	2009.1	226.6
2002	1652.1	464.5	313.8	186.8	11.9	8.43	0.86	0.19	0	0.10	0.15	0.04	0.04	0	0	2638.9	307.0
2003	3254.4	481.3	337.8	175.1	72.3	5.04	1.73	0.12	0.09	0.09	0.09	0.01	0.01	0	0	4328.1	408.3
2004	705.1	707.3	174.9	99.3	77.7	50.9	7.37	0.89	0.13	0.04	0.05	0.04	0.04	0.07	0	1824.2	307.5
2005	4400.9	369.6	315.7	140.1	50.9	61.7	10.2	0.25	0.08	0.01	0	0	0	0	0	5349.5	427.1
2006[2]	4879.2	1296.8	78.8	129.8	45.5	22.6	15.9	3.20	0.09	0.14	0	0.04	0	0	0.07	6470.4	449.1
2007[1]	3654.3	1679.9	459.1	81.0	84.8	26.1	5.38	2.23	1.35	0.77	0.07	0	0	0	0.03	5995.0	677.3
2008	831.1	2072.2	1578.8	581.3	52.9	54.0	7.05	10.6	0.16	0.04	0.08	0.05	0	0	0	5189.1	1099.2
2009	550.0	329.1	1237.3	760.1	372.3	25.8	12.3	0.85	0.09	0.34	0	0.01	0	0	0	3288.1	986.5
2010	1586.4	81.4	96.1	492.8	454.6	149.4	7.80	0.99	0.35	0.42	0.03	0.02	0	0	0	2870.5	760.6
2011	670.9	354.4	52.6	125.7	472.5	293.6	66.3	1.45	1.11	0	0	0.14	0.03	0	0	2038.6	834.4
2012[3]	1844.8	137.3	321.6	29.1	76.1	270.9	156.4	24.5	2.64	0.31	0.04	0.07	0	0	0	2863.7	747.2
2013	335.7	480.2	55.5	146.0	20.9	34.2	193.8	68.6	6.00	0.08	0	0	0	0	0	1340.9	602.3
2014	1129.0	119.8	370.6	30.3	100.4	21.9	46.5	95.2	40.0	1.52	0.46	0	0	0.02	0	1955.7	631.3
2015	1071.7	315.2	30.2	176.7	44.1	35.6	13.6	18.3	27.7	7.76	0.28	0.13	0	0	0	1741.2	373.2
2016	2202.8	509.2	152.7	32.9	105.8	19.6	40.0	10.3	27.5	24.7	4.04	0.92	0	0.14	0.06	3130.8	518.8
2017[3]	4676.6	734.6	127.5	95.8	4.32	45.1	8.72	13.0	1.20	8.02	5.94	3.18	0.72	0	0	5742.8	485.2
2018	2690.3	1608.3	321.2	84.0	61.0	5.57	11.9	2.75	2.01	1.33	3.95	3.46	0.82	0.13	0.0	4796.8	497.6

[1]Indices raised to also represent the Russian EEZ. [2] Not complete coverage in southeast due to restrictions, strata 7 area set to default and strata 13 as in 2005
[3]Indices raised to also represent uncovered parts of the Russian EEZ.

Table 6.7. HADDOCK. Abundance indices (numbers in millions) for new strata 24-26 from bottom trawl surveys in the Barents Sea winter 2014-2018.

	Age group																**Biomass ('000 t)**
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15+**	**Total**	
2014	125.6	1.21	12.4	0.68	2.22	0.12	3.38	1.16	0.75	0.07	0.03	0	0	0	0	147.6	20.8
2015	48.0	17.4	0.32	13.1	0.46	4.30	0.88	0.56	3.51	2.16	0.05	0	0.02	0	0	90.8	34.4
2016	41.4	4.51	10.1	0.52	9.68	2.45	1.36	2.41	4.87	3.13	0.36	0	0	0	0	80.8	45.7
2017	191.3	15.6	3.79	5.80	2.18	7.56	0.80	2.03	1.06	1.85	2.41	0.72	0	0	0	235.0	51.2
2018	1141.1	66.1	17.9	3.20	5.03	2.27	3.66	0.90	0.54	0.36	0.72	0.48	0.56	0	0	1242.8	78.0

Table 6.8. HADDOCK. Estimates of coefficients of variation (%) for swept area abundance indices. Barents Sea standard area winter 1994-2018.

	Age group													
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1994	12	13	13	13	15	25	47	45	34	61	39	100	-	-
1995	12	19	28	29	16	21	38	181	75	97	-	58	97	-
1996	14	12	11	26	29	25	60	64	-	98	-	95	96	-
1997[1]	12	34	13	15	17	21	18	57	55	-	-	-	65	92
1998[1]	15	13	13	14	16	25	18	16	35	107	106	-	-	-
1999	15	37	14	24	21	23	25	31	22	88	-	97	-	-
2000	9	11	21	10	18	14	32	51	32	35	65	91	105	-
2001	11	15	11	18	11	40	34	46	59	51	47	86	62	-
2002	9	12	11	12	19	17	27	44	-	57	52	54	80	-
2003	18	26	25	12	11	20	35	62	60	69	56	91	93	-
2004	10	12	16	14	11	12	28	26	43	56	56	94	59	51
2005	9	16	11	19	13	22	15	71	48	93	-	-	-	-
2006[2]	14	14	18	12	13	16	20	30	44	70	-	63	-	-
2007[1]	11	7	10	20	12	12	24	25	46	51	58	-	-	-
2008	12	18	17	17	20	29	29	80	45	81	67	88	-	-
2009	13	21	16	17	19	19	33	25	91	68	-	94	-	-
2010	11	17	18	23	21	22	24	32	49	64	126	150	-	-
2011	10	10	16	25	17	13	18	33	73	-	-	83	84	-
2012[2]	20	29	16	17	14	12	15	34	73	47	83	62	-	-
2013	12	12	15	15	28	25	28	14	26	49	-	-	-	-
2014	9	24	14	19	17	22	21	17	24	41	62	-	-	99
2015	8	13	26	12	40	14	27	19	21	32	44	50	-	-
2016	22	26	15	46	11	17	20	16	17	21	29	46	-	62
2017[2]	5	13	16	13	21	15	21	31	31	22	27	45	77	-
2018	6	17	14	12	10	20	17	21	19	21	20	23	40	52

[1] REZ not covered
[2] REZ partly covered

6.3 Growth and survey mortalities

Tables 6.9 and 6.10 present the time series (1994-2018) for mean length and mean weight at age for the standard area. Length estimates have been variable with no specific trends in the latest years. However, the variation is less than what it has been in earlier periods. Weight estimates also show less variation in later years. Annual weight increments are shown in Table 6.11, these are highly variable and show no trends.

Survey mortalities based on the acoustic indices (Table 6.12) have varied between years, and for most age groups there are no obvious trends. However, there are signs of co-variability within years. Survey mortalities based on the bottom trawl indices increased considerably from 2016 to 2017 to among the highest in the ten last years, but decreased somewhat from 2017 to 2018.

Table 6.9. HADDOCK. Length (cm) at age from bottom trawl surveys in the Barents Sea standard area winter 1994-2018. + indicates few samples.

Age/ Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1994	14.5	20.1	29.4	38.0	47.6	54.3	61.7	65.2	70.7	64.4	64.6	72.0	-	-
1995	15.1	18.4	28.7	34.0	42.8	51.0	59.6	60.0	67.2	68.0	-	64.7	78.6	-
1996	15.3	20.9	28.0	37.0	41.3	47.2	53.8	58.7	-	76.0	-	74.0	75.0	-
1997[1]	15.8	19.4	27.0	33.5	40.5	46.9	47.6	53.3	62.0	-	-	-	75.6	78.0
1998[1]	14.1	19.6	28.9	34.2	41.6	46.5	50.3	52.8	58.2	72.1	65.0	-	-	-
1999	14.3	18.0	32.3	38.6	46.5	51.9	56.1	55.1	58.8	62.0	-	72.0	-	-
2000	15.5	21.7	29.9	42.0	47.1	51.1	52.7	59.3	59.4	62.0	63.3	+	+	-
2001	14.6	22.1	32.1	37.6	48.0	50.1	59.2	55.0	64.9	66.3	67.7	+	+	-
2002	15.0	20.9	29.2	39.8	45.6	51.5	58.0	58.6	-	62.0	64.4	67.7	70.1	-
2003	15.8	24.0	26.4	36.5	45.8	49.8	54.5	61.2	62.6	60.3	66.0	70.0	+	-
2004	14.1	22.1	30.1	35.7	42.7	49.9	49.6	58.8	63.3	73.6	75.7	+	+	+
2005	14.8	20.6	29.9	36.1	40.4	48.4	51.5	56.2	60.8	67.0	-	-	-	-
2006	14.4	22.1	30.7	37.9	43.3	47.3	50.7	56.6	60.5	69.9	-	+	-	-
2007[1]	15.2	23.5	28.2	31.2	43.5	43.9	50.0	58.0	58.1	+	62.0	-	-	-
2008	15.7	23.7	29.6	37.9	42.7	46.0	52.9	52.5	58.5	+	63.3	63.0	-	-
2009	14.2	22.6	29.7	35.5	41.8	48.1	48.9	56.4	65.0	62.3	-	62.0	-	-
2010	14.4	19.8	30.6	36.8	40.8	45.1	49.9	59.9	58.9	62.3	+	66.5	-	-
2011	13.6	23.3	28.5	39.5	42.9	46.1	48.2	62.7	+	-	-	63.3	+	-
2012	14.6	19.2	31.6	35.1	43.7	47.1	50.2	50.8	47.6	65.0	67.0	72.0	-	-
2013	14.5	22.8	30.0	40.9	42.8	48.6	52.3	52.8	55.6	67.3	-	-	-	-
2014	15.5	18.6	31.9	39.0	46.5	52.7	53.5	55.3	54.9	60.3	59.2	-	-	75.0
2015	14.5	20.4	26.1	39.8	45.3	52.6	53.4	57.6	56.9	60.2	59.6	67.4	-	-
2016	14.8	18.5	30.7	35.8	47.8	53.0	56.0	58.4	61.0	60.4	59.8	64.5	-	72.0
2017	15.8	20.6	30.4	39.7	49.4	52.7	55.8	60.4	59.8	63.0	62.1	63.9	69.0	-
2018	14.3	22.1	30.4	39.5	47.6	54.1	57.7	61.1	64.3	66.0	64.4	63.4	67.1	68.6

1) Adjusted lengths, REZ not covered

Table 6.10. HADDOCK. Weight (g) at age from bottom trawl surveys in the Barents Sea standard area winter 1994-2018. + indicates few samples.

Age/ Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1994	25	87	248	539	1056	1601	2201	2846	3439	2680	2712	3890	-	-
1995	30	71	221	380	775	1331	2005	2070	2685	2905	-	2502	3972	-
1996	32	93	218	472	668	1020	1537	1768	-	4630	-	4018	3626	-
1997[1]	35	85	188	329	619	1034	1064	1532	2474	-	-	-	3731	4130
1998[1]	24	89	232	416	815	1032	1298	1559	2006	3740	3040	-	-	-
1999	27	75	335	570	1022	1435	1791	1722	2011	2440	-	3525	-	-
2000	32	110	275	736	1061	1366	1521	2123	2239	2588	2741	+	+	-
2001	28	107	337	581	1145	1402	2147	1896	2903	3110	2965	+	+	-
2002	30	85	245	618	940	1375	1940	2048	-	2352	2670	3252	3497	-
2003	36	129	192	490	958	1209	1479	1933	2479	2533	3055	3470	+	-
2004	23	98	271	456	750	1162	1204	1958	2658	3926	4157	+	+	+
2005	29	98	261	474	666	1093	1372	1976	2120	2730	-	-	-	-
2006	25	109	302	561	810	1083	1358	1917	2102	3991	-	+	-	-
2007[1]	30	114	246	356	894	956	1388	2135	2508	+	2959	-	-	-
2008	32	113	245	553	832	1080	1573	1417	2120	+	2280	2840	-	-
2009	26	96	225	442	747	1147	1275	1726	2377	2563	-	2594	-	-
2010	27	87	270	466	658	949	1260	1897	2143	2512	+	3184	-	-
2011	21	117	220	520	727	939	1163	2285	+	-	-	+	2805	-
2012	28	73	305	432	816	1015	1285	1282	1219	2683	2980	3264	-	-
2013	24	113	272	644	783	1130	1350	1495	1836	3098	-	-	-	-
2014	32	68	357	611	1014	1424	1551	1677	1671	2141	2184	-	-	4800
2015	23	88	201	588	848	1423	1465	1921	1834	2078	2256	3133	-	-
2016	27	74	282	458	1057	1457	1752	2078	2280	2266	2404	2843	-	3555
2017	33	95	290	621	1220	1520	1785	2280	2309	2610	2594	2789	3369	-
2018	25	97	273	625	1040	1637	1941	2327	2697	2853	2667	2577	2997	3369

[1)] Adjusted weights, REZ not covered

Table 6.11. HADDOCK. Yearly weight increment (g) from bottom trawl surveys in the Barents Sea standard area winter 1994-2018.

Year\Age	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10
1994-95	46	134	132	236	275	404	-131	-161	-534
1995-96	63	147	251	288	245	206	-237	-	1945
1996-97	53	95	111	147	366	44	-5	706	-
1997-98	54	147	228	486	413	264	495	474	1266
1998-99	51	246	338	606	620	759	424	452	434
1999-00	83	200	401	491	344	86	332	517	577
2000-01	75	227	306	409	341	781	375	780	871
2001-02	57	138	281	359	230	538	-99	-	-551
2002-03	99	107	245	340	269	104	-7	431	-
2003-04	62	142	264	260	204	-5	479	725	1447
2004-05	75	163	203	210	343	210	772	162	72
2005-06	80	204	300	336	417	265	545	126	1871
2006-07	89	137	54	333	146	305	777	591	-
2007-08	83	131	307	476	186	617	29	-15	-
2008-09	64	112	197	194	315	195	153	960	443
2009-10	61	174	241	216	202	113	622	417	135
2010-11	90	133	250	261	281	214	1025	-	-
2011-12	52	188	212	296	288	346	119	-1066	-
2012-13	85	199	339	351	314	335	210	554	1879
2013-14	44	244	339	370	641	421	327	176	305
2014-15	56	133	231	237	409	41	370	157	407
2015-16	51	194	257	469	609	329	613	359	432
2016-17	68	216	339	762	463	328	528	231	330
2017-18	64	178	335	419	417	421	542	417	544

Table 6.12. HADDOCK. Survey mortality from surveys in the Barents Sea standard area winter 1994-2018.

Year	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9
Acoustic investigations								
1994-95	2.30	1.51	1.05	0.46	0.94	1.12	2.64	1.01
1995-96	2.54	1.08	0.63	0.57	1.01	2.13	1.09	-
1996-97	1.61	0.50	0.30	0.35	0.20	0.83	0.19	2.60
1997-98	1.21	-0.24	-0.03	-0.09	0.70	1.38	1.11	1.18
1998-99	1.95	0.59	0.45	0.98	1.37	1.60	1.29	2.03
1999-00	0.48	-0.19	0.10	0.43	0.56	1.37	1.07	0.66
2000-01	1.38	0.55	-0.10	0.60	1.85	2.06	2.28	1.77
2001-02	1.03	0.04	0.15	0.78	1.26	0.32	1.71	1.67
2002-03	1.29	0.27	0.32	0.39	0.41	0.67	1.81	0.73
2003-04	1.77	0.88	0.69	0.54	0.86	0.48	1.65	-0.11
2004-05	1.30	0.75	0.27	0.57	0.64	1.51	3.00	1.28
2005-06	1.29	0.94	0.58	0.89	1.09	1.43	1.37	1.56
2006-07	0.79	1.09	0.20	0.43	0.49	0.66	0.99	0.36
2007-08	0.14	0.16	-0.37	-0.67	0.08	1.36	-0.25	1.13
2008-09	1.31	0.69	0.25	0.13	0.84	1.62	1.77	3.63
2009-10	1.64	0.49	0.34	0.04	0.47	1.17	1.60	0.27
2010-11	1.69	0.46	0.42	0.70	0.73	1.11	1.95	1.12
2011-12	1.51	0.41	0.10	-0.05	0.01	0.53	0.60	1.20
2012-13	1.36	0.34	0.27	0.32	0.51	0.33	0.52	0.76
2013-14	0.99	0.23	0.57	0.31	0.46	0.45	0.97	1.07
2014-15	2.03	1.53	0.64	0.40	1.01	0.99	0.47	1.59
2015-16	2.67	1.19	0.69	1.12	0.77	0.86	0.19	0.31
2016-17	1.36	0.28	0.09	0.99	0.55	0.70	0.86	1.52
2017-18	1.46	0.71	0.28	0.03	-0.26	0.92	0.93	1.15
Bottom trawl investigations								
1994-95	1.18	1.34	0.66	0.23	0.52	0.59	1.54	1.45
1995-96	1.74	1.19	0.57	0.01	0.30	0.45	0.52	-
1996-97	1.15	1.11	0.34	0.58	0.96	1.06	1.74	2.63
1997-98	1.70	1.48	0.81	1.13	1.73	2.02	2.69	1.75
1998-99	1.10	1.23	0.31	1.35	1.50	1.33	1.84	2.08
1999-00	1.02	1.20	0.47	0.81	0.84	1.49	4.45	0.47
2000-01	0.60	0.39	-0.08	0.46	1.38	1.65	2.38	-1.79
2001-02	0.96	0.36	0.45	0.79	0.99	0.70	1.41	-
2002-03	1.23	0.32	0.58	0.95	0.86	1.58	1.97	0.75
2003-04	1.53	1.01	1.22	0.81	0.35	-0.38	0.66	-0.08
2004-05	0.65	0.81	0.22	0.67	0.23	1.61	3.38	2.41
2005-06	1.22	1.55	0.89	1.12	0.81	1.36	1.16	1.02
2006-07	1.07	1.04	-0.03	0.43	0.56	1.44	1.96	0.86
2007-08	0.57	0.06	-0.24	0.43	0.45	1.31	-0.68	2.63
2008-09	0.93	0.52	0.73	0.45	0.72	1.48	2.12	4.77
2009-10	1.91	1.23	0.92	0.51	0.91	1.20	2.52	0.89
2010-11	1.50	0.44	-0.27	0.04	0.44	0.81	1.68	-0.11
2011-12	1.59	0.10	0.59	0.50	0.56	0.63	1.00	-0.60
2012-13	1.35	0.91	0.79	0.33	0.80	0.33	0.82	1.41
2013-14	1.03	0.26	0.61	0.37	-0.05	-0.31	0.71	0.54
2014-15	1.28	1.38	0.74	-0.38	1.04	0.48	0.93	1.23
2015-16	0.74	0.72	-0.09	0.51	0.81	-0.12	0.28	-0.41
2016-17	1.10	1.38	0.47	2.03	0.85	0.81	1.12	2.15
2017-18	1.07	0.83	0.42	0.45	-0.25	1.33	1.15	1.87

7 Distribution and abundance of redfish

Earlier reports from this survey has presented distribution maps and abundance indices based on acoustic observations of redfish. In recent years, blue whiting has dominated the acoustic records in some of the main redfish areas. Due to incomplete pelagic trawl sampling the splitting of acoustic records between blue whiting and redfish has been very uncertain. The uncertainty relates mainly to the redfish, since it only makes up a minor proportion of the total value. This has been the case since the 2003 survey, and the acoustic results for redfish are therefore not included in the reports.

7.1 Golden redfish (*Sebastes norvegicus)*

Figure 7.1 shows the geographical distribution of golden redfish based on the catch rates in bottom trawl. In most years, the distribution is completely covered except towards northwest. Golden redfish was found in the extended survey area in 2014-2018, mainly west of Spitsbergen (strata 24). On average over all size groups about 20% of the amount found in the standard survey area by numbers was found in the extended area in 2018 (Table 7.1). Table 7.2 presents the time series (1994-2018) of swept area indices by 5 cm length groups for the standard area. The indices have remained low since 1999 for all length groups. This indicates that about the twenty last year classes are very weak. However, in 2016 and 2017 there was an increase in the indices of fish above 25 cm and the total index was the highest since 1998. In 2018 the total index was at the same level as in 2017, while the total biomass was slightly lower. Table 7.3 present swept area abundance indices by length groups for new strata 24-26 in 2014-2018.

Table 7.4 presents estimates of coefficients of variation (%) by length groups. A CV of 20% or less could be viewed as acceptable in a traditional stock assessment approach if the indices are unbiased (conditional on a catchability model). Values above this indicate a highly uncertain index with little information regarding year class strength. In most years, CVs for most length groups are above what could be considered as acceptable.

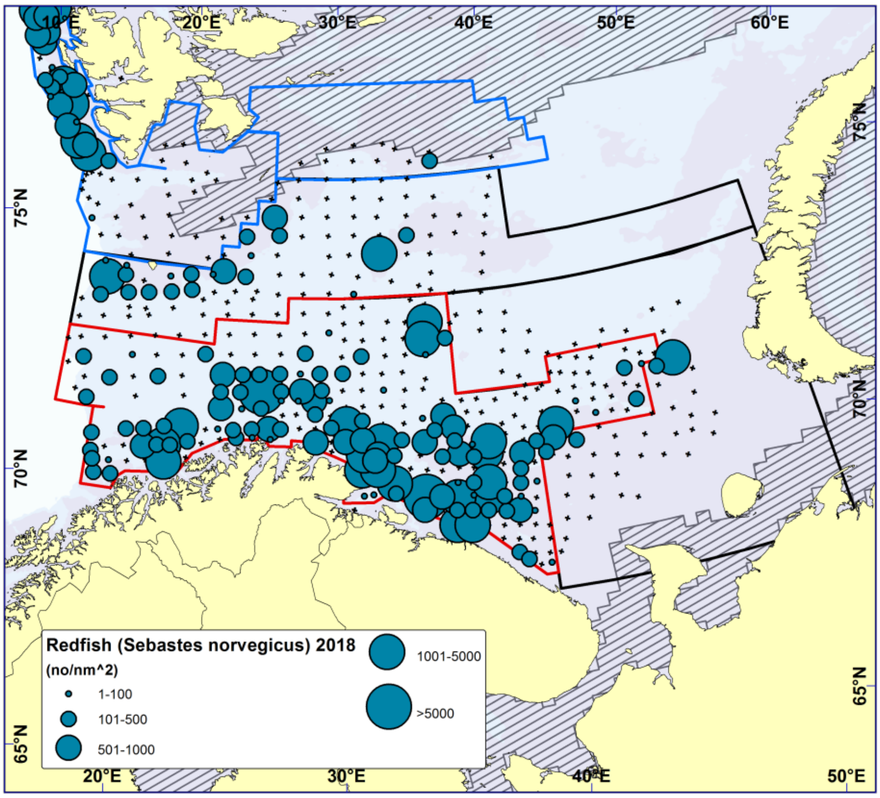

Figure 7.1. GOLDEN REDFISH (*Sebastes norvegicus)*. Distribution in the trawl catches winter 2018 (number per nm^2). Black crosses indicate zero catches.

Table 7.1. GOLDEN REDFISH (*Sebastes norvegicus)*. Abundance indices from bottom trawl hauls for main areas of the Barents Sea winter 2018 (numbers in thousands).

	Length group (cm)													Biomass
Year	**5-9**	**10-14**	**15-19**	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**50-54**	**55-59**	**>60**	**Total**	**(tons)**
A	0	77	37	38	332	792	1606	1529	467	535	306	140	5859	6716
B	0	54	0	0	126	287	885	668	387	301	0	76	2784	3353
C	0	52	26	0	77	148	331	280	125	200	101	24	1364	1657
D	819	1525	989	735	1475	2347	2781	1686	1002	564	253	58	14234	9183
D'	310	675	525	488	286	190	190	0	0	0	0	0	2665	437
E	0	111	0	167	170	445	111	0	0	0	56	0	1060	523
S	0	255	222	249	817	483	430	161	32	30	0	0	2678	1003
ABCD	819	1708	1052	773	2010	3574	5603	4163	1981	1600	660	298	24241	20908
AS	1129	2750	1799	1678	3282	4693	6335	4323	2012	1630	715	299	30645	22871
N	58	824	750	647	639	964	1855	546	50	0	0	0	6331	2598
Total	1187	3574	2549	2325	3921	5657	8190	4869	2062	1630	715	299	36976	25469

Table 7.2. GOLDEN REDFISH (S*ebastes norvegicus)*. Abundance indices (numbers in thousands) from bottom trawl surveys in the Barents Sea standard area winter 1994-2018.

	Length group (cm)													Biomass
Year	**5-9**	**10-14**	**15-19**	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**50-54**	**55-59**	**≥60**	**Total**	**(tons)**
1994	675	7493	10100	12840	10914	17834	10065	4799	1645	937	202	121	77623	31841
1995	387	4658	13515	13118	10398	15429	16223	10587	3112	852	455	148	88883	42151
1996	40	715	3291	5983	8863	14089	15709	7502	2692	893	168	165	60010	35775
1997[1]	0	500	1197	2809	6522	22751	28797	8235	1747	1092	239	97	73985	44977
1998[1]	51	4525	2043	10795	73085	30862	14707	6984	1712	456	142	0	145363	49253
1999	181	928	2070	4002	4351	6275	6143	5474	2618	738	75	0	32854	20330
2000	533	1122	1506	4196	4895	5146	3611	1908	620	466	89	0	24092	10946
2001	55	411	398	2452	5802	5463	4509	3239	1154	343	96	37	23960	13896
2002	133	1053	2043	1854	3955	4204	3335	3654	1656	619	192	28	22726	13242
2003	0	478	1303	1538	4192	4081	2765	3204	1996	548	123	327	20554	13399
2004	700	195	420	973	2842	4365	5404	3858	2281	562	140	45	21786	15758
2005	0	119	203	362	1110	2090	3849	4664	2730	1276	299	128	16831	16389
2006[2]	0	0	0	178	2495	5534	6307	4155	3179	950	124	12	22934	18790
2007[1]	0	97	453	214	772	1526	2823	4275	2742	1194	197	58	14351	14553
2008	1736	2540	201	171	440	710	1969	2547	3049	1231	157	19	14768	12647
2009	0	0	86	0	39	436	1745	3779	4200	1959	267	101	12728	17237
2010	372	2017	1168	527	136	60	833	1062	2073	1596	205	128	10175	9787
2011	342	3187	2068	288	402	125	274	2329	3030	1912	131	243	14332	13302
2012[3]	805	4375	3995	1835	550	316	881	3645	4083	1775	320	85	22664	16011
2013	75	7418	4896	3952	1550	355	878	821	1284	1594	384	451	23658	11456
2014	128	1043	1440	3005	3363	1023	507	1427	2139	1176	633	193	16077	12087
2015	139	881	1467	3019	2603	2013	458	720	1237	1216	874	82	14710	10120
2016	748	1291	1484	2396	4290	3673	3391	1658	2147	2307	1114	250	24749	19847
2017[3]	341	1304	898	1065	4462	9060	6661	2980	2087	1776	604	498	31735	25050
2018	1129	2750	1799	1678	3282	4693	6335	4323	2012	1630	715	299	30645	22871

[1] Indices raised to also represent the Russian EEZ
[2] Not complete coverage in southeast due to restrictions, strata 7 area set to default and strata 13 as in 2005
[3] Indices not raised to also represent uncovered parts of the Russian EEZ.

Table 7.3. GOLDEN REDFISH (S*ebastes norvegicus)*. Abundance indices (numbers in thousands) for new strata 24-26 from bottom trawl surveys in the Barents Sea winter 2014-2018.

	Length group (cm)									Biomass
Year	**5-9**	**10-14**	**15-19**	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**>45**	**Total**	**(tons)**
2014	35	333	358	1440	2594	1315	211	501	379	7166	2913
2015	0	202	197	127	804	804	363	0	154	2651	1261
2016	0	0	103	300	597	1186	828	107	32	3151	1405
2017	0	66	93	587	519	679	547	96	66	2654	1053
2018	58	824	750	647	639	964	1855	546	50	6331	2598

Table 7.4. GOLDEN REDFISH (S*ebastes norvegicus)*. Estimates of coefficients of variation (%) for swept area abundance indices. Barents Sea standard area winter 1994-2018.

	Length group (cm)										
Year	**5-9**	**10-14**	**15-19**	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**50-54**	**55-59**
1994	51	42	22	27	18	34	13	29	20	23	40
1995	47	39	38	31	16	33	31	33	21	22	34
1996	68	51	47	25	16	27	25	20	16	24	46
1997[1]	-	40	30	28	20	64	71	37	14	19	34
1998[1]	67	28	25	56	82	64	48	42	27	28	44
1999	62	38	37	35	33	25	33	59	57	29	70
2000	46	27	21	24	22	28	28	26	22	21	56
2001	53	28	31	24	31	27	38	50	29	26	45
2002	54	61	51	25	29	23	28	39	49	26	41
2003	-	29	34	34	27	23	16	20	27	36	70
2004	72	38	26	32	35	54	52	26	30	22	54
2005	-	73	46	32	20	25	31	22	23	34	65
2006[2]	-	-	-	46	46	45	37	30	22	18	43
2007[1]	-	69	61	56	31	21	23	27	23	17	32
2008	33	30	41	60	42	27	22	23	17	24	64
2009	-	-	69	-	73	31	30	24	23	24	29
2010	54	31	45	51	41	70	31	34	17	19	31
2011	45	37	23	48	30	55	40	66	44	33	48
2012[2]	38	41	21	21	35	40	28	40	45	29	43
2013	55	40	27	17	22	45	38	39	38	27	44
2014	61	35	31	22	21	26	37	35	28	26	26
2015	64	44	33	29	26	24	30	36	27	18	37
2016	50	28	22	24	26	25	19	23	28	20	29
2017[2]	100	40	45	31	33	71	40	32	31	41	30
2018	37	24	19	25	20	17	22	19	23	21	24

[1] REZ not covered

[2] REZ partly covered

7.2 Beaked redfish (*Sebastes mentella)*

The coverage of beaked redfish (Figure 7.2) was not complete west and north of Spitsbergen. About 10% of the amount found in the standard survey area by numbers was found in the extended survey area in 2018 (Table 7.5), which is less than what was found for golden redfish. Table 7.6 presents the time series (1994-2018) of swept area abundance indices by 5 cm length group in the standard area, while table 7.7 present indices for new strata 24-26 in 2014-2018. In 2015 and 2016, the estimated indices for 20-39 cm beaked redfish were among the highest in the time series, and in 2017 the indices for 30-39 cm beaked redfish were the highest in the time series, as were the total index and total biomass. The indices for most length groups decreased somewhat from 2017 to 2018.

Table 7.8 presents estimates of coefficients of variation (%) by length groups. A CV of 20% or less could be viewed as acceptable in a traditional stock assessment approach if the indices are unbiased (conditional on a catchability model). Values above this indicate a highly uncertain index with little information regarding year class strength. In most years, CVs for length groups between 10 and 29 cm are at a level that could be considered as acceptable, and in most recent years up to 44 cm.

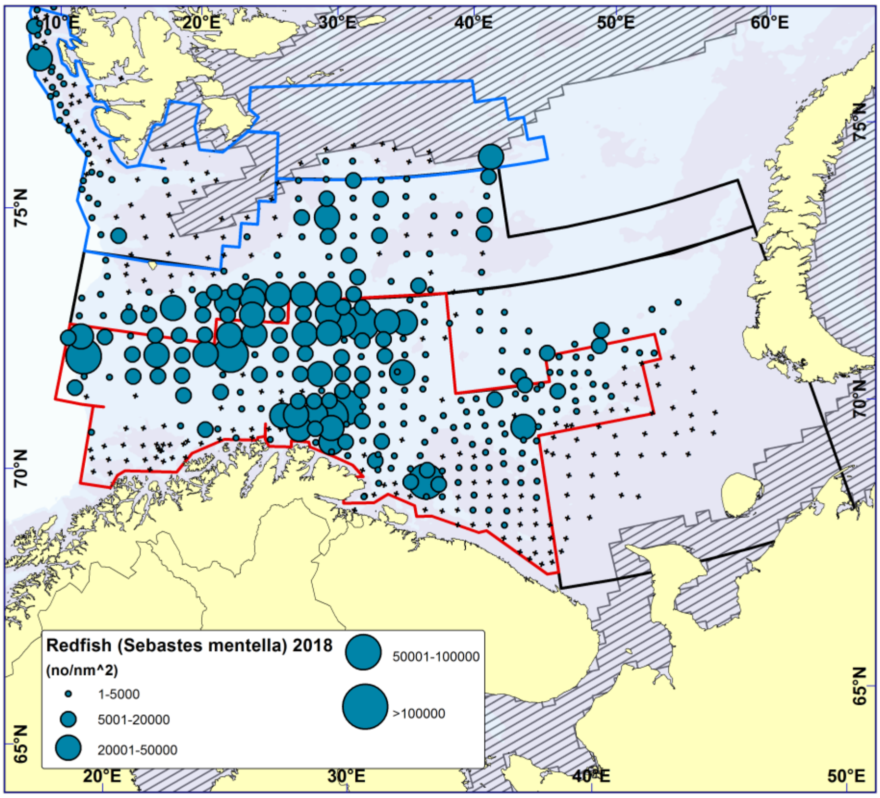

Figure 7.2. BEAKED REDFISH (*Sebastes mentella)*. Distribution in the trawl catches winter 2018 (number per nm^2). Black crosses indicate zero catches.

Table 7.5. BEAKED REDFISH (*Sebastes mentella*)[1]. Abundance indices from bottom trawl hauls for main areas of the Barents Sea winter 2018 (numbers in millions).

	Length group (cm)										Biomass
Year	**5-9**	**10-14**	**15-19**	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**>45**	**Total**	**('000 t)**
A	34.8	41.9	16.8	27.0	57.9	139.7	127.0	13.7	0.13	458.9	175.7
B	7.94	4.28	0.08	0.12	0.50	1.41	2.61	0.75	0.17	17.9	3.4
C	25.7	18.1	4.0	2.60	13.3	35.5	15.2	2.70	0.61	117.7	33.4
D	68.1	80.1	33.1	38.5	37.7	37.3	20.5	1.23	0.23	316.8	46.5
D'	9.52	25.1	9.21	6.72	1.41	0	0	0	0	51.9	2.4
E	33.5	63.1	9.05	6.39	8.43	5.65	2.02	0.25	0	128.4	8.3
S	10.4	20.7	10.9	28.7	72.0	50.9	49.3	3.92	0	247.0	78.9
ABCD	136.5	144.4	54.0	68.3	109.5	213.8	165.3	18.4	1.13	911.2	259.0
AS	189.9	253.3	83.2	110.1	191.3	270.4	216.6	22.6	1.14	1338.5	348.6
N	47.9	74.0	2.33	1.76	4.58	5.91	5.83	0.63	0	143.0	8.6
Total	237.9	327.3	85.5	111.9	195.9	276.3	222.4	23.2	1.14	1481.5	357.2

[1] Includes unidentified *Sebastes* specimens, mostly less than 10cm

Table 7.6. BEAKED REDFISH *(Sebastes mentella)*[1]. Abundance indices (numbers in millions) from bottom trawl surveys in the Barents Sea standard area winter 1994-2018.

Year	Length group (cm)									Total	Biomass
	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	≥45		('000 t)
1994	8.3	295.7	479.4	488.4	74.4	74.4	17.1	2.6	0.1	1440.4	161.2
1995	310.1	83.9	570.6	390.5	82.7	57.7	23.9	2.8	0.4	1522.5	153.0
1996	214.6	101.5	198.5	342.9	136.0	42.0	16.6	1.4	0.2	1053.8	127.9
1997[2]	64.6	118.45	22.0	242.4	258.2	70.2	39.1	4.4	0.1	819.4	165.3
1998[2]	1.0	88.0	62.4	101.4	203.2	40.0	12.9	1.7	0.2	510.7	96.1
1999	2.1	6.8	69.5	36.8	171.2	73.9	21.8	3.2	0.7	385.4	98.8
2000	9.2	12.9	40.2	78.0	142.2	94.8	24.5	7.0	1.5	410.3	111.5
2001	9.8	23.1	7.2	56.8	78.8	74.7	9.6	0.6	0.1	260.8	65.3
2002	16.5	7.5	19.3	36.5	96.2	116.7	23.9	1.4	0.03	318.1	90.2
2003	3.8	4.1	10.3	12.6	70.4	198.1	45.9	5.7	0.3	351.1	139.4
2004	2.2	3.0	6.9	18.5	32.8	86.3	31.6	1.9	0.8	183.4	68.4
2005	0	6.3	7.4	10.7	28.4	153.7	86.2	3.8	0.2	296.6	131.3
2006[3]	100.0	1.9	9.6	14.6	22.8	103.8	82.8	2.7	0.7	338.8	108.2
2007[2]	374.2	121.8	2.8	6.7	12.3	121.0	120.7	7.1	0	766.7	136.6
2008	858.2	359.1	26.8	4.6	11.5	103.6	165.4	4.7	0.1	1533.9	169.3
2009	95.3	324.7	135.5	5.4	8.8	67.1	162.6	5.8	0.4	805.7	155.1
2010	652.2	276.0	214.7	64.2	7.1	73.6	191.3	5.9	0.4	1485.4	198.1
2011	501.6	229.7	212.5	149.0	14.1	46.6	157.3	4.9	0.2	1315.8	177.8
2012[4]	129.4	280.1	86.4	125.3	47.3	14.4	153.9	17.7	0.2	854.7	170.7
2013	249.6	226.6	245.4	159.2	143.2	35.2	193.3	27.1	0.3	1279.8	242.2
2014	90.7	175.3	250.1	113.7	124.6	50.6	115.1	13.8	0.2	934.1	170.2
2015	175.2	110.7	216.2	302.2	289.8	214.8	170.9	18.1	0.2	1498.0	344.6
2016	615.1	105.3	148.6	331.5	213.1	162.7	123.6	14.1	0.6	1714.6	262.5
2017[5]	603.6	201.9	70.4	198.5	286.9	308.9	231.5	10.6	0.23	1914.9	403.9
2018	189.9	253.3	83.2	110.1	191.3	270.4	216.6	22.6	1.14	1338.5	348.6

[1] Includes unidentified *Sebastes* specimens, mostly less than 10cm
[2] Indices raised to also represent the Russian EEZ
[3] Not complete coverage in southeast due to restrictions, strata 7 area set to default and strata 13 as in 2005
[4] Indices not raised to represent uncovered parts of the Russian EEZ
[5] Indices raised to also represent uncovered parts of the Russian EEZ

Table 7.7. BEAKED REDFISH (*Sebastes mentella)*[1]. Abundance indices (numbers in millions) for new strata 24-26 from bottom trawl surveys in the Barents Sea winter 2014-2018.

Year	Length group (cm)									Total	Biomass
	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	>45		('000 t)
2014	19.6	9.19	11.5	6.80	5.43	1.67	2.31	0.36	0	56.9	5.5
2015	13.5	5.51	8.27	11.3	11.4	5.23	3.43	0.12	0.03	58.9	9.4
2016	54.6	3.10	2.17	4.48	4.82	4.15	1.42	0.34	0	75.0	4.5
2017	81.9	13.1	1.32	4.45	6.01	6.44	3.59	0.60	0.03	117.4	7.8
2018	47.9	74.0	2.33	1.76	4.58	5.91	5.83	0.63	0	143.0	8.6

[1] Includes unidentified *Sebastes* specimens, mostly less than 10cm

Table 7.8. BEAKED REDFISH (*Sebastes mentella*)[1]. Estimates of coefficients of variation (%) for swept area abundance indices. Barents Sea standard area winter 1994-2018.

	Length group (cm)								
Year	**5-9**	**10-14**	**15-19**	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**
1994	40	14	25	28	20	23	26	49	53
1995	18	25	23	25	17	20	18	34	39
1996	18	23	27	22	19	36	23	37	58
1997[2]	18	15	13	11	14	17	26	53	53
1998[2]	28	16	21	14	17	16	21	31	77
1999	20	17	15	11	18	22	29	56	65
2000	16	12	17	12	16	21	31	64	76
2001	17	14	14	12	13	19	17	26	67
2002	57	13	15	18	16	21	19	31	65
2003	56	17	18	17	18	27	27	43	88
2004	19	15	15	19	16	14	18	21	59
2005	-	23	15	16	16	17	21	38	40
2006[3]	11	49	25	28	18	17	16	24	85
2007[2]	15	23	18	13	15	24	19	41	59
2008	14	15	29	23	20	23	22	24	45
2009	13	10	18	22	40	28	22	24	46
2010	14	12	12	18	22	31	31	22	80
2011	10	12	10	15	16	32	25	27	56
2012[3]	16	12	13	11	21	32	37	54	44
2013	15	15	35	23	32	29	39	41	49
2014	10	12	11	15	21	22	30	27	48
2015	14	11	14	18	26	22	19	29	52
2016	10	11	13	20	16	16	18	18	58
2017[3]	10	16	16	14	17	16	16	15	97
2018	8	9	11	14	11	14	17	21	33

[1] Includes unidentified *Sebastes* specimens, mostly less than 10cm

[2] REZ not covered

[3] REZ partly covered

7.3 Norway redfish (*Sebastes viviparus)*

Figure 7.3 shows the geographical distribution of Norway redfish and Table 7.9 presents the time series (1994-2018) of swept area indices by 5 cm length groups in the standard area. Almost all Norway redfish are found in areas ABCD, mainly in main area B, and almost nothing in the extended survey area (Table 7.10). A few large catches often drive the indices. There was a large and unexplained increase in the indices of most length groups from 2013 to 2014 and 2015 to among the highest levels in the time series. In 2016 and 2017 the indices for most length groups were somewhat lower, while in 2018 there was a new increase for most length groups and the total index was the highest in time series.

Table 7.11 presents estimates of coefficients of variation (%) by length groups. A CV of 20% or less could be viewed as acceptable in a traditional stock assessment approach if the indices are unbiased (conditional on a catchability model). Values above this indicate a highly uncertain index with little information regarding year class strength. In most years, CVs for most length groups are far above what could be considered as acceptable.

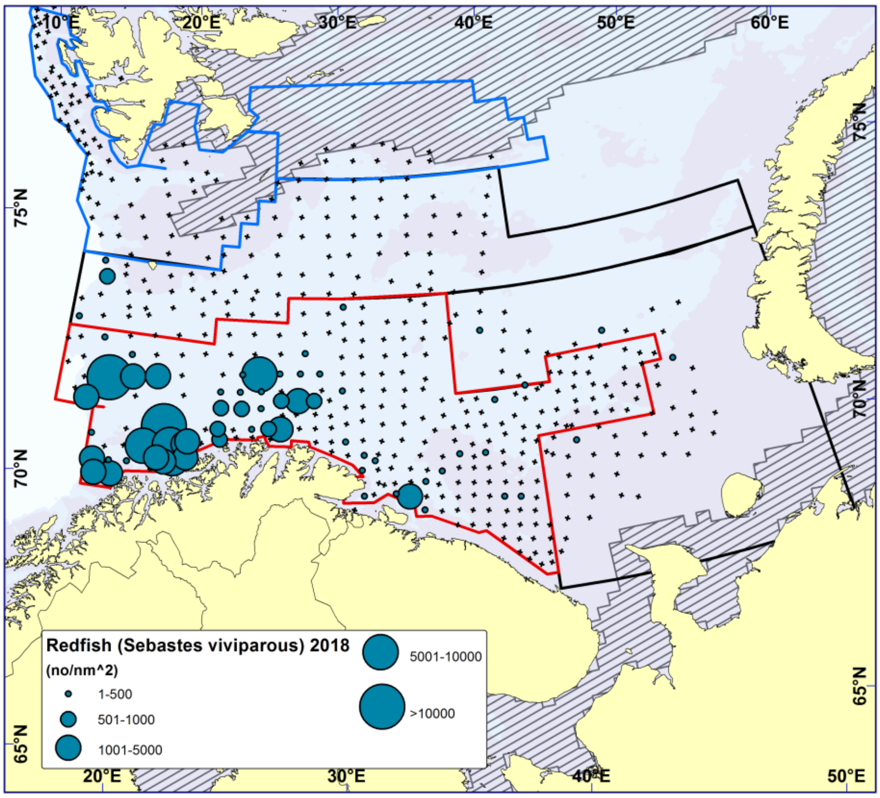

Figure 7.3. NORWAY REDFISH (*Sebastes viviparus*). Distribution in the trawl catches winter 2018 (number per nm^2). Black crosses indicate zero catches.

Table 7.9. NORWAY REDFISH *(Sebastes viviparus)*. Abundance indices (numbers in thousands) from bottom trawl surveys in the Barents Sea standard area winter 1994-2018.

Year	Length group (cm)						Total
	5-9	10-14	15-19	20-24	25-29	≥30	
1994	75355	94809	17218	12818	1377	279	201857
1995	10716	68713	22737	9349	3306	503	115325
1996	439	45798	43673	35921	5498	87	131417
1997[1]	898	24202	28857	18768	4397	0	77122
1998[1]	703	9835	42183	20801	2939	91	76102
1999	1577	10134	11675	2921	707	35	27049
2000	1011	5127	37429	22122	2118	140	67947
2001	249	2243	30082	34405	3802	120	70901
2002	332	3345	17674	15168	1276	88	37884
2003	234	4306	22603	31019	4277	181	62619
2004	102	1794	24462	32769	3294	291	62712
2005	172	1582	16444	37360	6153	356	62068
2006[2]	819	4480	3653	10381	2244	205	21782
2007[1]	704	5238	15652	34395	2448	80	58517
2008	0	1882	5910	21022	4561	30	33344
2009	506	528	3096	11032	3405	419	18988
2010	1712	455	10134	53181	7572	22	73076
2011	533	1250	2169	7758	2197	106	14013
2012[1]	586	3950	4080	29157	6212	74	44059
2013	1211	9522	3302	23464	8545	100	46144
2014	11388	17755	21079	64094	15135	1990	131441
2015	7384	27351	30768	65870	9048	88	140509
2016	2795	26824	18396	29229	11286	933	89464
2017[1]	3848	58422	21556	22580	5685	426	112518
2018	700	24371	61515	37470	26283	1344	151763

[1] Indices not raised to represent the Russian EEZ or uncovered parts, *Sebastes viviparus* is mainly found in NEZ
[2] Not complete coverage in southeast due to restrictions, strata 7 area set to default and strata 13 as in 2005

Table 7.10. NORWAY REDFISH (*Sebastes viviparus)*. Abundance indices (numbers in thousands) for new strata 24-26 from bottom trawl surveys in the Barents Sea winter 2014-2018).

Year	Length group (cm)						Total
	5-9	10-14	15-19	20-24	25-29	≥30	
2014	0	87	44	0	0	0	131
2015	0	0	35	0	0	0	35
2016	0	0	111	0	0	0	111
2017	0	0	0	0	0	0	0
2018	0	0	160	126	32	0	318

Table 7.11. NORWAY REDFISH (*Sebastes viviparous)*. Estimates of coefficients of variation (%) for swept area abundance indices. Barents Sea standard area winter 1994-2018.

	Length group (cm)					
Year	**5-9**	**10-14**	**15-19**	**20-24**	**25-29**	**30-34**
1994	34	52	25	39	41	70
1995	42	31	43	34	70	89
1996	62	24	31	36	51	57
1997[1]	84	31	27	48	56	-
1998[1]	39	20	43	68	71	79
1999	78	58	32	25	37	65
2000	52	29	47	48	41	51
2001	39	26	31	30	34	85
2002	61	34	20	23	46	83
2003	73	34	35	30	31	76
2004	57	36	38	35	24	66
2005	69	35	40	31	34	69
2006[2]	75	75	25	30	21	58
2007[1]	75	78	39	39	29	87
2008	-	58	32	28	42	73
2009	61	48	25	24	27	61
2010	47	42	47	52	57	97
2011	51	59	50	48	45	75
2012[2]	45	30	48	45	43	100
2013	58	32	25	41	51	98
2014	43	36	40	40	41	79
2015	38	32	34	43	53	100
2016	37	28	29	28	23	46
2017[2]	46	62	23	30	27	52
2018	46	46	47	54	40	60

[1] REZ not covered

[2] REZ partly covered

8 Distribution and abundance of Greenland halibut

Figure 8.1 shows the distribution of bottom trawl catch rates of Greenland halibut. The most important distribution areas for the adult fish (depths between 500 and 1000 m along the western slope), are not covered by the survey. The observed distribution pattern in 2018 was similar to those observed in previous years' surveys. Greenland halibut was also found in the extended survey area in 2014-2018 (Tables 8.1). In 2018, a higher number of fish less than 40 cm was found in the extended area than in the standard area (strata 1-23). On average over all size groups about 40% of the amount found in the standard survey area by numbers was found in the extended area, which is more than two times higher than last year.

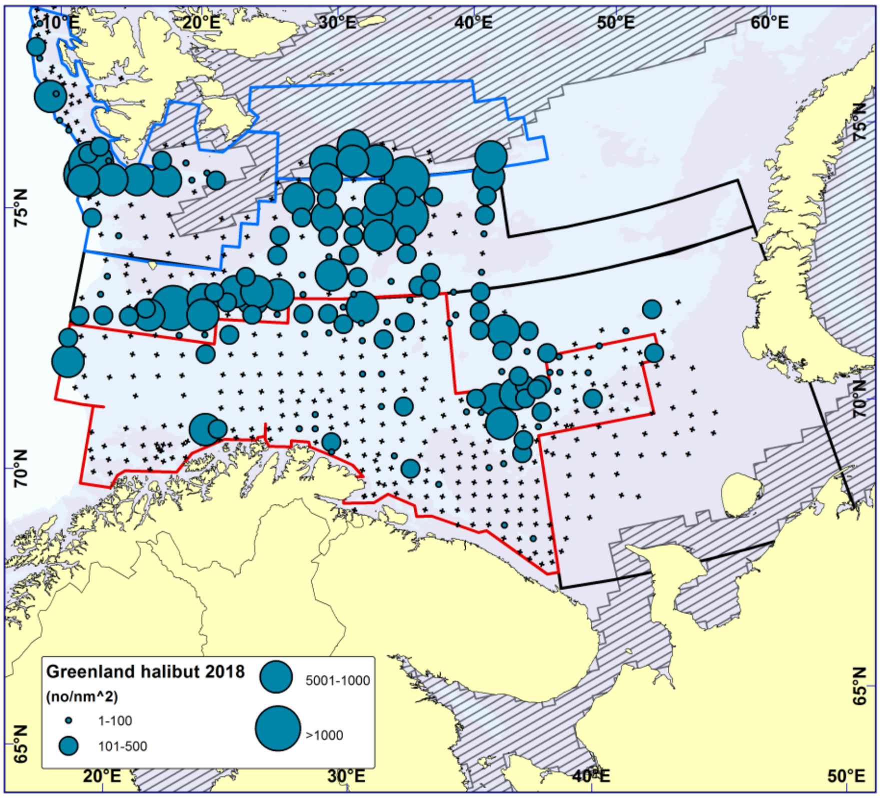

Figure 8.1 GREENLAND HALIBUT. Distribution in the trawl catches winter 2018 (number per nm^2). Black crosses indicate zero catches.

The time series (1994-2018) of swept area abundance indices by 5 cm length groups in the standard area is presented in Table 8.2. Abundance indices have been low in the whole period, with few signs of improved recruitment in the covered area. However, recruitment from more northern areas has led to an increase in abundance indices of length groups above 30 cm since about 2005. There was a large increase in the indices of most length groups between 30 and 79 cm from 2014 to 2015, and the total index was the highest in the time series back to 1990. In 2016, the indices of length groups between 25 and 44 cm showed an increase, while the indices of fish between 45 and 69 cm were lower than in 2015. The indices for most length groups decreased from 2016 to 2017 and the total index was the second lowest since 2004. In 2018 the indices were quite like those from 2017 but on average slightly lower, and the total index was the lowest since 2004.

Table 8.4 presents estimates of coefficients of variation (%) for length groups. Estimates are based on a stratified bootstrap approach with 500 replicates (with trawl stations being primary sampling unit). A CV of 20% or less could be viewed as acceptable in a traditional stock assessment approach if the indices are unbiased (conditional on a catchability model). Values above this indicate a highly uncertain index with little information regarding year class strength. In most years, only CVs for length groups between 40 and 59 cm are at a level that could be considered as acceptable.

Table 8.1. GREENLAND HALIBUT. Abundance indices from bottom trawl hauls for main areas of the Barents Sea winter 2018 (numbers in thousands).

Area	Length group (cm)																Biomass (tons)
	≤14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	≥ 80	Total	
A	0	0	0	0	0	71	150	144	442	443	0	71	224	0	0	1544	2399
B	0	0	0	0	0	0	0	0	60	42	22	62	20	0	20	226	593
C	0	0	0	0	0	0	0	0	48	53	0	0	30	0	0	130	275
D	0	0	0	0	45	172	124	248	491	673	509	314	124	0	0	2701	4725
D'	0	0	0	0	0	0	217	605	605	738	487	479	0	163	0	3294	5749
E	0	0	62	0	171	626	889	1224	1142	418	422	263	283	0	0	5499	7381
S	0	0	0	0	168	465	668	1223	1469	1207	465	177	55	33	0	5930	7566
ABCD	0	0	0	0	45	243	274	392	1041	1211	531	447	398	0	20	4601	7992
AS	0	0	62	-	383	1333	2049	3445	4258	3573	1904	1366	736	196	20	19325	28688
N	136	28	0	434	775	1840	1099	1042	776	634	360	511	0	0	0	7636	7528
Total	136	28	62	434	1159	3174	3147	4486	5033	4208	2265	1877	736	196	20	26960	36216

Table 8.2. GREENLAND HALIBUT. Abundance indices (numbers in thousands) from bottom trawl surveys in the Barents Sea standard area winter 1994-2018.

	Length group (cm)																Biomass
Year	**≤14**	**15-19**	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**50-54**	**55-59**	**60-64**	**65-69**	**70-74**	**75-79**	**≥ 80**	**Total**	**(tons)**
1994	0	0	21	76	148	1117	3139	4740	3615	1941	889	541	21	0	0	16248	19228
1995	298	0	0	0	90	129	2877	7182	5739	2027	1622	839	489	86	0	21378	27459
1996	4121	0	0	0	62	124	1214	4086	4634	1871	1112	638	337	74	12	18285	20256
1997[1]	0	68	0	0	55	163	949	4313	5629	2912	1609	643	300	65	21	16728	24214
1998[1]	68	220	945	578	481	487	1088	4016	6591	3076	1798	707	326	93	44	20518	27248
1999	43	84	241	436	566	269	784	1701	3097	1669	1094	491	89	75	0	10640	14681
2000	140	184	344	836	1722	3857	2253	1560	2144	1714	1191	615	249	76	0	16883	17246
2001	68	49	147	179	737	1525	3716	3271	2302	2010	1088	529	160	50	39	15871	18224
2002	271	0	70	34	382	1015	1916	3803	3250	2279	1138	976	242	159	114	15648	21198
2003	51	0	74	19	304	715	1842	3008	4765	2235	714	561	245	146	0	14678	19635
2004	106	104	15	0	319	1253	1229	1717	2277	1227	798	298	148	94	26	9615	11872
2005	263	70	159	1139	2235	2621	4206	3782	3847	2037	917	585	336	118	0	22314	22293
2006[2]	0	72	94	414	1968	5149	4613	5743	4283	2132	891	449	258	34	18	26118	25579
2007[1]	0	18	146	1869	1418	3114	5710	5947	4287	2205	963	658	391	80	89	26896	28006
2008	0	0	0	243	1708	5974	4654	6136	5198	3403	827	638	174	82	50	29088	30153
2009	55	0	0	26	1044	4327	8133	4551	4084	2266	996	627	442	253	154	26960	28919
2010	0	0	0	99	678	3648	5729	6560	4897	2467	1064	552	229	128	41	26092	25979
2011	51	0	0	0	216	4396	5864	5498	5237	3698	699	936	327	252	97	27271	31552
2012[3]	77	0	0	0	51	1145	4524	5366	4517	2774	1147	195	73	0	48	19917	22656
2013	0	0	0	0	0	511	5368	4868	5374	3687	1944	939	348	313	154	23504	31748
2014	0	0	46	92	156	368	2271	5587	5903	3555	2251	1369	154	260	79	22090	31112
2015	367	0	61	0	284	1612	3187	6452	7249	6752	3350	1936	587	334	0	32172	46828
2016	205	0	124	511	950	1953	3486	4539	5479	5613	1999	1973	646	98	80	27657	35831
2017[4]	52	0	0	78	592	1328	1885	3850	4852	4550	1721	1455	317	190	23	20827	29756
2018	0	0	62	-	383	1333	2049	3445	4258	3573	1904	1366	736	196	20	19325	28688

[1] Indices raised to also represent the Russian EEZ
[2] Not complete coverage in southeast due to restrictions, strata 7 area set to default and strata 13 as in 2005
[3] Indices not raised to also represent uncovered parts of the Russian EEZ.
[4] Indices raised to also represent uncovered parts of the Russian EEZ

Table 8.3. GREENLAND HALIBUT. Abundance indices (numbers in thousands) for new strata 24-26 from bottom trawl surveys in the Barents Sea winter 2014-2018.

Year	Length group (cm)															Biomass (tons)
	≤14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	≥ 80	Total	
2014	0	134	141	0	138	453	1350	1443	1351	293	803	39	117	0	0	6261	7366
2015	0	0	0	269	30	263	550	863	597	567	555	66	107	38	0	3903	5092
2016	678	933	607	436	336	431	331	728	340	254	68	34	140	0	34	5349	3059
2017	31	0	0	193	583	861	662	456	301	33	298	30	0	34	0	3485	2990
2018	136	28	0	434	775	1840	1099	1042	776	634	360	511	0	0	0	7636	7528

Table 8.4. GREENLAND HALIBUT. Estimates of coefficients of variation (%) for swept area abundance indices. Barents Sea standard area winter 1994-2018.

Year	Length group (cm)														
	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84
1994	0	0	105	57	46	28	17	20	17	15	20	26	97	-	-
1995	91	-	-	-	71	40	18	22	25	24	27	41	63	94	-
1996	33	-	-	-	69	45	22	25	18	19	36	29	40	58	-
1997[1]	-	53	-	-	82	48	26	23	18	16	16	24	28	73	101
1998[1]	66	53	26	44	42	18	22	23	28	26	28	31	33	50	101
1999	91	54	53	26	32	31	24	21	18	16	18	25	52	51	-
2000	71	66	72	83	56	58	41	20	22	23	21	36	45	54	-
2001	92	99	85	47	40	48	44	46	37	14	17	34	43	56	-
2002	71	-	70	104	29	27	17	13	16	16	14	27	24	37	55
2003	66	-	63	95	30	27	20	44	34	32	44	28	38	37	-
2004	78	59	97	-	26	17	16	16	17	17	15	29	39	46	92
2005	66	70	37	46	33	15	19	17	16	20	25	24	28	64	-
2006[2]	-	81	81	67	32	18	18	11	11	16	22	22	30	67	-
2007[1]	-	99	52	23	20	13	12	12	14	14	24	37	26	44	99
2008	-	-	-	36	20	21	15	14	18	14	22	20	43	56	68
2009	98	-	-	103	23	14	16	16	19	18	17	21	26	46	53
2010	-	-	-	57	26	18	13	12	14	18	19	23	45	57	101
2011	66	-	-	-	43	18	15	14	17	14	25	26	33	46	70
2012[2]	93	-	-	-	100	23	13	14	14	11	24	70	72	-	-
2013	-	-	-	-	-	44	39	12	16	20	19	33	50	50	-
2014	-	-	99	68	68	37	20	14	20	18	18	24	53	51	72
2015	83	-	99	-	49	24	22	15	13	18	34	37	33	46	-
2016	-	-	101	50	43	31	21	34	26	31	16	20	36	70	98
2017[2]	102	-	-	72	42	25	23	13	14	17	21	26	45	65	95
2018	-	-	107	-	51	24	15	18	18	15	17	23	32	54	93

[1] REZ not covered [2] REZ partly covered**.**

9 Distribution and abundance of capelin, polar cod and blue whiting

9.1 Capelin

Although capelin is primarily a pelagic species, small amounts of capelin are normally caught in the bottom trawl throughout most of the investigated area. In Figure 9.1 catch rates of capelin smaller and larger than 14 cm are shown for the winter survey in 2018. Capelin smaller than 14 cm during this period will mainly comprise the immature stock component, while the larger capelin constitutes the prespawning capelin stock. Some few trawl hauls show large capelin catches (numbers exceeding 100 000 individuals) and these can probably not be considered representative for the density in the area, because such hauls will either result from hitting a capelin school at the bottom or up in the water column. For this reason, we chose not to present swept-area based indices for capelin in this report.

At this time of the year, mature capelin has started their approach to the spawning areas along the coast of Troms, Finnmark and the Kola peninsula, while immature capelin will normally be found further north and east, in the wintering areas. This is reflected on the maps of capelin distribution, even though some large capelin is always found north of 75°N, and smaller capelin are found sporadically in near-coastal areas. The geographical coverage of the total capelin stock is incomplete, but the maturing component is probably best covered. In 2018 more capelin > 14 cm was caught along the Murman and Troms-Finnmark coast than in 2017.

It has been noted during several surveys that when sampling capelin from demersal and pelagic trawls, the individuals from demersal trawls are normally larger (and older) than those sampled pelagically. This has led to formation of a hypothesis saying that larger individuals tend to stay deeper than smaller individuals and some even to take up a demersal life. This hypothesis has not been tested, and during the winter surveys there are probably too few pelagic hauls to study the vertical distribution of capelin in a systematic way.

9.2 Polar cod

Polar cod are not well represented in the trawl hauls conducted during the winter surveys (Figure 9.2). This reflects the more northern and eastern distribution area of this endemic arctic species. During this time of the year, the polar cod is known to be spawning under the ice-covered areas of the Pechora Sea and close to Novaya Zemlya. It is not clear whether the concentrations found in open water this time of the year are mature fish either on their way to spawning or from the spawning areas, or if this is immature fish.

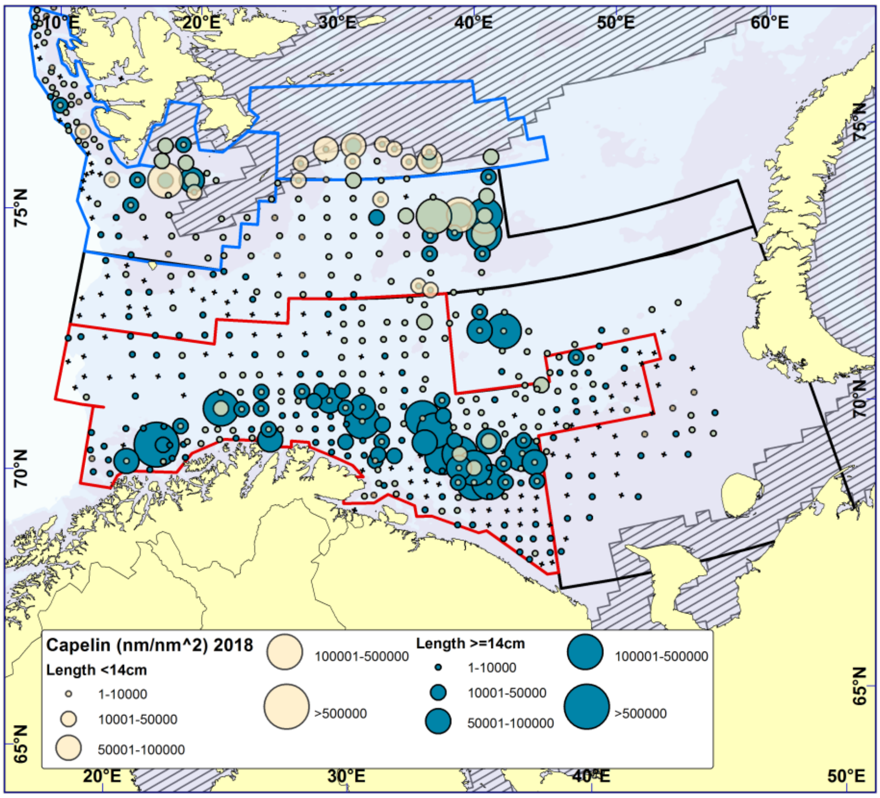

Figure 9.1. CAPELIN. Distribution in the trawl catches winter 2018 (number per nm^2). Black crosses indicate zero catches.

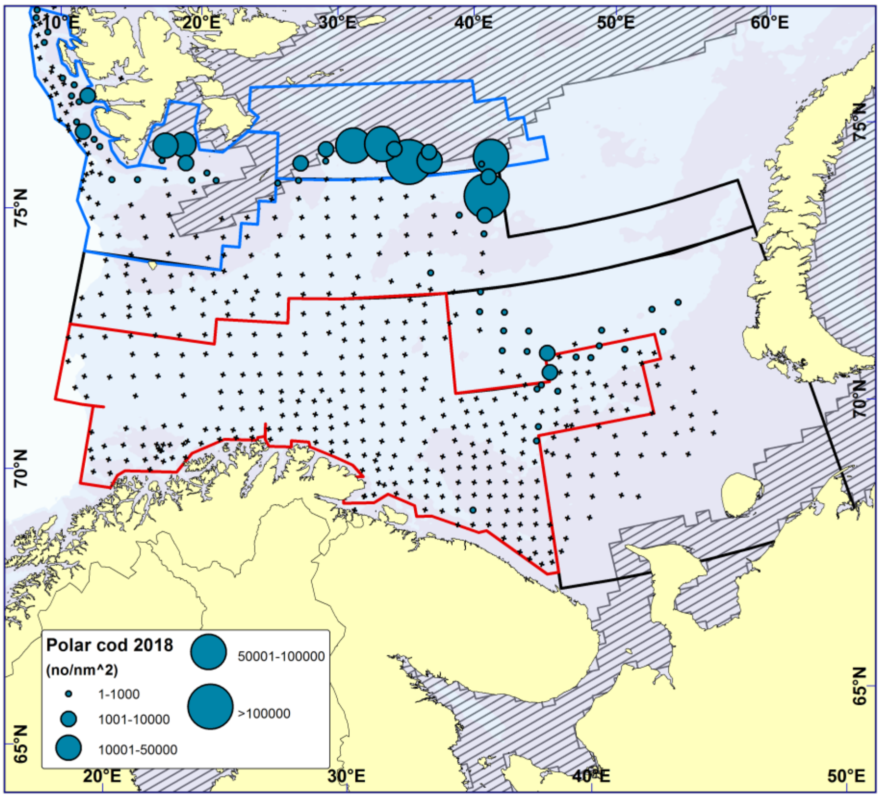

Figure 9.2 POLAR COD. Distribution in the trawl catches winter 2018 (number per nm^2). Black crosses indicate zero catches.

9.3 Blue whiting

Since the second part of the 1990s, blue whiting has shown a wider distribution than previously, and echo recordings indicated higher abundance in the Barents Sea. Figure 9.3 shows the geographical distribution of the bottom trawl catch rates of blue whiting in 2018. Since the fish is mainly found pelagically, the bottom trawl does not reflect the real density distribution, but gives some indication of the distribution limits. Acoustic observations would better reflect the relative density distribution. The number of pelagic hauls has, however, been too low to properly separate the pelagic recordings. During the years with high abundance of blue whiting, dense concentrations of blue whiting might have masked recordings of pelagic redfish, haddock and small cod.

Table 9.1 shows the bottom trawl swept area estimates by 5 cm length groups for the years 1994-2018. High abundance of fish below 20 cm in 2001, 2002, 2004, 2005, 2012 and 2015 reflects abundant recruiting (age 1) year classes. These recruits are observed in the survey as larger fish in the following years. As for some of the other target species in the survey, there was a large increase in the indices for most length groups from 2014 to 2015. The recruitment signal was less in 2017, while the total index of fish above 20 cm and total biomass were the largest since 2006. In 2018 most indices and total biomass were the lowest since 2011. Only small amounts of blue whiting were found in the extended survey area (Tables 9.2). Table 9.3 presents estimates of coefficients of variation (%) by length groups. In most years, CVs for most length groups are far above what could be considered as acceptable for stock assessment.

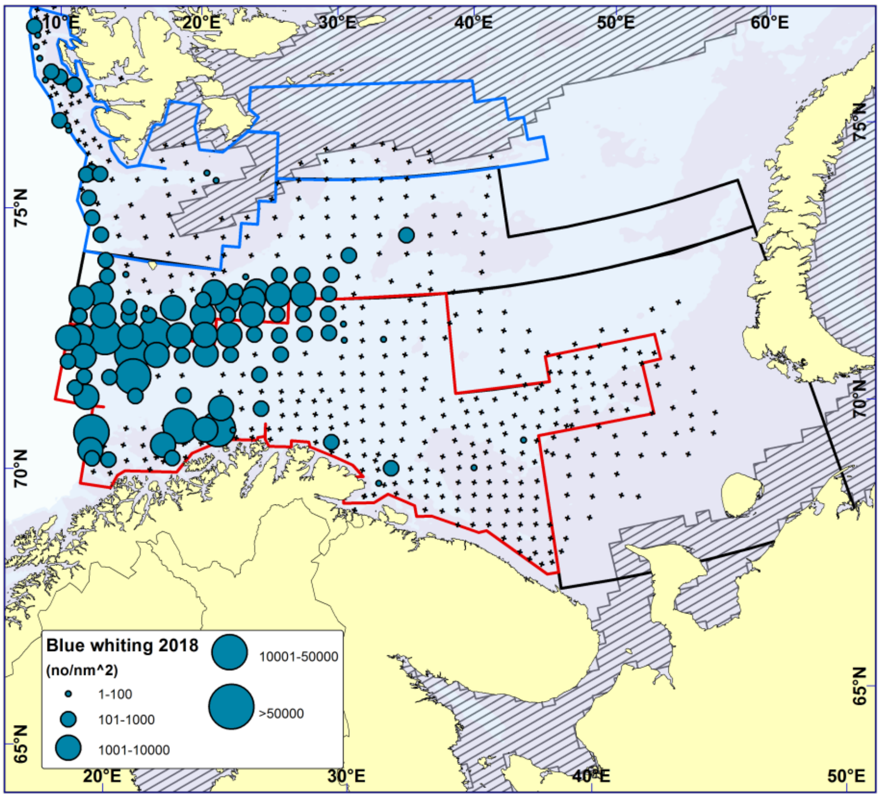

Figure 9.3 BLUE WHITING. Distribution in the trawl catches winter 2018 (number per nm^2). Black crosses indicate zero catches.

Table 9.1. BLUE WHITING. Abundance indices (numbers in millions) from bottom trawl surveys in the Barents Sea standard area winter 1994-2018.

Year	Length group (cm)								Total	Biomass
	5-9	10-14	15-19	20-24	25-29	30-34	35-39	≥40		('000 t)
1994	0	0	1.2	13.6	25.7	10.9	1.1	0.1	52.6	NA
1995	0	0.5	0.8	2.4	10.3	10.8	3.9	0.2	29.0	NA
1996	0	80.0	1371.8	8.4	18.6	7.1	3.8	0.1	1489.9	38.2
1997[1]	0	608.7	681.5	273.8	3.1	5.3	1.8	0.1	1574.3	NA
1998[1]	0	1.2	34.5	42.2	3.6	1.5	1.4	0.1	84.5	NA
1999	0	0.02	11.0	40.0	16.1	5.0	1.7	0.1	74.0	NA
2000	0	12.3	557.5	44.1	25.7	4.4	0.7	0.1	644.9	NA
2001	0.04	311.6	1420.8	631.5	46.0	5.4	1.6	0.1	2417.0	NA
2002	0	0.9	428.9	636.3	77.6	17.5	3.2	0.1	1164.4	56.6
2003	0	3.9	220.5	493.4	73.4	28.0	4.0	0.3	823.4	48.1
2004	0	7.1	712.0	821.6	276.2	37.8	1.1	0.2	1856.0	95.8
2005	0	125.1	717.2	984.7	223.3	31.8	0.1	0.1	2082.4	105.0
2006[2]	0	0	164.4	1500.5	598.0	69.0	2.0	0.1	2333.9	172.9
2007[1]	0	0	4.0	628.0	299.3	23.5	1.6	0.4	956.8	79.8
2008	0	0	0.3	12.1	126.1	19.8	1.3	0.1	159.7	20.6
2009	0	0	0.02	2.7	50.6	21.2	1.5	0.02	76.1	11.4
2010	0	0	0.5	1.6	9.4	16.9	1.0	0	29.4	5.2
2011	0	0	0.1	0.3	2.8	5.1	2.5	0	10.6	2.2
2012[1]	0	85.6	674.6	1.1	1.8	5.3	2.0	0.3	770.7	18.2
2013	0	0	75.3	395.9	12.6	11.5	6.8	0.1	502.2	28.6
2014	0	0	182.1	34.2	9.7	1.6	1.5	0.04	229.2	8.5
2015	0	115.6	907.4	141.2	40.8	8.8	7.4	0	1221.3	34.2
2016	0	0.1	260.0	367.6	38.0	6.3	3.0	0.1	674.9	39.1
2017[1]	0	0	29.1	939.6	279.2	26.1	11.5	0.05	1285.6	99.7
2018	0	0.02	0.8	45.4	50.2	8.3	1.7	0	106.5	10.5

[1] Indices not raised to represent the Russian EEZ or uncovered parts, blue whiting is mainly found in areas A, B, C and S

[2] Not complete coverage in southeast due to restrictions, strata 7 area set to default and strata 13 as in 2005

Table 9.2. BLUE WHITING. Abundance indices (numbers in millions) for new strata 24-26 from bottom trawl surveys in the Barents Sea winter 2014-2018.

Year	Length group (cm)								Total	Biomass
	5-9	10-14	15-19	20-24	25-29	30-34	35-39	≥40		('000 t)
2014	0	0	0.29	0.28	0.10	0.19	0.13	0	1.0	0.12
2015	0	0	0.16	0.10	0.25	0.78	0.42	0	1.7	0.27
2016	0	0	2.12	5.35	1.54	0.46	0.35	0	9.8	0.84
2017	0	0	0.08	20.91	4.10	1.34	0.39	0	26.8	1.98
2018	0	0	0	0.16	0.37	0.23	0.16	0	0.9	0.13

Table 9.3. BLUE WHITING. Estimates of coefficients of variation (%) for swept area abundance indices. Barents Sea standard area winter 1994-2018.

	Length group (cm)							
Year	**5-9**	**10-14**	**15-19**	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**
1994	-	-	94	68	51	28	31	49
1995	-	59	55	51	66	32	28	48
1996	-	49	79	56	49	30	33	59
1997[1]	-	30	29	33	36	29	37	70
1998[1]	-	91	60	33	35	33	28	70
1999	-	98	26	27	28	31	43	71
2000	-	37	21	20	25	29	31	95
2001	69	21	18	25	26	35	39	90
2002	-	56	25	17	20	33	52	69
2003	-	87	47	23	17	27	58	83
2004	-	86	23	19	15	14	30	61
2005	-	28	25	16	24	24	71	90
2006[2]	-	-	17	12	13	26	46	61
2007[1]	-	-	50	16	12	17	42	84
2008	-	-	51	59	27	22	47	82
2009	-	-	97	60	21	20	61	95
2010	-	-	91	80	29	25	33	-
2011	-	-	100	88	45	48	62	-
2012[2]	-	32	30	39	45	38	29	98
2013	-	-	70	31	57	44	44	99
2014	-	-	23	23	24	27	18	137
2015	-	50	21	21	31	31	37	-
2016	-	96	33	24	17	27	29	97
2017[2]	-	-	24	16	16	16	42	101
2018	-	102	49	25	17	19	32	-

[1] REZ not covered

[2] REZ partly covered

10 Registrations of other species

During the 2007-2018 surveys, a total of 98 fish species were recorded belonging to 37 families (Table 10.1), 50 species were recorded all years. Distribution maps for all species caught at the winter survey 2007-2012 were presented as a separate report (Wienerroither et al. 2013) similar to the Atlas of the Barents Sea fishes based on data from the ecosystem survey (Wienerroither et al. 2011). Since the start of the winter survey in 1981 the number of fish taxa recorded has increased due to expansion of the surveyed area, better taxonomic skills and identification keys (Johannesen et al. 2009). Routines for freezing specimens of problematical groups for later identification on land by taxonomists have been established and have given satisfactory results, but there is room for improvement and some groups still pose unresolved taxonomic challenges, mainly liparids (see also footnotes in Table 10.1).

Table 10.1. Fish species recorded at the winter survey 2007-2018, all gears included. The number of years each species was recorded is given and for species not caught every year the capture history (1 = caught and 0 = not caught) is shown in parenthesis for consecutive years 2007-2018. Some clear misidentifications have been left out.

Order	Family	Species	Number of years caught
Myxiniformes	Myxinidae	*Myxine glutinosa*	5 (0,1,0,1,1,0,0,0,1,0,1,0)
Squaliformes	Dalatiidae	*Etmopterus spinax*	4 (1,1,0,0,1,1,0,0,0,0,0,0)
		Somniosus microcephalus	5 (1,0,1,0,1,0,0,0,1,1,0,0)
Rajiformes	Arhynchobatidae	*Bathyraja spinicauda*	12
	Rajidae	*Amblyraja hyperborea*	11 (1,1,1,1,1,1,0,1,1,1,1,1)
		Amblyraja radiata	12
		Rajella fyllae	12
		Rajella lintea	7 (0,1,1,0,1,0,1,0,1,1,0,1)
Chimaeriformes	Chimaeridae	*Chimaera monstrosa*	12
Clupeiformes	Clupeidae	*Clupea harengus*	12
		Clupea pallasii suworowi	6 (0,1,0,0,1,0,1,1,0,1,0,1)
Osmeriformes	Argentinidae	*Argentina silus*	12
	Alepocephalidae	*Xenodermichthys copei*	1 (0,0,0,0,0,0,0,0,1,0,0,0)
	Osmeridae	*Mallotus villosus*	12
Salmoniformes	Salmonidae	*Oncorhynchus gorbuscha*	1 (0,0,0,0,0,0,0,1,0,0,0,0)
Stomiiformes	Sternoptychidae	*Argyropelecus hemigymnus*	3 (0,0,0,1,0,1,0,0,0,1,0,0)
		Maurolicus muelleri	12
Aulopiformes	Paralepididae	*Arctozenus risso*	12
Myctophiformes	Myctophidae	unidentified	11 (1,1,1,1,1,1,0,1,1,1,1,1)
		Benthosema glaciale	10 (0,0,1,1,1,1,1,1,1,1,1,1)
Gadiformes	Macrouridae	*Macrourus berglax*	12
	Gadidae	*Boreogadus saida*	12
		Gadiculus argenteus	12
		Gadus morhua	12
		Melanogrammus aeglefinus	12
		Merlangius merlangus	12
		Micromesistius poutassou	12
		Pollachius pollachius	1 (0,0,0,0,0,0,0,1,0,0,0,0)
		Pollachius virens	12
		Trisopterus esmarkii	12
		Trisopterus minutus	3 (0,0,0,1,0,0,0,0,0,1,0,1)
	Lotidae	*Brosme brosme*	12
		Enchelyopus cimbrius	12
		Gaidropsarus argentatus	6 (0,0,1,0,1,0,1,0,1,0,1,1)
		Molva dypterygia	1 (0,0,0,0,0,0,0,0,1,0,0,0)
		Molva molva	12
	Phycidae	*Phycis blennoides*	10 (0,0,1,1,1,1,1,1,1,1,1,1)

Order	Family	Species	Number of years caught
Ophidiiformes	Carapidae	*Echiodon drummondii*	2 (0,0,0,0,0,0,0,1,0,0,0,1)
Lophiiformes	Lophiidae	*Lophius piscatorius*	8 (1,1,1,1,0,1,0,1,0,0,1,1)
Gasterosteiformes	Gasterosteidae	*Gasterosteus aculeatus*	12
Syngnathiformes	Syngnathidae	*Entelurus aequoreus*	2 (1,1,0,0,0,0,0,0,0,0,0,0)
Scorpaeniformes	Sebastidae	*Sebastes mentella*	12
		Sebastes norvegicus	12
		Sebastes viviparus	12
	Triglidae	*Eutrigla gurnardus*	10 (1,1,1,0,1,1,1,1,0,1,1,1)
	Cottidae	*Artediellus atlanticus*	12
		Gymnocanthus tricuspis	3 (0,1,1,0,0,0,0,1,0,0,0,0)
		Icelus spp.[1]	12
		Myoxocephalus scorpius	10 (1,1,1,1,0,1,0,1,1,1,1,1)
		Triglops murrayi	12
		Triglops nybelini	7 (1,1,1,1,0,0,0,1,0,1,1,0)
		Triglops pingelii	6 (1,1,0,1,1,0,0,1,0,1,0,0)
	Psychrolutidae	*Cottunculus microps*	12
	Agonidae	*Agonus cataphractus*	1 (0,0,0,0,0,0,0,1,0,0,0,0)
		Aspidophoroides olrikii	5 (0,1,0,1,1,0,1,0,1,0,0,0)
		Leptagonus decagonus	12
	Cyclopteridae	*Cyclopterus lumpus*	12
		Eumicrotremus derjugini	4 (0,0,0,0,1,1,0,0,1,1,0,0)
		Eumicrotremus spinosus	11 (1,1,1,1,1,1,0,1,1,1,1,1)
	Liparidae	*Careproctus* spp.[2]	12
		Liparis bathyarcticus	8 (1,1,0,0,0,1,0,1,1,1,1,1)
		Liparis fabricii	10 (1,1,0,1,1,1,0,1,1,1,1,1)
		Liparis liparis[3]	11 (1,1,1,1,1,1,0,1,1,1,1,1)
		Liparis montagui[3]	2 (0,0,0,1,0,0,0,0,0,1,0,0)
		Liparis tunicatus[3]	3 (0,0,0,1,0,0,0,1,1,0,0,0)
Perciformes	Epigonidae	*Epigonus* sp.[4]	1 (0,0,0,0,0,0,0,0,0,0,1,0)
	Zoarcidae	*Gymnelus* spp.[5]	10 (1,0,1,1,1,1,1,1,1,1,1,1)
		Lycenchelys kolthoffi	3 (0,0,0,0,0,0,1,1,1,0,0,0)
		Lycenchelys muraena	1 (0,0,0,1,0,0,0,0,0,0,0,0)
		Lycenchelys sarsii	5 (0,0,0,0,0,1,1,0,1,1,0,1)
		Lycodes esmarkii	12
		Lycodes eudipleurostictus	12
		Lycodes gracilis	12
		Lycodes pallidus	12
		Lycodes polaris	1 (0,1,0,0,0,0,0,0,0,0,0,0)
		Lycodes reticulatus	12
		Lycodes rossi	12
		Lycodes seminudus	10 (1,1,1,1,1,1,0,1,1,0,1,1)
		Lycodes squamiventer	3 (1,0,0,0,0,1,0,1,0,0,0,0)
	Stichaeidae	*Anisarchus medius*	9 (1,0,1,1,1,1,0,1,0,1,1,1)
		Leptoclinus maculatus	12
		Lumpenus fabricii	1 (0,1,0,0,0,0,0,0,0,0,0,0)
		Lumpenus lampretaeformis	12
	Anarhichadidae	*Anarhichas denticulatus*	12
		Anarhichas lupus	12
		Anarhichas minor	12
	Ammodytidae	*Ammodytes* spp.[6]	5 (0,1,0,1,0,0,0,0,1,1,0,1)

[1] *I. bicornis* has been verified each year, the occurrence of *I. spatula* is uncertain.

[2] Due to open taxonomic issues fishes in the genus *Careproctus* are not identified to species level, but two morphologically different types are registered since 2015.

[3] Early records of this species might represent misidentifications.

[4] Needs closer examination, but genus verified.

[5] *G. retrodorsalis* has been verified each year, the occurrence of other *Gymnelus*-species is uncertain.

[6] *A. marinus* has been verified in the catches, but due to high numbers not all specimens could be checked.

Order	Family	Species	Number of years caught
Perciformes	Scombridae	*Scomber scombrus*	1 (0,0,0,0,0,0,0,0,0,0,1,0)
	Centrolophidae	*Schedophilus medusophagus*	1 (0,0,1,0,0,0,0,0,0,0,0,0)
Pleuronectiformes	Scophthalmidae	*Lepidorhombus whiffiagonis*	12
		Phrynorhombus norvegicus	1 (0,0,0,0,0,0,0,0,0,0,1,0)
	Pleuronectidae	*Glyptocephalus cynoglossus*	12
		Hippoglossoides platessoides	12
		Hippoglossus hippoglossus	12
		Limanda limanda	10 (0,1,1,1,1,1,1,1,1,1,0,1)
		Microstomus kitt	12
		Pleuronectes platessa	12
		Reinhardtius hippoglossoides	12

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Appendix 2. Changes in survey design, methods, gear etc.

Year	Change from	To
1984	Representative age sample, 100 per station	Stratified age sample, 5 per 5-cm length group
1986	1 research vessel, 2 commercial trawlers	2 research vessels, 1 commercial trawler
1987	60 min. tow duration	30 min. tow duration
1989	Bobbins gear	Rock-hopper gear (time series adjusted for cod and haddock)
1990	Random stratified bottom trawl stations	Fixed station grid, 20 nm distance
	Simrad EK400 echo sounder	Simrad EK500 echo sounder and BEI post processing
1993	TS = 21.8 log L – 74.9 for cod and haddock	TS = 20 log L – 68 for all demersal species (time series corrected)
	Fixed survey area (ABCD), 1 strata system, 35 strata	Extended, variable survey area (ABCDD'ES) 2 strata systems, 53 + 10 strata
	Fixed station grid, 20 nm distance	Fixed station grid, 20/30/40 nm distance
	No constraint technique (strapping) on bottom trawl doors	Constraint technique on some bottom trawl hauls
	5 age samples per 5-cm group, 2 per stratum	2 age samples per 5-cm group, 4 per stratum (cod and haddock)
	Weighting of age-length keys by total catch	Weighting of ALK by swept area estimate
1994	35-40 mm mesh size in cod-end	22 mm mesh size in cod-end
	Strapping on some hauls	Strapping on every 3. haul
	Hull mounted transducers	Keel mounted transducers Johan Hjort
1995	Variable use of trawl sensors	Trawl manual specifying use of sensors
	Constant effective fishing width of the trawl	Fish size dependent effective fishing width (time series corrected)
	Strapping on every 3. haul	Strapping on every 2. haul
	2 research vessels, 1 commercial trawler	3 research vessels
1996	2 strata systems and 63 strata, 20/30/40 nm distance	1 strata system and 23 strata, 16/24/32 nm distance
	2 age samples per 5-cm group, 4 per stratum	1 age sample per 5-cm group, all stations with > 10 specimens (cod and haddock)
1997	16/24/32 nm distance	20 nm distance
	Hull mounted transducers	Keel mounted transducers G.O. Sars (Sarsen)
1998	Strapping on every 2. haul	Strapping on every haul
	20 nm distance	20/30 nm distance
2000	3 Norwegian research vessels	2 Norwegian and 1 Russian research vessel
2002	20/30 nm distance station grid	16/20/24/32 nm distance station grid
2003	Height trawl sensor for opening and bottom contact	Trawl eye for opening and bottom contact
2004	Vaco trawl doors	V- doors G.O. Sars and Johan Hjort
	EK 500 Sarsen	ER60 G.O. Sars
2005	EK 500	ER60 Johan Hjort and Russian vessels
2006	Standard Campelen rigging	"Tromsø rigging" on Norwegian vessels
2007	BEI	LSSS Norwegian vessels
2008	V trawl doors	Thyborøn doors Jan Mayen/Helmer Hanssen
2010	V trawl doors	Thyborøn doors G.O. Sars and Johan Hjort
2011	30 min. tow duration	15 min. tow duration
2015	"Tromsø rigging" on Norwegian vessels	Standard Campelen rigging
2017	Swept-area estimates by the Survey Program	Swept-area and CV estimates by StoX software
	EK 60 on G.O. Sars	EK80 in EK 60 modus on G.O. Sars
2018	Acoustic estimates by the BEAM Program	Acoustic and CV estimates by StoX software
	EK 60 on Johan Hjort	EK80 in EK 60 modus on Johan Hjort

Appendix 3. Scientific participants 2018

Research vessel	Participants
“Helmer Hanssen” (20.01- 27.02)	**Part 1 (20.01 – 10.02)** **T. Wenneck (cruise leader),** M.L. Guldbrandsen, A. Storaker (to 29.01), H.L. Mørk (to 29.01), J. Kristiansen, T. Haugland, S. Gundersen (from 29.01), G. Hillersøy, I.N. Moksness (from 29.01) **Part 2 (10.02 – 27.02)** **H. Gjøsæter (cruise leader),** T. Haugland, H. Senneset, J. Skadal, A. Sæverud, E. Hermansen, I. Huse, R. Berntsen (UiT)
“Johan Hjort” (28.01 – 12.03)	**Part 1 (31.01 – 13.02)** **A. Aglen (cruise leader),** G. Thorsheim, E. Holm, F. Midtøy (UiB), E. Langhelle, J. Solhaug, M. Mjanger **Part 2 (13.02 – 27.02)** **J.A. Godiksen (cruise leader),** E. Langhelle, S.E. Seim, A. Storaker, K.A. Gamst, A.B. Rolland, O.S. Fossheim, Å.N. Sudmann, I. Tretyakov (PINRO), R.Y. Vladimirovich (inspector RU) **Part 3 (04.03 – 12.03)** **S. Mehl (cruise leader),** E. Odland, M.L. Guldbrandsen, J. Vedholm, G. Thorsheim, J. Alvarez, E. Erdal, L. Drivenes, J. Wangensten
“Fritjof Nansen” (08.02 – 11.03)	**A. Russkikh (cruise leader),** A.V. Amelkin, A.V. Antipin, D.M. Draganov, E.V. Evseeva, Yu. L. Firsov, M.A. Gubanishchev, A.A. Kanishchev, M.Yu. Kalashnikova, R.N. Klepikovskiy, A.S. Mikhina, M.A. Nosov, M.V. Osipov, N.G. Puodzunas, M.O. Rybakov, T.M. Sergeeva, A.V. Stesko

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