2 Cod in subareas 1 and 2 (Norwegian coastal waters) AFWG 2019

Spaly assessment procedure, new catch-at-age time-series Need for benchmark

The stock was a part of the WKARCT benchmark meeting in January 2015 (ICES 2015/ACOM: 31). There is high uncertainty in the estimation of commercial catch, and useful information about recreational fishing and tourist fishing is largely lacking. A new time-series for commercial catch numbers-at-age with uncertainty estimates was presented to the benchmark by using the ECA-model (Hirst *et al.,* 2012). The corresponding catches in tonnes are presented in Table 2.1a. The benchmark meeting accepted the new catch estimates, but noticed that the differences compared to the old method should be further explored. Work after the benchmark has revealed some years with problematic sampling data in some areas (see section 2.2.1). This has now been partly resolved, and results with the new catch-at-age series are presented and compared to the results from the old series for the years 1984–2018 (section 2.2.1, Figures 2.5b and 2.5.c.)

There is a need for a new Benchmark to be set up (preferably in 2021) to deal with:

- Consider a split of the assessment area in two or three regions. There are genetic analysis indicating reasons for splitting the stock in two or more units (Dahle *et al.*, 2018), and more studies are ongoing. Both survey data and catch sampling data have better quality north of 67 than south of 67. About 80% of the annual catches of coastal cod are taken north of 67;
- A new fyke net/gillnet-survey series in shallow areas has been initiated south of 67, alternating one year between 67 and 65°N (2013, 2016, and 2018), and next year between 65 and 62°N (2015,2017,2019).
- Ongoing work aims at using the software StoX (Johnsen *et al.,* 2016) for producing a swept-area time-series based on bottom-trawl hauls in the coastal survey (NOcoast-Aco-4Q), as well as re-estimating the acoustic time-series by use of StoX, and an improved strata system;
- Evaluate new information from the recreational fishery;
- Choice of assessment model.

2.1 Stock status summary

Both the coastal acoustic survey in autumn (Figure 2.14) and the current assessment (Figure 2.17) show a considerable decline in SSB in the late 1990s. The current assessment indicates some increased SSB in the years 2001–2016 and a decline in 2017 and 2018. The highest recruitments occurred in the two first years of the time-series (1984, 1985). Since then there seem to be a long-term declining trend in recruitment. Fishing mortality was very high at the beginning of the time-series (1984–1989) and rather high during 1997–1999. F shows a declining trend over the period 1998–2015, then higher again in the latest three years. The Fs in 2016–2018 are above the target in the rebuilding plan. The abundance indices from the coastal surveys in autumn 2013 and 2014 showed some increase compared to previous years. Later surveys have showed rather low indices, like those in the 2002–2012 period.

2.2 Fisheries

Coastal cod is fished throughout the year and within nearly all the distribution area in the Norwegian statistical areas 03, 04, 05, 00, 06, 07, Figures 2.1–2.3). Most of the coastal cod catches are taken as a bycatch during fisheries aimed at NEA cod during its spawning migration or feeding migration to coastal waters. The main fishery for coastal cod, therefore, takes place in the first half of the year. The main fishing areas are along the coast from Varangerfjord to Lofoten (areas 03, 04, 05, 00).

Except for the open fjords in eastern Finnmark, the quantities fished inside fjords are quite low. In the period 2011–2015 the average % share between gear types in the estimated coastal cod commercial landings was around 46% for gillnet, 26% for Danish seine, 26% for longline/handline and 2% for bottom trawl. In 2017, there was some increase for Danish seine (35%) and longline (25%), and a decrease for gillnet (38%). Table 2.1b. shows catches in 2018 by gear groups for coastal cod plus NEA cod in statistical areas 00, 03, 04, 05, and 06+07, and table 2.1c show the ECA-estimated catches of coastal cod for gillnet, trawl and others.

Recreational and tourist fisheries take an important fraction of the total catches in some local areas, especially near the coastal cities, and in some fjords where commercial fishing activity is low. There is no reporting system for coastal cod (NCC) taken by recreational or tourist fishers in Norway. However, there are a few reports trying to assess the amount in certain years. In 2010, these reports were used to construct a time-series (ICES CM 2010/ACOM:05) of recreational catches. These catch estimates are rather uncertain. No additional information has been included in later years, and the annual recreational catch since 2010 has been assumed equal to the one estimated for 2009 (12 700 t). For those years, the total catch numbers-at-age (Table 2.1c) have been upscaled from the estimated catch-at-age in the commercial landings, according to the added amount in tonnes. There are some ongoing research projects on recreational fishing. There is a need for synthesising the results from those.

2.2.1 Sampling fisheries and estimating catches (Tables 2.1–2.4, Figures 2.1–2.5)

Catch numbers-at-age are estimated by the ECA model. The commercial catches of Norwegian Coastal cod (NCC) have been calculated back to 1984 (Table 2.1a). For this period, the estimated annual landings have been between 27 kt and 65 kt. The commercial landings of NCC in 2018 were estimated to 36.4 kt t (Table 2.1a, Figure 2.3). Table 2.1b shows the estimated catch by gears, area and quarters in 2018. Figure 2.5e compares the ECA-estimates and the results of the "traditional calculation method".

Commercial catches of cod are separated to types of cod by the structure of the otoliths in commercial samples. Figure 2.4 illustrates the main difference between the two types: The figure and the following text is from (Berg *et al*., 2005): *Coastal cod has a smaller and more circular first translucent zone than northeast Arctic cod, and the distance between the first and the second translucent zone is larger* (Figure 2.4). *The shape of the first translucent zone in northeast Arctic cod is similar to the outer edge of the broken otolith and to the subsequent established translucent zones. This pattern is established at an age of 2 years, and error in differentiating between the two major types does not increase with age since the established growth zones do not change with age*. The precision and accuracy of the separation method has been investigated by comparison of different otolith readers and results from genetic investigation of cod. The results indicate high accuracy using in the otolith method (Berg *et al*., 2005). Nevertheless, in cases with a low percentage misclassification of large catches of pure NEA cod, the catches of coastal cod could be severely overestimated.

Sampling and landings

The basis for estimating coastal cod catches is the total landings of cod in the Norwegian statistical areas 03, 04, 05, 00, 06, 07 (Figures 2.1—2.2), combined with the sampling of these fisheries. Since the catches are separated to type of cod by the structure of the otoliths, the numbers of age samples are critical for the estimated catch of coastal cod. Table 2.2a shows the sampling of the cod fishery by quarters and areas in 2017, and in Tables 2.2b for 2016 and 2015. The sampling level in 2018 was somewhat improved compared to 2016 and 2017. Table 2.3 compares the numbers of fish sampled by quarters for the period 1985–2018. A total of 16 062 fish were aged. 5196 of these otoliths were classified as coastal cod. (Table 2.2a, b). This represents 40% of all cod otoliths sampled within the coastal cod area. This percentage is similar to 2016, but well above the time-series average (Table 2.3).

The Norwegian sampling program was changed in 2010. This led to poor sampling in that year. The sampling in later years has gradually improved, and the number of samples (but not the number of otoliths) is now well above the level prior to 2010. Still there are too few samples in area 05 in quarter 3 (Table 2.2a).

Table 2.4 shows the total cod catch by area and quarters within the 12 n-mile and the estimated catches of coastal cod by statistical area and quarter for the years 2017 and 2016. The corresponding fractions of coastal cod in cod catches are also shown. The total cod catch within 12 n-mile was lower in 2017 than 2016, while the coastal cod catch (and fraction costal cod) was higher in 2017.

The ECA-estimate of coastal cod in 2017 is close the traditional estimate. For the period 2003–2014 the ECA estimates were consistently above the traditional (Figure 2.5e).

2.2.2 Regulations

The Norwegian cod TAC is a combined TAC for both the NEAC stock and NCC stock. Landings of cod are counted against the overall cod TAC for Norway, where the expected catch of coastal cod is in the order of 10%. The coastal cod part of this combined quota was set 40 000 t in 2003 and earlier years. In 2004, it was set to 20 000 t, and in the following years to 21 000 t. There are no separate quotas given for the coastal cod for the different groups of the fishing fleet. Catches of coastal cod are thereby not effectively restricted by quotas.

Since the coastal cod is fished under a merged coastal cod/northeast Arctic cod quota, the main objective of these regulations is to move the traditional coastal fishery from areas with high fractions of coastal cod to areas where the proportion of NEA cod is higher.

Most regulation measures for northeast Arctic cod also applies to coastal cod; minimum catch size, minimum mesh size, maximum bycatch of undersized fish, closure of areas having high densities of juveniles, and some seasonal and area restrictions.

A number of regulations contribute to some protection of coastal cod: Trawl fishing for cod is not allowed inside the 6-nautical mile line (in the years 2006–2010 about 10 fresh fish trawlers had a dispensation to fish between the 4 and 6-mile line in a few areas in the period 15 April–15 September). Since the mid-1990s the fjords in Finnmark and northern Troms (areas 03 and 04) have been closed for fishing with Danish seine. Since 2000, the large longliners have been restricted to fish outside the 4 nautical mile line.

Regulations introduced 2004–2010

To achieve a reduction in landings of coastal cod additional technical regulations in coastal areas were introduced in May 2004 (after the main fishing season) and continued with small modifications in 2005 and 2006. In those regulations "fjord-lines" were drawn along the coast to close

the fjords for direct cod fishing with vessels larger than 15 metres. In 2005 also a box closed to all fishing gears except handline and fishing rod was defined in the Henningsvær-Svolvær area. This is an area where spawning concentrations of coastal cod are usually observed and where the catches of coastal cod have been high. Since the coastal cod is fished under a merged coastal cod/northeast Arctic cod quota, these regulations are aimed at moving parts of the traditional coastal fishery from the catching of coastal cod in the fjords to a cod fishery outside the fjords, where the proportion of northeast Arctic cod is higher.

The regulations for the closed spawning area near Henningsvær-Svolvær were during the 2012 spring fishery relaxed by allowing vessels less than 11 m to fish. This was continued in 2013–2017. The openings of this area were based on "real-time" genetic monitoring of catches, started in 2007 (Dahle *et al*., 2018). The area was closed in the seasons 2005–2010, and for the first time opened late in the 2011-season, based on the monitoring showing high percentage of NEA cod (>70%). In the spawning season in 2011–2016 large concentrations of NEA cod were observed in this area, and the fraction of coastal cod in the catches was low.

Further restrictions were introduced in 2007 by not allowing pelagic gillnet fishing for cod and by reducing the allowed bycatch of cod when fishing for other species inside fjord lines from 25–5%, and outside fjord lines from 25–20%. The regulations were maintained in 2008.

Since 2009 the most important coastal cod spawning area in the southern part of the stock distribution area (Borgundfjorden near Ålesund) has been closed to fishing (except for handline and fishing rod) during the spawning season. A similar real-time monitoring was set up for monitoring the fraction of NEA cod during the spring fishery (Johansen *et al*., 2017). No samples during the years 2009–2015 showed fractions of NEA cod above 70%, and the areas has been kept closed in all the yeas 2009–2018.

7000 t of the Norwegian cod quota has since 2010 been set aside to cover the catches taken in the recreational and tourist fisheries and catches taken by young fishers (to motivate young people to become fishers).

Additional regulations in 2011: No dispensations for fresh fish trawlers to fish inside 6 n-mile. In the recreational fishery, the maximum gillnet length per person was reduced from 210 m to 165 m, and the allowance for selling cod per person is reduced from 2000 kg to 1000 kg per year. Minimum landing size now also applies to recreational and tourist fishing. For cod this is set to 44 cm in the area north of 62°N. A reallocation of unfished quotas towards the end of 2011 lead to some increased fishing effort aimed at cod in coastal areas. This reallocation has contributed to the increase in coastal cod catch in 2011.

Additional regulations in 2012 and later: The rebuilding plan (Annex 3.4.2) was put into operation in 2011. Since the spawning biomass index in the 2011 autumn survey was higher than the 2010 value, the rebuilding plan, implied that the 2011 regulation could be unchanged in 2012. A minimum mesh size (126 mm full mesh) for gillnets in recreational fisheries was activated from 1 January 2012. This had been announced more than a year in advance to allow people to prepare for the change.

The 2012 survey index for spawning biomass was lower than the previous, and the same was the case with the 2015 survey. According to the rebuilding plan additional measures for reducing catches of coastal cod should apply both for 2013 and 2016. For 2013–2016 no regulations in addition to those in place in 2011 and 2012 have been communicated to ICES.

In 2017, the Norwegian Directorate of Fisheries has extended the Fjord Lines to give more protection for some coastal cod spawning areas. In addition, a maximum number of hooks per day is introduced for the longline fishery within Fjord Lines. It will also be a more restrictive practice for dispensations for purse-seine fishing targeting herring and mackerel inside Fjord Lines.

From 28 November 2017 vessels less than 11 m length (and less than 4.5 m width and less than 20 m^3 container volume) have been allowed catch cod with Danish seine inside the fjord lines, except for some fjords in Finnmark and Troms where local regulations applies. Special restrictions on the gear also applies. The regulation is valid until 31 December 2018. IMR and the Norwegian Directorate of Fisheries (NFD) have evaluated the effects of this new regulation. 12 vessels participated, and the estimated total catches from this fishery inside fjord lines in the period 1 November 2017-14. October 2018 was 146 t (0.4% of the total catch of coastal cod in 2018)

2.3 Survey data

A trawl-acoustic survey along the Norwegian coast from the Russian border to 62°N was started in autumn 1995. In 2003 the survey was somewhat modified by being combined with the former saithe survey at the coastal banks and the survey (ICES acronym: NOcoast-Aco-Q4) was moved from September to October–November.

2.3.1 Indices of abundance and biomass (Tables 2.5-2.13, Figures 2.6-2.12)

The results of the 2018 survey (Staby *et al.*, 2018) are presented in Tables 2.6–2.12 for the area inside the 12 n.-miles border in the Norwegian statistical areas 03, 04, 05, 00, 06, and 07 (Figures 2.1 and 2.2). The survey time-series of estimated numbers of NCC per age group is given in Table 2.6 and in Figure 2.6. The 2018 estimate of spawning biomass is around 30% higher than the 2017 estimate. The uncertainty of the survey estimates is rather large.

Figures 2.7–2.12 show the survey series of stock number within each statistical area.

2.3.2 Age reading and stock separation (Tables 2.4, 2.5, 2.8-2.12)

A total of 1887 cod otoliths were sampled during the 2016 survey. As in previous years, NCC was found throughout the survey area (Table 2.5).

It must be emphasized that the Norwegian coastal surveys are conducted in October-November, and there is usually more NEA cod in the coastal areas at other times of the year, especially during the spawning season in the late winter. This is reflected in the commercial sampling as shown in Table 2.12.

2.3.3 Weights-at-age (Table 2.8, Figure 2.13)

Table 2.8 and Figure 2.13 show the time-series of mean weights at age for the whole survey. For age 8 and older the mean weights show large variations, probably caused by few fish sampled in some years.

There are large growth differences between areas (Berg and Albert, 2003); there is a general tendency for coastal cod to have higher weights-at-age in the southernmost area. The overall mean weights-at-age are therefore influenced by the sampling level relative to the abundance in the various areas.

2.3.4 Maturity-at-age (Table 2.10, Figure 2.13b)

The fraction of mature fish in the autumn survey (Table 2.10) show rather large variation between years. Parts of this variation could be caused by the difficulty of distinguishing mature and immature cod in autumn. Based on the records of spawning zones in the otoliths a back-

calculation of proportion mature at age (Gulland, 1964) was considered at the 2010 AFWG. The analysis was based on samples from the spawning fisheries in March-April. The results are shown in Figure 2.13b. This does not confirm the amount of year-to-year variation seen in the survey observation, and thereby gives some support for rather using a fixed maturation as introduced by the 2010 WG.

Since the age at maturation is higher in northern areas compared to southern areas (Berg and Albert, 2003), the back-calculation analysis should be refined by ensuring a reasonable balance in the amount of data from northern and southern areas.

2.4 Data available for the catch-at-age Assessment (XSA and SVPA)

2.4.1 Catch-at-age (Table 2.1a-e, and table 2.14)

The estimated commercial catch-at-age (2–10+) for the period 1984–2017 is given in Table 2.1a. Table 2.1c shows the total catch numbers-at-age when recreational and tourist fishing is included.

There have been conducted two investigations trying to estimate the level of discarding and misreporting from the coastal vessels in two periods (2000 and 2002–2003, WD 14 at 2002 WG). The amount of discard was calculated, and the report from the 2000-investigation concluded there was both discard and misreporting by species in 2000. In the gillnet fishery for cod this represents approximately 8–10% relative to reported catch. 1/3 of this is probably coastal cod. The last report concluded that misreporting in the Norwegian coastal gillnet fisheries have been reduced significantly since 2000.

2.4.2 Weights-at-age (Tables 2.8 and 2.13)

Weight-at-age in catches is derived from the commercial sampling and is shown in Table 2.13. The same weight-at-age is assumed for the recreational and tourist catches.

The weight-at-age in the stock is obtained from the Norwegian coastal survey (Table 2.8). The survey is covering the distribution area of the stock. Weight-at-age from the survey is therefore assumed to be a relevant measure of the weight-at-age in the stock at survey time (October). These weights (Table 2.13) will, however, overestimate the stock biomass at the start of the year.

2.4.3 Natural mortality

A fixed natural mortality of 0.2 has been assumed in the assessment. However, in the Barents Sea cod cannibalism has been documented to be a significant source of mortality that varies in relation to alternative food and in relation to the abundance of large cod. This might also be the case for the coastal cod (Pedersen and Pope, 2003a and b). In the 2005 coastal cod survey 1125 cod stomachs were analysed (Mortensen, 2007). The observed average frequency of occurrence of cod in cod stomachs was around 4%. Other important predators on cod in coastal waters are cormorants, harbour porpoises and otters (Anfinsen, 2002; Pedersen *et al*., 2007; Mortensen, 2007). Young saithe (ages 2–4) has been observed to consume postlarvae and 0-group cod during summer/autumn (Aas, 2007).

2.4.4 Maturity-at-age (Tables 2.10, 2.13, Figure 2.13)

The average maturity-at-age observed over the survey period 1995–2009 has been used in the assessment (Table 2.13), since there are uncertainties related to the annual variations seen in the survey observations of maturity (Figure 2.13b). The analyses based on back-calculation of spawning zones (Figure 2.13b) are relevant, but still preliminary.

2.5 Methods used for assessing trends in stock size and mortality (Table 2.13-2.18, Figure 2.16-2.18)

Earlier attempts to assess the stock using XSA analysis have shown retrospective problems. For several years the main basis for assessing the stock was the survey time-series (plotted in Figures 2.6–2.13), and SURBA was used for further analysing the survey trends.

In the 2010 WG mortality signals from the survey and from the catch-at-age data were analysed and an SVPA ("user-defined VPA" in the Lowestoft VPA95-menu) were run using the survey based estimate of F_{2009} (details described in Annex 10 in ICES CM 2010/ACOM:05) as terminal F. The same procedure was used this year: By using the survey indices for ages 2 to 8 (Table 2.6) a trial XSA (Tables 2.13–2.15) was run to obtain historic values of $F_{(4-7)}$. Calculated survey mortalities (Table 2.16 and Figure 2.15) were regressed with XSA F_s for the years 1996–2007 (Figure 2.15). This regression was used for converting the 2017 survey mortality to a VPA $F_{(4-7)}$ (Table 2.16). A selection pattern for 2018 was estimated as the average pattern over the years 2015–2017 in the trial XSA, and Fs on oldest true age was taken from the trial XSA. The SVPA, which is considered as the final assessment, was run by using the survey based $F_{(4-7)}$ for 2018 combined with the selection pattern and oldest true F_s described above. The same procedure was repeated for catch-at-age data including estimates of recreational catches, but the trial XSA for that dataset is not shown here.

The results are shown in Tables 2.17–2.18 and in Figures 2.16–2.18.

2.6 Results of the Assessment

2.6.1 Comparing trends with last year's assessment (Table 2.6, 2.15—2.18, Figures 2.6, 2.13–2.14, 2.16–2.18)

The 2018 survey estimate of spawning biomass (18.4 kt) is above the 2017 Tables 2.9 and 2.11, Figure 2.17).

The survey based estimate of the F_{2018} is 0.27 when relating to commercial catch and 0.23 when relating to total catch data. The text table below compares those with corresponding values earlier years (see also Figure 2.16). The table also compares the SSB-results of SVPA-runs aimed at those F_s used as terminal F_s. The high catches in 2015–2017 (containing reasonable amounts of old fish) has in the current assessment caused some upward stock revision for several years back in time. Corresponding downward revisions of F is observed. The "F on oldest true age" in the SVPA is derived from a trial XSA with a 20 year tuning window with time taper. The effect of the high survey estimates at the beginning of the time-series has thereby been reduced in the later assessments compared to the earlier. This has further contributed to upward revisions of SSB, and downward revisions of F seen in the text table below (also visible in Figure 2.17 for the years 2015–2017). **Note that the results of the 2019 assessment are based on a revised catch number-at-age series.**

Ass Yr	F 09	F 10	F 11	F 12	F 13	F 14	F 15	F 16	F 17	F 18
2010	0.37									
2011	0.38	0.38								
2012	0.28	0.26	0.33							
2013	0.29	0.23	0.33	0.37						
2014	0.31	0.26	0.34	0.36	0.27					
2015	0.31	0.27	0.36	0.37	0.29	0.27				
2016	0.29	0.25	0.32	0.29	0.21	0.19	0.35			
2017	0.28	0.24	0.30	0.26	0.18	0.15	0.25	0.30		
2018	0.26	0.22	0.28	0.23	0.16	0.14	0.22	0.25	0.35	
2019	0.22	0.30	0.27	0.19	0.15	0..16	0.17	0.26	0.31	0.27

Ass Yr	SSB 09	SSB 10	SSB 11	SSB 12	SSB 13	SSB 14	SSB 15	SSB 16	SSB 17	SSB 18
2010	46									
2011	50	44								
2012	59	58	70							
2013	60	60	68	66						
2014	59	58	64	59	51					
2015	59	57	63	57	47	49				
2016	63	62	69	67	61	70	75			
2017	66	65	73	73	70	84	99	100		
2018	75	74	83	82	78	95	114	114	109	
2019	88	101	97	101	100	133	129	135	113	95

The recruitment estimate for the final year is highly uncertain in all assessments (Figures 2.16). Figure 2.17 shows the SSB-series from VPA and survey, both scaled to their average over the years 1995–2017. Figure 2.18 compares the various time-series of F. The SVPA is fixed at the survey-derived F for the terminal year, but for most of the years 2001–2016 the SVPA give lower F than the one derived from the survey. For the SVPA based on commercial catch this happened in 13 of those 16 years, and for the SVPA based on total catch this was the case in 11 of the 16 years. This pattern seems to indicate some conflicts between the annual catch-at-age and the annual numbers-at-age in the survey-

2.6.2 Recruitment (Table 2.6, Figure 2.16)

The younger ages are poorly represented both in the survey and in the catch data. The VPA-estimates of recruits in latest data year, therefore, show large retrospective revisions (Figure 2.16). The survey estimate for age 2 is somewhat higher in the three recent years compared to the period 2002–2013. It is worth to notice that the recruitment started to decline a few years before the spawning stock, indicating that the recruitment failure is an important cause for the stock decline in the late 1990s.

2.6.3 Catches in 2019

No catch prediction for 2019 have been made.

2.7 Comments to the Assessment

Uncertain estimates of catch-at-age and limited information about the recreational fishery and the tourist fishery leads to high uncertainty in the catch-at-age based analysis. The series with recreational and tourist fisheries included may be said to scale the stock size to a more realistic level, but at the same time brings in additional uncertainty.

The acoustic survey has a rather large uncertainty. This is because cod contributes to a low fraction of the total observed acoustic values. The cod estimate is thus vulnerable to allocation error. The Norwegian coastal survey is the only survey covering the main distribution area of the stock.

The survey is conducted in the period October/November. In this period, the maturity stage can be variable and difficult to define, and a survey index of SSB based on the long-term mean (currently 1995–2009) maturity-at-age is considered to reduce some annual variation caused by staging uncertainty.

2.8 Reference points

No biological reference points are established.

2.9 Management considerations

Estimated catches were rather stable in the period 2004–2014, while they were considerably higher in the years 2015–2017. For most years in the period 2004–2014 the regulations seem to have reduced the catches and fishing mortality compared to pre-2004 level, but have not been sufficient to cause persistent further reductions. Since 2013 the quotas for NEA cod has been very high. This has likely contributed to increased catches of coastal cod. In 2015, 2016 and 2017 catches of coastal cod were exceptionally high in January in southern Troms and northern Nordland (Figure 1.16), where coastal cod where feeding on aggregations of herring. This fishery occurred before the NEA cod spawning migration reached those areas. Such concentrations of coastal cod were in 2015 rather unexpected, and illustrates a need for considering flexible regulations that on short notice may move fisheries from coastal cod to Northeast arctic cod.

The time-series of estimated recreational catch presumes rather stable catches, and they represent thereby a higher fraction (about 35%) during the period 2004–2014 when the commercial catch was low.

The rebuilding plan (Annex 3.4.2) was put into operation in 2011. The plan specifies the following plan for reducing the fishing mortality in every year when the latest survey shows a reduced SSB-index:

Action year	1	2	3	4	5	6	7
Reduction relative to F_{2009}	15%	30%	45%	60%	75%	90%	100%

The spawning biomass index in the 2010 survey was below the index in the 2009 survey. This means that the regulation in 2011 was aimed at a 15% reduction of F relative to 2009. The 2011 survey gave a higher spawning biomass index than in 2010. The 2012 survey index for spawning biomass was lower than the previous, and according to the rebuilding plan additional measures for reducing F by 30% (relative to 2009) should apply for 2013. For 2013 and later years no regulations in addition to those in place in 2011 and 2012 have been communicated to ICES. The survey showed an increase both in 2013 and 2014. Therefore, the 30% reduction of F still applied for 2015. The 2015 survey showed a decline, and the regulations in 2016 should aim for 45% reduced F. The 45% also applies for 2017, since the latest survey gave a higher SSB-estimate then the previous. Since the 2017 survey was lower than in 2016, the forth step (60% reduction) should apply for 2018. Since the 2018 survey was above the 2017, the 60% also applies for 2019.

The VPA analysis presented indicate some reduction of F over the period 1999–2015, followed by increased F in 2016, 2017 and a possible decline in 2018.

2.10 Rebuilding plan for coastal cod

The following rebuilding plan was suggested by Norway in 2010:

"The overarching aim is to rebuild the stock complex to full reproductive capacity, as well as to give sufficient protection to local stock components. Until a biologically founded rebuilding target is defined, the stock complex will only be regarded as restored when the survey index of spawning stock in two successive years is observed to be above 60 000 tonnes[1]. Importantly, this rebuilding target will be redefined on the basis of relevant scientific information. Such information could, for instance, include a reliable stock assessment, as well as an estimate of the spawning stock corresponding to full reproductive capacity.

Given that the survey index for SSB does not increase, the regulations will aim to reduce F[2] by at least 15 per cent annually compared to the F estimated for 2009. If, however, the latest survey index of SSB is higher than the preceding one - or if the estimated F for the latest catch year is less than 0.1 - the regulations will be unchanged.

Special regulatory measures for local stock components will be viewed in the context of scientific advice. A system with stricter regulations inside fjords than outside fjords is currently in operation, and this particular system is likely to be continued in future.

The management regime employed is aiming for improved ecosystem monitoring in order to understand and possibly enhance the survival of coastal cod. Potential predators are - among others - cormorants, seals and saithe.

When the rebuilding target is reached, a thorough management plan is essential. In this regard, the aim will be to keep full reproductive capacity and high long-term yield."

The Evaluation of this plan made at the 2010 WG (Annex 10 in ICES, 2010/ACOM:05) was not reviewed by the review group and advice drafting group dealing with the rest of the AFWG report. ICES selected some experts who during summer 2010 reviewed the evaluation, and an advice group wrote the response to Norwegian Authorities, issued on 1 October 2010. The conclusions are:

Based on simulations, ICES conclude that the plan, if fully implemented, is expected to lead to significant rebuilding. Nonetheless, accounting for realistic uncertainties in the catches, surveys, and the assessment model, a rather long rebuilding period is required even if fishing mortality is markedly reduced within the next several years. Whereas not fully quantifiable, the needed reductions in fishing mortality will require accompanying reductions in the catches.

ICES consider the proposed rule to be provisionally consistent with the Precautionary Approach. The basis of this evaluation has been the precautionary approach, and not the new ICES MSY framework.

This rebuilding plan was in 2010 adopted by Norwegian authorities. Results from the coastal survey are available in early December, and management decisions for the following year will then be made according to the SSB index and the rebuilding plan.

Has the rebuilding plan worked?

According to the catch estimates, the commercial catch of coastal cod was quite high in the years 2015–2017, while the 2018 catch was somewhat lower. The high catches in 2015–2017 are mainly

[1]The average survey index in the years 1995–1998

[2] Ages 4–7

caused by targeting aggregations of cod during the first quarter in southern Troms and northern Nordland, prior to arrival of the spawning NEA cod.

The rebuilding plan has now been in operation for 9 years. The plan implies that the fishing mortality in 2018 should be at least 60% lower than the 2009 value. The 2018 data indicate a fishing mortality similar to 2009, and the estimated catch in 2017 is well above the catch in 2009. The regulations have therefore not been sufficient for constraining the coastal cod catches in the years 2015–2018, and the most recent estimate of F is above the F in 2009.

The Norwegian Ministry of Fisheries is working on a new rebuilding plan. Fisheries scientists need to discuss with managers, how to facilitate a rebuilding of the stock, evaluate rebuilding targets and measures to avoid high fishing pressure in areas with high fractions of coastal cod.

Since coastal cod to a large extent is a bycatch in the fishery for northeast Arctic cod, the regulations should, in particular, aim for reducing catches in areas where the fraction of coastal cod is high. Stronger restrictions are required in all areas where coastal cod is distributed. These restriction requirements include coastal cod taken as bycatch in northeast Arctic cod, haddock, and saithe fisheries.

2.11 Recent ICES advice

For the years 2004–2011 the advice was; No catch should be taken from this stock and a recovery plan should be developed and implemented.

For 2012, and later the advice has been to follow the rebuilding plan. The latest ICES advice strongly recommends a new rebuilding plan.

Table 2.1a. Norwegian coastal cod. Estimated commercial landings in numbers ('000) at-age, and total tonnes by year.

	Age									Tonnes
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10+**	**Landed**
1984	127	1251	3350	5629	5111	3412	359	93	175	63818
1985	72	4302	4794	5660	3377	1319	387	81	750	62954
1986	304	4192	5831	4801	2956	1913	610	223	621	56107
1987	22	177	3294	7016	3314	1153	505	171	281	48274
1988	17	280	836	6686	6222	2573	645	280	252	55065
1989	53	471	1162	1602	5779	2493	813	184	251	41242
1990	50	387	987	805	683	2022	603	91	135	20920
1991	9	273	913	1420	1226	937	1384	190	202	24837
1992	57	401	2156	3296	2477	1201	468	695	346	38195
1993	21	140	1793	2874	3120	2555	1190	355	889	50420
1994	32	117	1015	4266	3011	2709	1276	412	843	51664
1995	31	210	1098	2997	5013	3404	1876	1032	899	64964
1996	50	459	837	1583	2460	2759	1062	524	640	41672
1997	121	594	1804	1752	2152	3164	1970	502	669	51123
1998	105	723	2640	2164	1287	937	924	372	361	30472
1999	55	660	2578	3506	1981	933	539	462	489	35805
2000	20	796	2830	3614	1922	772	401	142	356	34815
2001	20	372	1985	2250	1769	1074	393	128	355	27253
2002	52	405	1763	2880	2610	1070	559	200	250	36405
2003	66	560	1183	2377	2242	1382	618	259	302	35381
2004	24	294	1042	1874	2264	1542	784	303	355	33650
2005	19	266	1179	1807	1904	1369	684	263	318	29255
2006	43	264	1327	2225	2652	1641	908	425	446	39343
2007	48	378	1382	1905	1450	1004	487	287	300	29227
2008	63	553	1955	2284	1857	1106	640	275	273	35552
2009	28	966	1500	1532	1573	902	433	187	288	29987
2010	118	728	1734	2712	2184	1002	815	277	474	40397

	Age									Tonnes
	2	3	4	5	6	7	8	9	10+	Landed
2011	74	702	1727	2917	1572	1002	523	287	508	36714
2012	408	1159	1376	1928	1660	918	458	254	503	35540
2013	131	571	1544	1609	1154	886	627	290	474	30144
2014	110	510	1020	1730	1440	1110	840	300	490	33660
2015	140	680	1470	1290	1950	1010	650	450	820	35843
2016	110	1630	1970	2220	1750	2130	1150	670	1070	54767
2017	190	860	1890	1980	2490	1580	1220	690	850	51053
2018	150	830	1580	1730	1600	1310	800	530	500	36375

Table 2.1b. Estimated commercial catch of coastal cod+NEA cod in 2018 by gear and area (t) within areas 00-07.

Year	2018						%
Area	03	04	00	05	06/07	Total	by gear
Gillnet	8 808	18 268	27 142	35 958	3 549	93 726	36.4
L.line/Jig	17 346	12 447	7 373	11 256	1 216	49 638	19.3
Danish seine	17 965	19 189	11 028	30 462	317	78 961	30.7
Trawl	12 722	16 958	0	4 454	717	34 851	13.5
Others	37	119	0	8	76	240	0.1
Total	56 879	66 981	45 544	82 138	5 875	257 416	

Table 2.1c. Estimated commercial catch of coastal cod in 2018 by gear and area (t) within areas 00-07

Year	2018				%
Area	03	04;05;00	06;07	Total	by gir
Gillnet	1 022	8 262	2 432	11 716	32.3
Trawl	881	2 364	519	3 764	10.4
Others	6 638	12 844	1 332	20 814	57.3
Total	8 541	23 470	4 283	36 294	

Table 2.1d. Norwegian coastal cod. Total estimated catch number ('000) at age, including recreational and tourist catches.

	AGE									Tonnes
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10+**	**landed**
1984	1479	5209	9070	8945	7198	5561	2397	952	624	77118
1985	3558	10438	9733	10444	7732	3291	835	512	264	76354
1986	4722	7128	15330	10565	6889	4303	1521	481	407	69607
1987	278	2912	12244	14611	5076	3080	1236	351	149	61774
1988	744	3328	4910	8159	8714	5237	1590	591	333	68665
1989	459	1984	2917	4057	6610	3238	1057	270	86	54942
1990	408	1843	2485	2012	3838	3906	846	141	73	35420
1991	1308	3305	4448	4456	2681	1880	977	203	94	40137
1992	469	1946	5509	5913	3622	2459	1744	921	279	54295
1993	51	1645	2994	3156	3530	3768	2073	995	690	65220
1994	389	1274	3416	5017	3755	4008	1907	901	798	66364
1995	818	1228	3149	6639	7131	4050	1868	737	433	79664
1996	1214	2967	2989	5547	6144	5533	2543	1125	543	56172
1997	1377	4145	4173	3021	3225	5124	4000	1091	684	65623
1998	803	3956	7113	5339	2857	1956	2155	1230	343	45072
1999	301	1788	3791	6202	3693	1959	949	995	320	49705
2000	219	1525	4817	5322	3715	1448	453	241	152	48415
2001	44	848	2572	4020	2962	2282	740	321	119	40653
2002	248	1191	3161	3877	3681	2134	1250	490	377	50005
2003	166	1449	2758	3422	3076	1824	842	584	99	49281
2004	38	560	1407	2637	2919	2271	967	388	264	47050
2005	36	744	1957	2686	2289	1830	936	364	143	42455
2006	90	551	2672	2562	2678	1858	986	453	224	52343
2007	137	861	2155	2805	1858	1355	718	413	196	42227
2008	107	1065	2181	2473	1882	1262	701	349	170	48352
2009	3	322	1628	2007	2251	1665	825	262	276	42687
2010	21	1103	2512	2945	1616	1092	652	308	272	53097
2011	43	912	2754	2566	2203	1636	704	333	455	49414

					AGE					Tonnes
	2	3	4	5	6	7	8	9	10+	landed
2012	30	622	1509	2066	2425	1771	821	472	638	48240
2013	140	843	2526	1928	1803	1054	788	384	340	42844
2014	36	1265	1908	2537	1556	1036	662	567	296	46360
2015	291	1240	2311	2438	2777	1892	997	638	895	48543
2016	384	2071	2283	2666	2311	2374	1198	682	906	67467
2017	338	2233	3090	3181	2938	2117	1572	832	962	63753
2018	202	1120	2132	2334	2159	1767	1079	715	675	49075

Table 2.1e. Norwegian coastal cod. Total estimated catch number ('000) at-age, in recreational and tourist catches.

					AGE					Tonnes
	2	3	4	5	6	7	8	9	10+	landed
1984	650	1731	2116	1667	1194	597	236	133		13300
1985	3162	2590	2366	1745	647	225	130	79	0	13400
1986	627	3033	2668	1659	1139	435	251	139	0	13500
1987	108	1972	4008	2181	649	431	109	38	0	13500
1988	634	1407	1567	1708	2088	550	129	94	0	13600
1989	418	825	1483	1758	1413	518	108	34	0	13700
1990	401	1494	1252	682	2709	450	73	0	0	14500
1991	1183	2698	2996	1342	808	583	104	71	0	15300
1992	429	1281	2349	1491	630	514	846	84	0	16100
1993	47	1276	1288	813	846	696	202	368	0	14800
1994	57	701	1723	715	1288	671	393	124	0	14700
1995	8	332	804	1451	1585	780	413	180	0	14700
1996	21	591	509	617	1497	1373	461	227	0	14500
1997	51	707	1023	763	735	1189	688	132	0	14500
1998	249	1137	2327	1316	585	410	329	255	0	14600
1999	49	466	1445	1939	920	357	198	221	0	13900
2000	63	554	1153	1515	1044	344	127	109	0	13600
2001	0	343	735	1046	964	873	198	134	0	13400

	AGE									Tonnes
	2	3	4	5	6	7	8	9	10+	landed
2002	56	298	830	1055	939	596	335	165	0	13600
2003	85	342	664	916	918	450	244	326	0	13900
2004	26	254	483	924	1099	827	358	162	0	13400
2005	21	270	658	858	853	715	423	176	0	13200
2006	19	236	1016	867	983	612	315	127	0	13000
2007	49	346	759	959	606	531	327	157	0	13000
2008	15	395	743	838	650	400	261	134	0	12800
2009	0	84	576	727	863	600	280	90	0	12700
2010	8	393	896	1050	576	389	232	110	97	12700
2011	13	281	847	789	678	503	216	102	140	12700
2012	9	177	430	588	690	504	234	134	182	12700
2013	51	305	912	696	651	380	284	139	123	12700
2014	13	448	676	898	551	367	234	201	105	12700
2015	71	302	563	594	676	461	243	155	218	12700
2016	85	459	506	591	512	526	265	151	201	12700
2017	66	432	598	616	569	410	304	161	186	12700
2018	52	290	552	604	559	457	279	185	175	12700

Table 2.2. Sampling from cod fisheries in 2018 in the statistical areas 00, 03, 04, 05, 06+07. Number of age samples of cod by quarter, and total number of cod otoliths.

Samples 2018 Quarter	03	04	00	05	06+07	Tot
1	18	54	110	104	49	335
2	26	34	23	19	28	130
3	4	7	34	4	9	58
4	21	23	71	2	26	143
Total samples	69	118	238	129	112	666
Total otoliths	1696	2622	2787	3047	1768	11920
Coastal cod type otoliths	501	818	1147	671	1435	4572

Table 2.3. Sampling from cod fisheries in 2017and 2016in the statistical areas 00, 03, 04, 05, 06+07. Number of age samples of cod by quarter, and total number of cod otoliths.

Samples 2017 Quarter	03	04	00	05	06+07	Tot
1	30	55	107	86	58	336
2	17	60	30	31	26	164
3	17	5	24	2	21	69
4	25	22	60	8	11	125
Total samples	89	142	221	127	116	694
Total otoliths	3271	4527	2716	3693	1860	16067
Coastal cod type otoliths	915	1133	982	755	1491	5196

Samples 2016 Quarter	03	04	00	05	06+07	Tot
1	46	42	107	99	40	330
2	38	30	26	10	27	131
3	8	7	4	5	8	32
4	18	23	7	15	19	82
Total samples	91	88	126	101	119	574
Total otoliths	3068	2703	2728	4058	2058	14615
Coastal cod type otoliths	845	906	687	1430	1787	5655

Table 2.4 Number of otoliths sampled by quarter from commercial catches in the period 1985–2018. Cc = coastal cod, NEAc = northeast Arctic cod.

	Quart	1	Quart	2	Quart	3	Quart	4	TOTAL	Total	
Year	Cc	NEAc	Cc	NEAc	Cc	NEAc	Cc	NEAc	CC	NEAc	%Cc
1985	1451	3852	777	1540	1277	1767	1966	730	5471	7889	41
1986	940	1594	1656	2579	0	0	669	966	3265	5139	39
1987	1195	2322	937	3051	638	1108	1122	1137	3892	7618	34
1988	257	546	160	619	87	135	55	44	559	1344	29
1989	556	1387	72	374	65	501	97	663	790	2925	21
1990	731	2974	61	689	252	97	265	674	1309	4434	23
1991	285	1168	92	561	77	96	279	718	733	2543	22
1992	152	619	281	788	79	82	272	672	784	2161	27
1993	314	1098	172	1046	0	0	310	541	796	2685	23
1994	317	1605	179	923	21	31	126	674	643	3233	17
1995	188	1591	232	1682	2095	1057	752	1330	3267	5660	37
1996	861	5486	591	1958	1784	1076	958	2256	4194	10776	28
1997	1106	5429	367	2494	1940	894	1690	1755	5103	10572	33
1998	608	4930	552	1342	489	1094	2999	2217	4648	9583	33
1999	1277	4702	493	2379	202	717	961	1987	2933	9785	23
2000	1283	4918	365	2112	386	1295	472	668	2506	9993	20
2001	1102	5091	352	2295	126	786	432	983	2012	9155	18
2002	823	5818	321	1656	503	831	897	1355	2544	9660	21
2003	821	4197	445	2850	790	936	1112	1286	3168	9269	25
2004	1511	7539	758	2565	532	685	531	1317	3332	12106	22
2005	1583	6219	767	4383	473	258	877	1258	3700	12188	23
2006	2244	5087	1329	2819	590	271	119	71	4282	8248	34
2007	1867	5895	944	2496	503	648	637	1163	3951	10202	28
2008	1450	4162	1116	3122	626	515	693	999	3885	8798	31
2009	1114	5109	558	2592	126	253	842	465	2640	8419	24
2010	736	2000	572	992	464	195	325	270	2097	3457	38
2011	643	2271	789	2548	412	296	732	443	2576	5558	32

Year	Quart 1 Cc	NEAc	Quart 2 Cc	NEAc	Quart 3 Cc	NEAc	Quart 4 Cc	NEAc	TOTAL CC	Total NEAc	%Cc
2012	1294	6283	749	1864	379	85	324	185	2746	8417	25
2013	966	5389	832	3155	216	88	1115	385	3129	9017	26
2014	1019	4470	869	3312	338	29	1060	524	3286	8335	28
2015	746	7770	618	3619	327	354	511	547	2202	12290	15
2016	2465	5581	1073	2445	616	207	1501	727	5655	8960	39
2017	2276	4568	879	2742	810	151	1231	475	5196	7936	40
2018	2007	4927	924	1882	498	104	1143	435	4572	7348	40
Av85-18	***1064***	***4018***	***614***	***2102***	***521***	***489***	***796***	***880***	***2996***	***7521***	***28***

Table 2.5. Coastal cod. Acoustic abundance indices by subareas and in total in 2018 (in thousands). Age 1 is not split between coastal cod and NEA cod.

	Age (Year class)										
Area	1 (17)	2 (16)	3 (15)	4 (14)	5 (13)	6 (12)	7 (11)	8 (10)	9 (09)	10+ (08+)	Sum
03	3313	914	883	874	614	401	145	103	65	93	7405
04	3577	1324	753	1147	688	812	329	85	69	115	8900
05	434	304	264	361	414	488	248	153	84	135	2884
00	1572	127	318	308	74	150	32	79	-	28	2688
06	2264	326	302	192	168	31	14	3	-	-	3300
07	-	-	17	58	252	124	37	21	39	-	548
Tot	11160	2995	2537	2940	2209	2006	805	444	257	371	25725

Table 2.6. Coastal cod. Acoustic abundance indices by age 1995–2018 (in thousands). Age 1 is not split between coastal cod and NEA cod. Fjords in area 07 not covered in 2013.

	Age										
Year	1	2	3	4	5	6	7	8	9	10+	Sum
1995	28707	20191	13633	15636	16219	9550	3174	1158	781	579	109628
1996	1756	17378	22815	12382	12514	6817	3180	754	242	5	77843
1997	30694	18827	28913	17334	12379	10612	3928	1515	26	663	124891
1998	14455	13659	15003	13239	7415	3137	1578	315	169	128	69099
1999	6850	11309	12171	10123	7197	3052	850	242	112	54	51960
2000	9587	11528	11612	8974	7984	5451	1365	488	85	97	57171
2001	8366	6729	7994	7578	4751	2567	1493	487	189	116	40270
2002	1329	2990	4103	4940	3617	2593	1470	408	29	128	21607
2003	2084	2145	3545	3880	2788	2389	1144	589	364	80	19008

	Age										
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10+**	**Sum**
2004	3217	3541	3696	4320	2758	1940	783	448	98	110	20914
2005	1443	1843	3525	3198	3217	1700	1120	552	330	78	17006
2006	1929	2525	4049	3783	3472	2509	1811	399	229	13	20719
2007	2202	3300	4080	5518	3259	2447	1444	760	197	34	23241
2008	2128	2181	2475	2863	2101	1219	815	403	319	177	14681
2009	3442	2059	2722	3959	2536	1603	1259	793	443	141	18955
2010	7768	2513	2729	2820	2417	1098	501	426	260	305	20837
2011	9015	3266	3950	4571	3012	2185	448	478	171	339	27435
2012	4887	2292	3003	2993	1990	1125	814	339	144	430	18015
2013	10478	3222	2780	3545	2742	2072	1164	971	449	431	27854
2014	5104	5516	3425	2659	4514	2660	2053	1189	980	676	28776
2015	6939	5084	3695	3441	2053	1984	1029	601	529	404	25759
2016	4857	4214	4850	3760	3108	1455	1022	955	187	474	24881
2017	1712	3950	4402	2910	2220	1412	664	436	248	234	18186
2018	11160	2995	2537	2940	2209	2006	805	444	257	371	25725

Table 2.7. Coastal cod. Mean length (cm) at-age 1995–2018.

	Age									
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10+**
1995	21.5	33.0	43.0	52.0	59.1	64.1	76.0	87.4	89.0	108.3
1996	19.0	30.2	41.7	52.5	59.2	65.2	79.1	84.8	87.0	114.2
1997	16.8	28.7	40.8	51.6	58.1	65.9	73.6	80.8	102.0	110.7
1998	20.3	33.3	43.8	51.4	59.1	66.3	74.1	81.0	93.2	116.9
1999	21.5	32.6	43.8	54.6	59.6	65.8	77.9	90.8	99.4	118.0
2000	21.6	33.3	43.4	53.5	61.0	66.1	75.5	90.8	99.1	105.5
2001	21.1	33.3	44.5	53.6	62.9	64.7	88.7	84.2	85.7	102.1
2002	22.5	34.4	44.6	56.0	61.6	67.7	72.4	66.6	89.0	108.3
2003	18.9	33.8	42.1	51.6	60.0	67.2	72.7	76.9	84.9	94.8
2004	20.7	32.9	43.5	54.5	59.9	68.0	71.9	75.0	74.6	91.8
2005	22.5	32.8	42.2	57.9	60.6	64.0	71.3	69.9	73.5	108.4
2006	22.2	36.1	47.0	55.5	61.4	68.0	69.5	77.8	87.0	100.5
2007	21.6	36.0	48.0	57.9	62.2	66.8	71.8	86.6	100.2	106.3
2008	21.9	36.9	49.2	59.0	66.1	70.9	71.7	74.1	77.6	98.8
2009	20.9	34.5	47.8	57.8	65.8	70.5	77.9	78.4	85.1	73.5
2010	20.3	34.9	46.4	57.5	64.6	71.2	76.9	75.2	78.9	82.7
2011	20.6	32.9	47.2	59.5	66.1	71.5	79.9	82.0	81.1	83.9
2012	21.3	32.4	46.9	58.8	66.1	72.0	77.0	77.5	82.2	87.3
2013	21.5	33.6	44.5	56.7	66.2	71.3	74.2	84.2	84.6	88.1
2014	21.7	35.1	47.7	57.3	66.4	73.5	76.6	80.5	81.7	93.0
2015	19.9	33.5	46.9	58.0	66.5	70.3	77.8	77.7	80.5	85.5
2016	20.5	32.9	47.8	58.7	67.8	72.2	75.1	83.0	89.7	86.9
2017	23.5	35.6	47.2	58.3	66.1	72.6	75.2	82.4	82.6	91.2
2018	19.4	35.4	47.7	58.8	68.1	71.3	79.8	80.3	85.5	84.4

Table 2.8. Coastal cod. Mean weight (grammes) at-age 1995–2018.

	Age									
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10+**
1995	81	390	791	1525	2222	2881	4665	6979	6759	9897
1996	59	252	724	1433	2053	2748	4722	6685	6932	9723
1997	43	240	683	1364	1893	2816	4426	6406	7805	1827
1998	52	372	883	1456	2107	2950	4319	5625	8323	12468
1999	70	323	841	1675	2192	2857	4540	6579	9454	12902
2000	72	365	809	1554	2539	3049	4352	6203	8527	12066
2001	51	396	966	1524	2314	3320	3695	6144	8768	12468
2002	103	428	895	1741	2433	3133	4273	4397	7759	12992
2003	62	385	738	1353	2145	3103	3981	4921	6923	9956
2004	83	352	834	1690	2255	3312	4150	4594	4383	9733
2005	112	359	786	2168	2265	2756	4174	3373	4502	15887
2006	105	474	1080	1746	2430	3336	3684	5125	7028	14650
2007	103	518	1185	2011	2500	3160	4241	6806	11051	14931
2008	96	508	1208	2095	2987	3671	3976	4387	5415	11588
2009	85	434	1116	2003	2894	3632	4875	5400	6125	4719
2010	75	419	1026	1996	2839	3665	4868	4895	5685	6504
2011	77	343	1062	2119	2882	3761	5505	6336	6309	6570
2012	89	336	1038	2006	2998	3727	4783	5071	5851	7446
2013	88	365	851	1815	2856	3561	4122	6435	5974	7670
2014	93	423	1071	1845	2886	3905	4495	5249	5871	8762
2015	75	370	1045	1940	2910	3518	4927	4753	5868	7277
2016	77	344	1121	2033	3081	3734	4286	5895	7556	6980
2017	78	421	1026	1868	2687	3746	4419	6050	6887	7637
2018	69	392	1158	1948	3192	3705	5304	5354	6428	6038

Table 2.9. Coastal cod. Acoustic biomass indices (tonnes) in 1995–2018. Age 1 is not split between coastal cod and NEA cod. Fjords in area 07 not covered in 2013 and partly covered in 2016.

	Age										
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10+**	**Sum**
1995	2337	7868	10786	23846	36039	27515	14445	8761	4933	7779	144309
1996	145	4386	16521	17739	25687	18731	15562	4376	3130	46	106323
1997	1319	4518	19748	23644	23435	29884	15060	8860	249	8643	135360
1998	752	5078	13247	19274	15627	9255	6675	1646	1329	2083	74966
1999	477	3650	10233	16960	15774	8720	4723	2097	1220	567	64421
2000	688	4321	9824	14464	20482	17067	5936	4359	926	1232	79299
2001	425	2662	7724	11548	10993	8521	5517	3010	1705	1917	54022
2002	137	1279	3672	8600	8801	8124	6282	1794	225	1663	40577
2003	125	876	2569	5328	5788	6995	4201	2754	2674	1136	32446
2004	329	1269	3087	7394	6089	6901	3009	1779	454	1058	31405
2005	109	675	2947	6521	7167	4807	3648	1942	1315	1205	30336
2006	202	1197	4374	6605	8435	8367	6672	2045	1602	190	39689
2007	227	1709	4835	11097	8148	7733	6124	5173	2177	508	47731
2008	206	1212	3120	6085	6593	4203	3437	2014	1492	2066	30506
2009	294	893	3037	7933	7335	5821	6137	4282	2707	665	39107
2010	583	1053	2800	5629	6862	4024	2439	2085	1478	1984	28936
2011	695	1120	4195	9686	8681	8218	2466	3029	1079	2227	41396
2012	295	767	2974	5914	5574	4143	3820	1673	775	3265	29199
2013	519	1192	2767	6890	8067	7252	4756	5937	2797	3178	43355
2014	456	2218	3849	5026	13418	9994	9691	6367	7308	6608	64935
2015	424	1972	3872	6423	5646	6546	4587	2747	3172	2794	38183
2016	250	1364	5792	7746	10236	5409	4165	6091	1322	3657	46023
2017	133	1664	4517	5436	5965	5289	2934	2638	1708	1787	32070
2018	770	1173	2939	5726	7051	7433	4270	2377	1652	2240	35631

Table 2.10. Coastal cod. Maturity-at-age as determined from maturity stages observed in the surveys over the period 1995 – 2018. Age 1 is not split between coastal cod and NEA cod.

Year	AGE									
	1	2	3	4	5	6	7	8	9	10+
1995	0.00	0.00	0.01	0.21	0.48	0.71	0.87	0.87	1.00	1.00
1996	0.00	0.00	0.03	0.25	0.56	0.81	0.92	0.99	1.00	1.00
1997	0.00	0.00	0.06	0.29	0.45	0.76	0.97	1.00	1.00	1.00
1998	0.00	0.02	0.15	0.25	0.53	0.74	0.87	0.89	1.00	1.00
1999	0.00	0.02	0.03	0.21	0.43	0.66	0.74	1.00	1.00	1.00
2000	0.00	0.00	0.00	0.16	0.31	0.61	0.76	0.64	0.99	1.00
2001	0.00	0.00	0.00	0.04	0.37	0.78	0.98	0.99	0.97	1.00
2002	0.00	0.02	0.02	0.26	0.88	0.93	0.90	0.97	1.00	1.00
2003	0.00	0.00	0.00	0.05	0.29	0.49	0.90	0.98	0.96	1.00
2004	0.00	0.00	0.01	0.09	0.37	0.76	0.95	0.98	1.00	1.00
2005	0.00	0.00	0.00	0.07	0.40	0.56	0.89	0.98	1.00	1.00
2006	0.00	0.00	0.00	0.14	0.52	0.75	0.91	0.87	0.96	1.00
2007	0.00	0.00	0.00	0.14	0.54	0.76	0.96	0.83	1.00	1.00
2008	0.00	0.00	0.03	0.12	0.48	0.72	0.89	0.94	0.96	1.00
2009	0.00	0.00	0.02	0.06	0.26	0.35	0.59	0.74	0.60	0.92
2010	0.00	0.00	0.00	0.08	0.38	0.66	0.83	0.88	0.95	0.97
2011	0.00	0.01	0.00	0.06	0.42	0.73	0.81	0.53	0.92	0.85
2012	0.00	0.00	0.01	0.05	0.38	0.66	0.90	0.92	0.97	0.99
2013	0.00	0.00	0.00	0.01	0.32	0.65	0.86	0.94	0.99	0.96
2014	0.00	0.00	0.00	0.06	0.24	0.66	0.81	0.94	1.00	0.97
2015	0.00	0.00	0.00	0.07	0.23	0.57	0.75	0.88	0.89	0.94
2016	0.00	0.00	0.00	0.09	0.30	0.59	0.83	0.85	0.97	1.00
2017	0.00	0.00	0.00	0.07	0.30	0.65	0.88	0.94	0.97	0.97
2018	0.00	0.00	0.01	0.15	0.41	0.69	0.83	0.95	1.00	0.92

Table 2.11. Coastal cod. Acoustic spawning biomass indices (tonnes) 1995–2018, corresponding to maturities in Table 2.10. Age 1 is not split between coastal cod and NEA cod.

Year	Age										
	1	2	3	4	5	6	7	8	9	10+	Sum
1995	0	0	96	4925	17424	19614	12573	7648	4933	7779	74992
1996	0	0	468	4467	14320	15130	14365	4311	3130	46	56237
1997	0	0	1185	6857	10546	22712	14608	8860	249	8643	73660
1998	0	92	2026	4870	8252	6804	5774	1461	1329	2083	32691
1999	0	56	315	3544	6778	5716	3478	2097	1220	567	23771
2000	0	0	0	2366	6354	10426	4486	2798	916	1232	28579
2001	0	0	15	508	4102	6662	5398	2978	1650	1917	23230
2002	0	20	87	2240	7702	7551	5650	1747	225	1663	26885
2003	0	0	0	269	1670	3428	3778	2686	2554	1136	15521
2004	0	0	28	679	2252	5253	2853	1736	434	722	13959
2005	0	0	0	447	2844	2670	3247	1898	1315	288	12709
2006	0	0	0	925	4386	6275	6072	1779	1538	571	21546
2007	0	0	0	1554	4400	5877	5879	4294	2177	508	24689
2008	0	0	107	734	3189	3012	3049	1902	1434	2066	15493
2009	0	0	61	476	1907	2037	3621	3169	1624	612	13508
2010	0	0	0	450	2608	2656	2024	1835	1404	1924	12901
2011	0	11	0	581	3646	5999	1997	1605	993	1893	16725
2012	0	0	22	278	2126	2748	3457	1539	755	3219	14143
2013	0	0	0	56	2580	4713	4112	5576	2773	3046	22856
2014	0	0	0	314	3222	6593	7831	5958	7307	6433	37659
2015	0	0	0	457	1301	3719	3436	2414	2811	2627	16763
2016	0	0	0	725	3084	3196	3464	5190	1278	3657	20597
2017	0	0	0	734	1779	3464	2582	2489	1662	1729	14078
2018	0	0	29	859	2891	5129	3544	2258	1652	2061	18423

Table 2.12. Proportion coastal cod among sampled cod during the coastal survey by age and statistical areas in the years 2005–2018. Age 1 is not split between coastal cod and NEA cod.

Year	Area/Age	2	3	4	5	6	7	8	9	10+
2005	3	0.63	0.54	0.54	0.45	0.35	0.30	0.20	0.48	0.03
2005	4	0.96	0.91	0.76	0.74	0.71	0.60	0.76	0.81	0.50
2005	5	0.00	0.54	0.65	0.68	0.52	1.00	1.00	0.67	
2005	0	0.11	0.39	0.70	0.61	0.70	0.85	0.50	1.00	
2005	6	1.00	1.00	0.93	0.87	0.81	0.81	0.59	0.96	
2005	7	1.00	1.00	1.00	1.00	1.00	0.86	0.67	0.00	
2006	3	0.79	0.77	0.63	0.59	0.45	0.37	0.30	0.39	0.00
2006	4	1.00	0.88	0.84	0.79	0.68	0.63	0.82	0.40	0.42
2006	5	1.00	0.98	0.81	0.88	0.77	0.63	0.80	0.00	0.50
2006	0	0.99	0.99	0.95	0.87	0.86	0.89	0.85	0.33	
2006	6	1.00	1.00	0.95	0.99	0.80	0.72	1.00	0.67	
2006	7	1.00	0.97	0.95	0.98	0.89	1.00	0.50		
2007	3	0.83	0.38	0.40	0.59	0.27	0.32	0.00	1.00	
2007	4	0.91	0.92	0.92	0.80	0.80	0.90	0.71	0.67	1.00
2007	5	0.97	1.00	0.97	0.94	0.94	0.95	0.86	0.67	0.00
2007	0	1.00	0.88	1.00	1.00	1.00	0.00	1.00	1.00	

Year	Area/Age	2	3	4	5	6	7	8	9	10+
2007	6	1.00	1.00	0.95	0.87	0.91	0.81			
2007	7	1.00	1.00	1.00	0.89	0.86	0.86	1.00	1.00	1.00
2008	3	0.98	0.97	0.80	0.83	0.79	0.72	0.53	1.00	0.40
2008	4	1.00	0.99	0.80	0.88	0.84	0.78	0.88	0.88	0.86
2008	5	1.00	1.00	0.93	0.96	1.00	0.80	0.67	1.00	1.00
2008	0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
2008	6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2008	7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2009	3	0.90	0.72	0.54	0.44	0.48	0.57	0.79	0.67	0.58
2009	4	0.95	0.89	0.78	0.62	0.69	0.92	0.72	0.78	0.79
2009	5	1.00	1.00	0.95	0.84	0.78	0.82	0.88	0.67	1.00
2009	0	1.00	1.00	1.00	1.00	1.00	1.00	0.50	1.00	
2009	6	1.00	1.00	1.00	1.00	0.82	1.00	1.00	1.00	0.50
2009	7	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00
2010	3	0.86	0.78	0.56	0.47	0.36	0.37	0.81	0.89	0.95
2010	4	0.98	0.96	0.87	0.71	0.49	0.77	0.87	1.00	1.00
2010	5	1.00	0.98	1.00	1.00	0.84	0.88	1.00	0.73	1.00

Year	Area/Age	2	3	4	5	6	7	8	9	10+
2010	0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2010	6	1.00	1.00	1.00	1.00	1.00	1.00		1.00	1.00
2010	7	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
2011	3	0.83	0.83	0.78	0.67	0.44	0.28	0.70	0.73	0.67
2011	4	0.99	0.99	0.95	0.87	0.79	0.77	0.74	0.93	1.00
2011	5	0.97	1.00	1.00	0.93	0.75	0.71	0.75		0.83
2011	0	1.00	1.00	1.00	1.00	1.00		1.00		
2011	6	1.00	1.00	1.00	1.00	1.00		1.00		1.00
2011	7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2012	3	0.50	0.83	0.65	0.67	0.51	0.51	0.49	0.78	0.64
2012	4	0.29	0.93	0.94	0.93	0.87	0.91	0.77	0.90	0.93
2012	5	0.84	0.91	0.92	0.89	0.72	0.83	0.75	0.80	0.89
2012	0	1.00	1.00	1.00	1.00	1.00		1.00	1.00	1.00
2012	6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2012	7	1.00	1.00	1.00	1.00	1.00	1.00	0.50		
2013	3	0.87	0.79	0.58	0.54	0.73	0.59	057	0.58	1.00
2013	4	0.98	0.94	0.90	0.87	0.77	0.76	0.89	0.80	1.00

Year	Area/Age	2	3	4	5	6	7	8	9	10+
2013	5	1.00	1.00	1.00	1.00	0.95	1.00	0.94	1.00	1.00
2013	0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2013	6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2013	7	1.00		1.00	1.00	1.00	1.00	0.50		
2014	3	0.99	0.98	0.92	0.84	0.76	0.85	0.68	0.73	0.70
2014	4	0.99	1.00	1.00	0.99	0.99	0.98	0.96	0.94	1.00
2014	5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00
2014	0	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00
2014	6	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
2014	7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2015	3	0.90	0.84	0.80	0.68	0.56	0.46	0.66	0.85	0.69
2015	4	0.93	0.89	0.89	0.77	0.81	0.68	0.68	0.71	0.86
2015	5	0.97	1.00	0.93	1.00	0.91	0.93	1.00	1.00	1.00
2015	0	1.00	1.00	1.00	1.00	1.00	0.92	0.75	1.00	1.00
2015	6	1.00	1.00	0.97	1.00	1.00	1.00	1.00	1.00	
2015	7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
2016	3	0.95	0.97	0.85	0.74	0.47	0.53	0.50	0.32	0.19
2016	4	0.99	0.98	0.89	0.84	0.71	0.72	0.64	0.59	0.16
2016	5	0.92	0.90	0.89	0.86	0.75	0.71	0.62	0.21	0.25
2016	0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00

Year	Area/Age	2	3	4	5	6	7	8	9	10+
2016	6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2016	7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2017	3	0.97	0.92	0.9	0.81	0.70	0.64	0.50	0.86	0.83
2017	4	0.98	0.97	0.94	0.82	0.64	0.76	0.87	0.75	0.88
2017	5	1.00	1.00	1.00	1.00	0.94	1.00	0.92	1.00	0.94
2017	0	1.00	1.00	1.00	1.00	1.00	0.00	0.00	1.00	
2017	6	1.00	1.00	0.94	0.94	1.00	1.00	1.00	1.00	
2017	7	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
2018	3	0.93	0.88	0.76	0.86	0.75	0.52	0.48	0.71	0.83
2018	4	0.99	0.95	0.93	0.87	0.81	0.71	0.85	1.00	0.83
2018	5	0.96	0.90	0.92	0.94	0.96	0.97	0.85	0.85	0.94
2018	0	0.97	1.00	1.00	1.00	1.00	1.00	1.00		
2018	6		1.00	1.00	1.00	1.00	1.00	1.00	1.00	
2018	7	0.93	0.88	0.76	0.86	0.75	0.52	0.48	0.71	0.83

Table 2.13. Norwegian Coastal Cod. Stock weight (SWT), catch weights (CWT) and proportion mature (MAT). Input data to all the VPA-analysis. Proportions of F and M before time of spawning was set to 0 for all ages and years.

SWT	2	3	4	5	6	7	8	9	10
1984	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.98	9.723
1985	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.98	9.723
1986	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.98	9.723
1987	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.98	9.723
1988	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.98	9.723
1989	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.98	9.723
1990	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.98	9.723
1991	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.98	9.723
1992	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.98	9.723
1993	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.98	9.723
1994	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.98	9.723
1995	0.298	0.7	1.338	1.973	2.649	4.164	7.051	6.41	14.326
1996	0.27	0.717	1.435	2.044	2.694	4.817	6.28	11.37	15.67
1997	0.232	0.677	1.363	1.903	2.816	3.833	5.849	9.60	13.037
1998	0.323	0.834	1.366	2.075	3.013	4.255	5.305	8.35	18.016
1999	0.318	0.804	1.559	2.042	2.798	4.678	7.151	8.96	18.340

SWT	2	3	4	5	6	7	8	9	10
2000	0.346	0.777	1.458	2.296	2.735	4.048	7.011	9.22	12.277
2001	0.347	0.878	1.543	2.213	2.862	3.321	4.849	7.339	11.542
2002	0.43	0.88	1.698	2.452	3.538	4.397	4.191	7.046	15.619
2003	0.308	0.686	1.299	2.149	3.135	4.048	5.008	5.789	10.069
2004	0.339	0.834	1.614	2.269	3.29	4.124	4.718	4.976	6.358
2005	0.407	0.846	1.748	2.2	2.693	3.817	3.797	5.344	14.829
2006	0.49	1.125	1.812	2.559	3.579	3.964	4.822	7.332	14.65
2007	0.518	1.185	2.011	2.5	3.16	4.241	6.806	11.051	14.931
2008	0.508	1.208	2.095	2.987	3.671	3.976	4.387	5.415	11.558
2009	0.434	1.116	2.003	2.894	3.632	4.875	5.4	6.125	4.719
2010	0.419	1.026	1.996	2.839	3.665	4.868	4.895	5.685	6.504
2011	0.343	1.062	2.119	2.882	3.761	5.505	6.336	6.309	6.57
2012	0.336	1.038	2.006	2.998	3.727	4.783	5.071	5.851	7.446
2013	0.365	0.851	1.815	2.856	3.561	4.122	6.435	5.974	7.67
2014	0.423	1.071	1.845	2.886	3.905	4.495	5.249	5.871	8.762
2015	0.37	1.045	1.94	2.91	3.518	4.927	4.753	5.864	7.277
2016	0.344	1.121	2.033	3.081	3.734	4.286	5.895	7.556	6.984

SWT	2	3	4	5	6	7	8	9	10
2017	0.421	1.026	1.868	2.687	3.746	4.419	6.05	6.887	7.637
2018	**0.392**	**1.158**	**1.948**	**3.192**	**3.705**	**5.305**	**5.354**	**6.428**	**6.038**
CWT	2	3	4	5	6	7	8	9	10
1984	0.832	1.262	1.873	2.608	3.52	5.202	6.23	7.186	14.435
1985	0.893	1.288	1.929	2.63	3.819	5.023	6.432	8.053	14.074
1986	0.225	0.539	1.531	2.393	3.354	4.72	6.13	7.309	14.555
1987	0.423	0.842	1.386	2.266	3.602	4.861	6.287	8.098	19.751
1988	0.349	0.741	1.299	1.878	3.074	4.493	5.898	7.219	18.64
1989	0.647	1.127	1.429	2.136	2.958	4.164	5.155	5.897	11.31
1990	0.779	1.294	1.796	2.5	3.354	4.326	5.326	6.379	13.051
1991	1.069	1.602	2.17	2.811	3.52	4.302	5.043	5.736	9.886
1992	1.009	1.481	2.081	2.748	3.466	4.397	5.16	5.972	10.286
1993	1.028	1.64	2.2	2.903	3.616	4.344	5.204	5.764	8.154
1994	0.882	1.396	1.912	2.567	3.412	4.239	5.017	6.175	9.328
1995	0.732	1.239	1.744	2.302	3.137	4.299	5.424	6.273	9.847
1996	0.845	1.432	2.122	2.93	3.454	4.176	5.135	6.016	9.25
1997	1.053	1.694	2.126	2.959	3.529	4.313	5.427	6.424	8.668

SWT	2	3	4	5	6	7	8	9	10
1998	0.789	1.335	1.779	2.556	3.55	4.24	5.066	5.761	10.589
1999	1	1.603	2.045	2.607	3.492	4.317	4.956	5.742	8.169
2000	1.075	1.551	2.205	2.75	3.587	4.483	5.607	6.187	10.939
2001	0.913	1.496	2.055	2.631	3.381	4.143	5.065	5.719	9.9
2002	0.973	1.733	2.352	2.972	3.98	4.877	5.646	6.883	11.221
2003	1.136	1.861	2.391	3.226	3.956	4.983	5.697	6.056	9.653
2004	1.063	1.857	2.308	2.883	3.79	4.769	5.644	6.239	8.494
2005	1.105	1.811	2.468	2.992	3.574	4.354	5.082	5.848	8.342
2006	1.326	1.737	2.244	3.094	3.794	4.522	5.375	6.296	8.802
2007	1.206	1.82	2.518	3.154	4.334	5.028	5.764	7.044	9.432
2008	1.27	1.76	2.693	3.239	4.137	5.264	5.97	6.69	9.77
2009	1.459	1.92	2.719	3.513	4.355	5.411	6.492	7.43	9.345
2010	1.232	1.903	2.703	3.441	4.31	5.127	5.503	6.654	8.374
2011	1.142	1.767	2.464	3.279	4.293	5.177	6.19	6.733	8.77
2012	1.091	1.736	2.549	3.493	4.571	5.635	6.724	7.532	10.09
2013	1.133	1.706	2.422	3.176	4.142	4.984	5.968	6.869	11.008
2014	1.214	1.915	2.609	3.385	4.302	5.336	6.048	6.725	9.785

SWT	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2015	1.095	1.633	2.272	3.195	3.977	4.952	5.881	6.722	9.119
2016	1.312	1.867	2.537	3.319	4.165	5.005	5.99	6.964	9.069
2017	**1.14**	**1.801**	**2.487**	**3.213**	**3.919**	**5.022**	**6**	**7.036**	**9.827**
2018	1.132	1.698	2.319	3.14	3.932	4.888	5.836	6.675	9.498
MAT	2	3	4	5	6	7	8	9	10
1984	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
1985	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
1986	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
1987	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
1988	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
1989	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
1990	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
1991	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
1992	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
1993	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
1994	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
1995	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1

SWT	2	3	4	5	6	7	8	9	10
1996	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
1997	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
1998	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
1999	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
2000	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
2001	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
2002	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
2003	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
2004	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
2005	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
2006	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
2007	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
2008	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
2009	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
2010	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
2011	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
2012	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1

SWT	2	3	4	5	6	7	8	9	10
2013	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
2014	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1
2015	0	0.02	0.16	0.46	0.69	0.87	0.91	0.96	1

Table 2.14. Norwegian Coastal Cod. Diagnostic output from XSA trial run based on commercial catch-at-age and survey index at age (ages 2–8 in Table 2.6). Proportions of F and M before time of spawning has been set to 0 for all years and ages.

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Lowestoft VPA Version 3.1

 28/04/2019  19:39

Extended Survivors Analysis

Norwegian Coastal Cod,COMBSEX,PLUSGROUP

CPUE data from file coast-9.txt

Catch data for  35 years. 1984 to 2018. Ages  2 to  10.

   Fleet,           First, Last, First, Last, Alpha,  Beta
                ,    year, year,  age ,  age
Norw. Coast. survey ,   1995, 2018,   0,     8,   .750,   .850


Time-series weights :

   Tapered time weighting applied
   Power =    3 over  20 years


Catchability analysis :

   Catchability dependent on stock size for ages <
4

      Regression type = C
      Minimum of   5 points used for regression
      Survivor estimates shrunk to the population mean for ages <  4


   Catchability independent of age for ages >=    7


Terminal population estimation :

   Survivor estimates shrunk towards the mean F
   of the final   2 years or the   4 oldest ages.

   S.E. of the mean to which the estimates  are shrunk =   1.000

   Minimum standard error for
population
```

estimates derived from each fleet = .300

Prior weighting not applied

Tuning had not converged after 60 iterations

Total absolute residual between iterations
59 and 60 = .00454

Final year F values
Age , 2, 3, 4, 5, 6, 7, 8, 9
Iteration 59, .0069, .0475, .1564, .2665, .2968, .4494, .5547, .5895
Iteration 60, .0069, .0475, .1564, .2671, .2977, .4498, .5538, .5911

1

Regression weights
, .751, .820, .877, .921, .954, .976, .990, .997, 1.000, 1.000

Fishing mortalities
Age, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018

2, .001, .005, .003, .021, .006, .005, .008, .006, .009, .007
3, .046, .038, .037, .056, .037, .028, .040, .115, .063, .048
4, .100, .110, .121, .096, .099, .087, .107, .156, .190, .156
5, .198, .265, .273, .192, .155, .154, .151, .234, .232, .267
6, .319, .480, .241, .246, .168, .202, .259, .314, .447, .298
7, .273, .345, .423, .216, .200, .243, .213, .503, .523, .450
8, .170, .426, .305, .348, .225, .297, .219, .400, .610, .554
9, .141, .157, .260, .238, .388, .160, .256, .368, .447, .591

1

XSA population numbers (Thousands)

	AGE						
YEAR ,	2,	3,	4,	5,	6,	7,	8,	9,
2009 ,	2.61E+04,	2.36E+04,	1.74E+04,	9.43E+03,	6.37E+03,	4.17E+03,	3.06E+03,	1.57E+03,
2010 ,	2.60E+04,	2.13E+04,	1.84E+04,	1.29E+04,	6.34E+03,	3.79E+03,	2.59E+03,	2.11E+03,
2011 ,	2.87E+04,	2.11E+04,	1.68E+04,	1.35E+04,	8.10E+03,	3.21E+03,	2.20E+03,	1.39E+03,
2012 ,	2.15E+04,	2.34E+04,	1.67E+04,	1.22E+04,	8.42E+03,	5.21E+03,	1.72E+03,	1.33E+03,
2013 ,	2.47E+04,	1.72E+04,	1.81E+04,	1.24E+04,	8.23E+03,	5.39E+03,	3.44E+03,	9.96E+02,
2014 ,	2.36E+04,	2.01E+04,	1.36E+04,	1.34E+04,	8.71E+03,	5.69E+03,	3.61E+03,	2.25E+03,
2015 ,	2.03E+04,	1.92E+04,	1.60E+04,	1.02E+04,	9.43E+03,	5.82E+03,	3.66E+03,	2.20E+03,
2016 ,	1.93E+04,	1.65E+04,	1.51E+04,	1.18E+04,	7.17E+03,	5.96E+03,	3.85E+03,	2.41E+03,
2017 ,	2.43E+04,	1.57E+04,	1.21E+04,	1.06E+04,	7.63E+03,	4.29E+03,	2.95E+03,	2.12E+03,
2018 ,	2.40E+04,	1.98E+04,	1.21E+04,	8.16E+03,	6.87E+03,	4.00E+03,	2.08E+03,	1.31E+03,

Estimated population abundance at 1st Jan 2019

,	0.00E+00,	1.95E+04,	1.54E+04,	8.44E+03,	5.11E+03,	4.17E+03,	2.09E+03,	9.80E+02,

Taper weighted geometric mean of the VPA populations:

,	2.38E+04,	1.94E+04,	1.52E+04,	1.14E+04,	7.76E+03,	4.72E+03,	2.79E+03,	1.65E+03,

Standard error of the weighted Log(VPA populations) :

,	.1241,	.1307,	.1452,	.1517,	.1219,	.1920,	.2536,	.3067,
				1				

Log catchability residuals.

Fleet : Norw. Coast. survey

Age ,	1995,	1996,	1997,	1998
2 ,	99.99,	99.99,	99.99,	99.99
3 ,	99.99,	99.99,	99.99,	99.99
4 ,	99.99,	99.99,	99.99,	99.99
5 ,	99.99,	99.99,	99.99,	99.99
6 ,	99.99,	99.99,	99.99,	99.99
7 ,	99.99,	99.99,	99.99,	99.99

8 , 99.99, 99.99, 99.99,
99.99

Age	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
2	-1.62	-1.55	-.93	.06	.45	-.04	.74	.40	-.15	.25
3	-1.41	-1.37	-.91	-.26	-.06	-.07	.05	-.04	-.03	.20
4	.91	.79	.58	.23	-.03	.15	-.13	.12	.54	-.03
5	1.07	1.09	.45	.16	-.06	-.14	.10	.23	.24	-.09
6	1.05	1.34	.44	.38	.25	.09	-.20	.41	.29	-.26
7	.73	.93	.72	.48	.26	-.18	.21	.51	.47	-.25
8	.32	.88	.44	-.02	.07	-.06	.03	-.16	.08	-.30

Age	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
2	.41	.19	-.20	.47	-.04	-.60	-.36	-.10	-.26	.07
3	.02	.12	-.22	-.08	.32	-.03	-.06	-.23	-.05	.26
4	-.01	-.40	.19	-.25	-.16	-.17	-.06	.13	.12	.11
5	.12	-.19	-.01	-.39	-.11	.30	-.21	.13	-.10	.18
6	.12	-.13	.12	-.58	.00	.22	-.11	-.10	-.09	.25
7	.35	-.42	-.31	-.36	-.05	.50	-.24	-.04	-.12	.08
8	.11	-.14	.04	-.02	.24	.45	-.30	.25	-.10	.05

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	4	5	6	7	8
Mean Log q	-1.2323	-1.1121	-1.0807	-1.1661	-1.1661
S.E(Log q)	.2226	.2125	.2604	.3253	.2233

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
2	-1.13	-2.320	19.37	.11	20	.38	-1.84

3, -.96, -4.185, 17.83, .31, 20, .20, -1.54,

Ages with q independent of year class strength and constant w.r.t. time.

Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e, Mean Q

4, 2.56, -1.376, -11.90, .07, 20, .55, -1.23,
5, 1.18, -.341, -.34, .27, 20, .26, -1.11,
6, 1.29, -.339, -1.23, .12, 20, .35, -1.08,
7, .77, .554, 2.81, .37, 20, .26, -1.17,
8, .82, .797, 2.33, .67, 20, .19, -1.14,

Terminal year survivor and F summaries :

Age 2 Catchability dependent on age and year class strength

Year class = 2016

Fleet, Estimated, Int, Ext, Var, N, Scaled, Estimated
, Survivors, s.e, s.e, Ratio, , Weights, F
Norw. Coast. survey , 20907., .395, .000, .00, 1, .097, .006

P shrinkage mean , 19388., .13,,,, .888, .007

F shrinkage mean , 18008., 1.00,,,, .015, .008

Weighted prediction :

Survivors, Int, Ext, N, Var, F
at end of year, s.e, s.e, , Ratio,
19508., .12, .05, 3, .422, .007

Age 3 Catchability dependent on age and year class strength

Year class = 2015

Fleet, Estimated, Int, Ext, Var, N, Scaled, Estimated
, Survivors, s.e, s.e, Ratio, , Weights, F
Norw. Coast. survey , 16611., .240, .249, 1.04, 2, .254, .044

P shrinkage mean , 15225., .15,,,, .731,
.048

F shrinkage mean , 8045., 1.00,,,, .015,
.089

Weighted prediction :

Survivors, Int, Ext, N, Var, F
at end of year, s.e, s.e, , Ratio,
15414., .12, .10, 4, .802, .048

1
Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2014

Fleet, Estimated, Int, Ext, Var, N, Scaled, Estimated
, Survivors, s.e, s.e, Ratio, , Weights, F
Norw. Coast. survey , 8486., .188, .061, .32, 3, .959, .156

F shrinkage mean , 7533., 1.00,,,, .041,
.174

Weighted prediction :

Survivors, Int, Ext, N, Var, F
at end of year, s.e, s.e, , Ratio,
8444., .18, .05, 4, .273, .156

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 2013

Fleet, Estimated, Int, Ext, Var, N, Scaled, Estimated
, Survivors, s.e, s.e, Ratio, , Weights, F
Norw. Coast. survey , 5076., .162, .123, .76, 4, .961, .269

F shrinkage mean , 5941., 1.00,,,, .039,
.234

Weighted prediction :

Survivors, Int, Ext, N, Var, F
at end of year, s.e, s.e, , Ratio,

5107., .16, .11, 5, .657, .267

1
Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 2012

Fleet, Estimated, Int, Ext, Var, N, Scaled, Estimated
, Survivors, s.e, s.e, Ratio, , Weights, F
Norw. Coast. survey , 4210., .144, .119, .82, 5, .966, .296

F shrinkage mean , 3099., 1.00,,,, .034,
.383

Weighted prediction :

Survivors, Int, Ext, N, Var, F
at end of year, s.e, s.e, , Ratio,
4166., .14, .11, 6, .747, .298

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 2011

Fleet, Estimated, Int, Ext, Var, N, Scaled, Estimated
, Survivors, s.e, s.e, Ratio, , Weights, F
Norw. Coast. survey , 2102., .137, .037, .27, 6, .956, .447

F shrinkage mean , 1751., 1.00,,,, .044,
.517

Weighted prediction :

Survivors, Int, Ext, N, Var, F
at end of year, s.e, s.e, , Ratio,
2085., .14, .04, 7, .264, .450

1
Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 2010

Fleet, Estimated, Int, Ext, Var, N, Scaled, Estimated
, Survivors, s.e, s.e, Ratio, , Weights, F
Norw. Coast. survey , 974., .133, .076, .57, 7, .951, .556

F shrinkage mean , 1090., 1.00,,,, .049,
.509

Weighted prediction :

Survivors, Int, Ext, N, Var, F
at end of year, s.e, s.e, , Ratio,
980., .14, .07, 8, .508, .554

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 2009

Fleet, Estimated, Int, Ext, Var, N, Scaled, Estimated
, Survivors, s.e, s.e, Ratio, , Weights, F
Norw. Coast. survey , 565., .133, .057, .43, 7, .914, .614

F shrinkage mean , 991., 1.00,,,, .086, .395

Weighted prediction :

Survivors, Int, Ext, N, Var, F
at end of year, s.e, s.e, , Ratio,
593., .15, .08, 8, .539, .591

Table 2.15. Norwegian Coastal Cod. Fishing mortalities from trial XSA run based on commercial catch-at-age and survey index at age (ages 2–8 in Table 2.6). (Proportions of F and M before time of spawning was set to 0 for all ages and years).

YR\AGE	2	3	4	5	6	7	8	9
1984	0.002	0.043	0.191	0.481	0.937	1.378	0.968	0.952
1985	0.001	0.104	0.231	0.568	0.602	0.673	0.530	0.598
1986	0.020	0.093	0.201	0.382	0.669	0.847	0.781	0.676
1987	0.001	0.015	0.098	0.396	0.498	0.605	0.562	0.519
1988	0.001	0.018	0.090	0.295	0.747	0.949	0.839	0.714
1989	0.002	0.019	0.097	0.248	0.449	0.785	0.943	0.612
1990	0.002	0.014	0.049	0.090	0.158	0.278	0.434	0.241
1991	0.000	0.010	0.041	0.093	0.192	0.339	0.311	0.235
1992	0.002	0.012	0.105	0.203	0.232	0.292	0.282	0.254
1993	0.001	0.006	0.070	0.200	0.301	0.400	0.529	0.360
1994	0.002	0.009	0.054	0.235	0.332	0.465	0.356	0.349
1995	0.002	0.019	0.113	0.225	0.477	0.785	0.694	0.550
1996	0.002	0.031	0.099	0.236	0.292	0.530	0.605	0.419
1997	0.005	0.030	0.164	0.309	0.583	0.762	0.939	0.654
1998	0.004	0.035	0.181	0.303	0.393	0.545	0.523	0.445
1999	0.002	0.031	0.166	0.388	0.504	0.556	0.713	0.545
2000	0.001	0.038	0.181	0.369	0.382	0.374	0.495	0.407
2001	0.001	0.019	0.124	0.215	0.311	0.383	0.332	0.288
2002	0.002	0.021	0.119	0.267	0.414	0.314	0.351	0.280
2003	0.003	0.032	0.079	0.232	0.344	0.403	0.301	0.272
2004	0.001	0.017	0.076	0.174	0.363	0.423	0.421	0.236
2005	0.001	0.016	0.087	0.182	0.269	0.390	0.336	0.242
2006	0.002	0.017	0.105	0.233	0.442	0.392	0.489	0.361
2007	0.002	0.025	0.115	0.216	0.235	0.297	0.191	0.279
2008	0.002	0.028	0.172	0.281	0.339	0.283	0.314	0.157
2009	0.001	0.046	0.100	0.198	0.319	0.274	0.170	0.141
2010	0.005	0.039	0.110	0.265	0.480	0.345	0.426	0.157
2011	0.003	0.037	0.121	0.273	0.241	0.423	0.305	0.260

YR\AGE	2	3	4	5	6	7	8	9
2012	0.021	0.056	0.096	0.192	0.246	0.217	0.348	0.238
2013	0.006	0.037	0.099	0.155	0.168	0.200	0.225	0.388
2014	0.005	0.028	0.087	0.154	0.202	0.243	0.297	0.160
2015	0.008	0.040	0.107	0.151	0.259	0.213	0.219	0.256
2016	0.006	0.115	0.156	0.234	0.314	0.503	0.400	0.368
2017	0.009	0.063	0.190	0.232	0.447	0.523	0.610	0.447
2018	0.007	0.048	0.156	0.267	0.298	0.450	0.554	0.591

Table 2.15 cont. Summary output from trial XSA run based on commercial catch

Run title	COMBSEX	PLUSGROUP : Norwegian Coastal Cod			
At 28/04/2019 19:43					
Table 16 Summary (without SOP correction)					
1984	58763	168477	68331	63818	0.934	0.7467
1985	63905	189068	74608	62954	0.8438	0.5184
1986	16661	194557	78130	56107	0.7181	0.5248
1987	21194	184102	80795	48274	0.5975	0.3993
1988	34526	178556	92634	55065	0.5944	0.5201
1989	38286	163910	84492	41242	0.4881	0.3947
1990	35982	171690	85300	20920	0.2453	0.1437
1991	44590	206187	105506	24837	0.2354	0.1661
1992	31836	231985	125158	38195	0.3052	0.2081
1993	17168	246138	145223	50420	0.3472	0.2423
1994	14963	238843	152812	51664	0.3381	0.2715
1995	20288	209496	145724	64964	0.4458	0.3999
1996	27146	182568	126726	41672	0.3288	0.2891
1997	28926	145668	91396	51123	0.5594	0.4545
1998	29144	138485	72312	30472	0.4214	0.3557
1999	29149	151398	78257	35805	0.4575	0.4037
2000	26519	140830	66391	34815	0.5244	0.3268
2001	26175	148583	72159	27253	0.3777	0.258

2002	24420	174306	89622	36405	0.4062	0.2783
2003	23934	150035	83663	35381	0.4229	0.2646
2004	22302	157880	84570	33650	0.3979	0.2588
2005	21435	161455	89268	29255	0.3277	0.2317
2006	20967	185880	104035	39343	0.3782	0.2932
2007	26768	187793	103227	29227	0.2831	0.2157
2008	28853	193179	99753	35552	0.3564	0.2687
2009	26055	180698	87904	29987	0.3411	0.2225
2010	25961	195902	101727	40397	0.3971	0.2998
2011	28669	193673	97573	36714	0.3763	0.2644
2012	21455	193760	100847	35540	0.3524	0.1875
2013	24716	183962	99639	30144	0.3025	0.1556
2014	23558	219055	129921	33660	0.2591	0.1712
2015	20335	209412	124053	35843	0.2889	0.1825
2016	19275	211948	127405	54767	0.4299	0.3016
2017	24342	176948	103159	51053	0.4949	0.3481
2018	23998	155424	77816	36375	0.4675	0.2928

Table 2.16. Calculated survey mortalities (Z) and vpa- values of F(4–7) predicted from survey mortalities, both for the vpa using commercial catch and the vpa using all catch.

year	av. survey Z	com. Catch	all catch
	ages 4–9	Predict F(4–7)	Predict F(4–7)
1996	0.881	0.3132	0.3404
1997	0.850	0.3103	0.3365
1998	1.604	0.3785	0.4301
1999	1.018	0.3255	0.3573
2000	0.538	0.2821	0.2977
2001	0.912	0.3159	0.3442
2002	1.084	0.3315	0.3655
2003	0.482	0.2770	0.2907
2004	0.725	0.2991	0.3210
2005	0.355	0.2656	0.2750
2006	0.324	0.2628	0.2711
2007	0.386	0.2684	0.2788
2008	0.925	0.3171	0.3457
2009	-0.030	0.2308	0.2272
2010	0.776	0.3037	0.3273
2011	0.229	0.2542	0.2594
2012	0.760	0.3022	0.3253
2013	-0.102	0.2243	0.2183
2014	-0.031	0.2307	0.2270
2015	0.677	0.2947	0.3150
2016	0.389	0.2687	0.2792
2017	0.802	0.3060	0.2903
2018	0.379	0.2678	0.2309

Table 2.17. Norwegian Coastal Cod. Stock summary for SVPA based on commercial catch-at-age and survey derived F in terminal year (2018)

AT 07/05/2019 14:50

TABLE 16 SUMMARY (WITHOUT SOP CORRECTION)

TRADITIONAL VPA USING FILE INPUT FOR TERMINAL F

	RECRUITS	TOTBIO	TOTSPBIO	LANDI	YIELD/SSB	F(4-7)
	AGE 2					
1984	58745	168380	68262	63818	0.9349	0.748
1985	63842	188814	74419	62954	0.8459	0.519
1986	16632	194344	77973	56107	0.7196	0.526
1987	21161	183864	80657	48274	0.5985	0.400
1988	34458	178286	92482	55065	0.5954	0.521
1989	38247	163621	84324	41242	0.4891	0.396
1990	35951	171348	85086	20920	0.2459	0.144
1991	44563	205780	105216	24837	0.2361	0.167
1992	31806	231554	124821	38195	0.306	0.209
1993	17158	245658	144821	50420	0.3482	0.243
1994	14952	238375	152407	51664	0.339	0.272
1995	20270	208984	145272	64964	0.4472	0.401
1996	27123	182155	126353	41672	0.3298	0.290
1997	28897	145355	91124	51123	0.561	0.455
1998	29119	138199	72078	30472	0.4228	0.356
1999	29115	151105	78013	35805	0.459	0.404
2000	26494	140572	66209	34815	0.5258	0.328
2001	26144	148353	71988	27253	0.3786	0.259
2002	24400	173980	89392	36405	0.4073	0.279
2003	23905	149760	83459	35381	0.4239	0.265
2004	22275	157607	84374	33650	0.3988	0.259
2005	21410	161132	89027	29255	0.3286	0.232
2006	20945	185477	103733	39343	0.3793	0.294
2007	26734	187398	102936	29227	0.2839	0.216
2008	28813	192835	99522	35552	0.3572	0.269
2009	26002	180403	87725	29987	0.3418	0.223
2010	25912	195488	101474	40397	0.3981	0.300
2011	31970	194401	97316	36714	0.3773	0.265
2012	23907	197019	100636	35540	0.3532	0.188
2013	25933	189893	100089	30144	0.3012	0.153
2014	22688	227762	132562	33660	0.2539	0.164
2015	23051	220258	129490	35843	0.2768	0.167
2016	20790	224844	135272	54767	0.4049	0.262
2017	15654	188550	113310	51053	0.4506	0.307
2018	21298	167844	94611	36375	0.3845	0.269

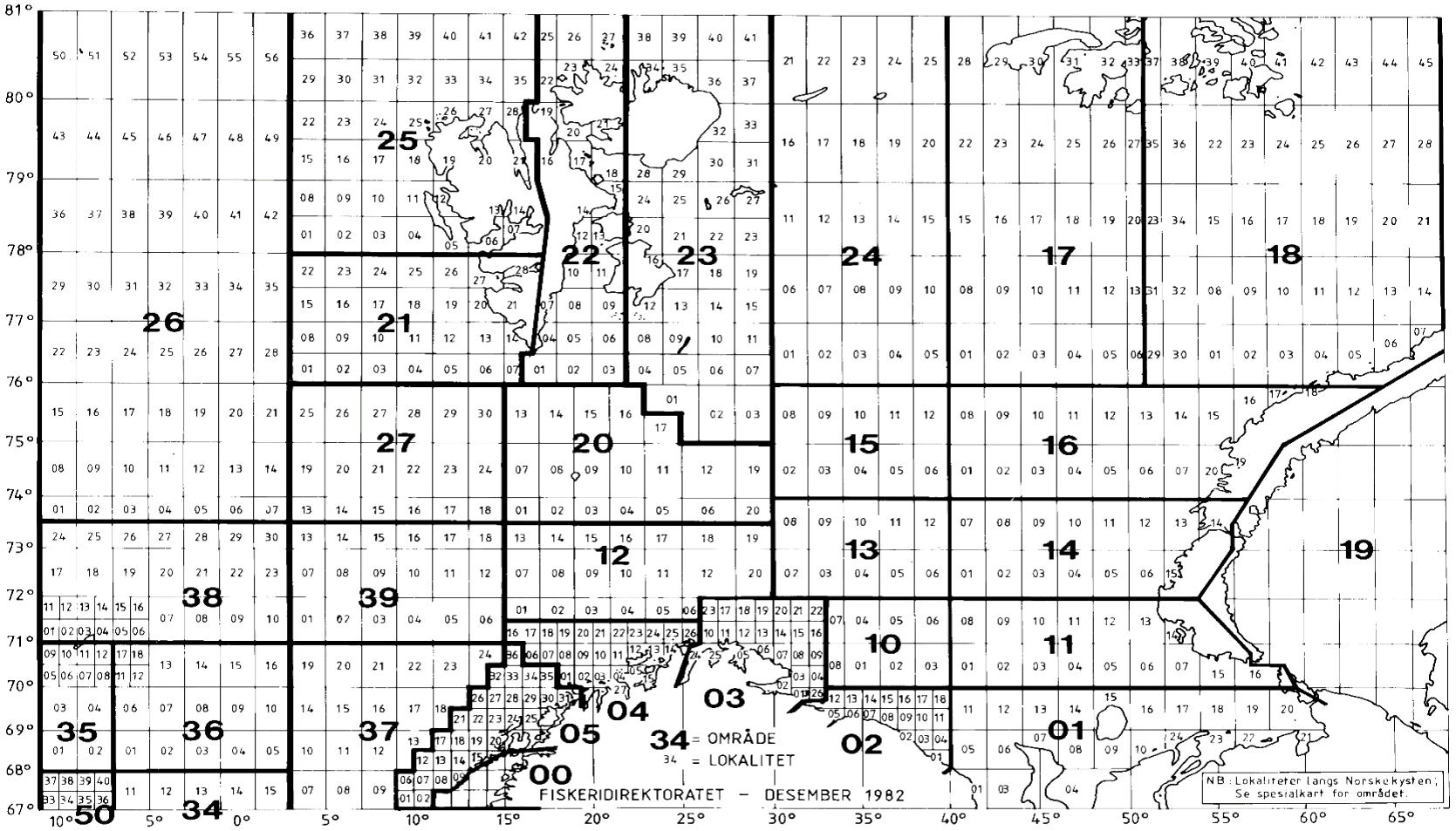

Figure 2.1a. Norwegian statistical rectangles in the Barents Sea. Coastal cod catches are estimated from the total cod catch taken inside 12 n.mile in areas 03 and 04. The same areas are also referred to in the survey results (sec. 2.3).

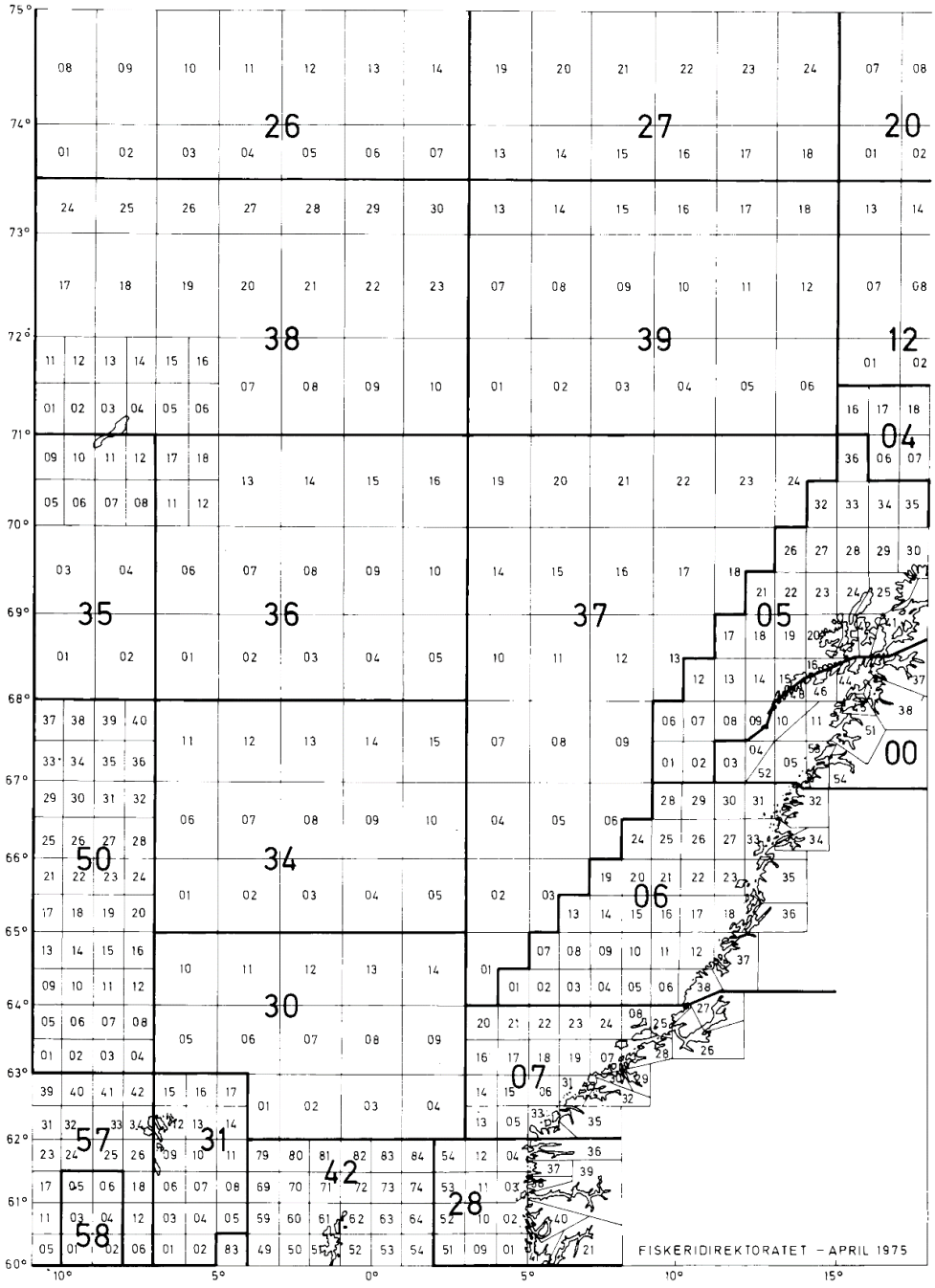

Figure 2.1b. Norwegian statistical rectangles in the Norwegian Sea. Coastal cod catches are estimated from the total cod catch taken inside 12 n.mile in areas 05, 00, 06 and 07. The same areas are also referred to in the survey results (sec. 2.3).

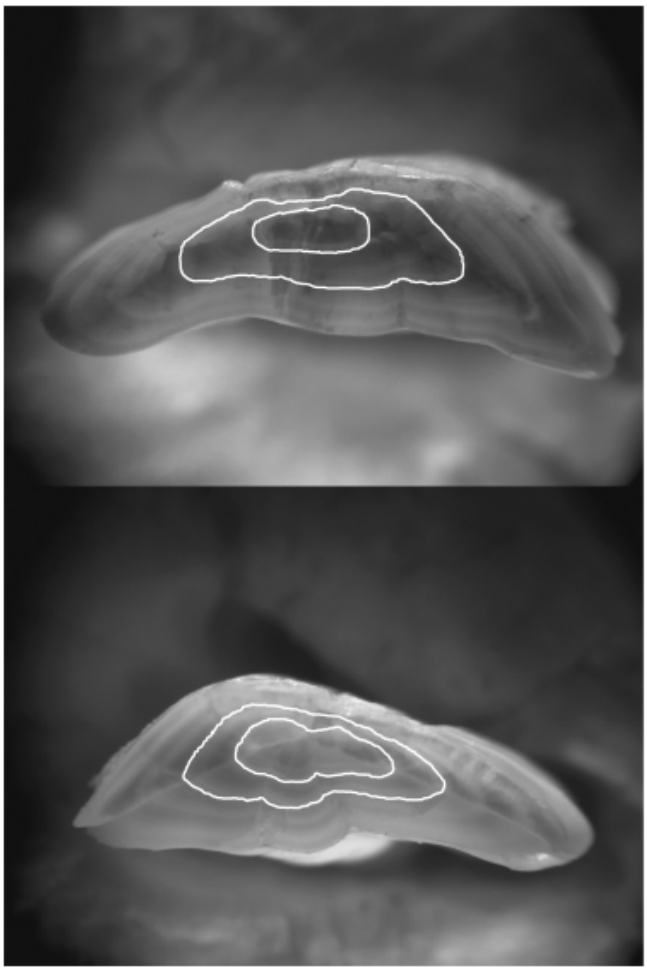

Figure 2.2. An image of a coastal cod otolith (top) and a northeast Arctic cod otolith (bottom). The two first translucent zones are highlighted. (from Berg *et al.*, 2005).

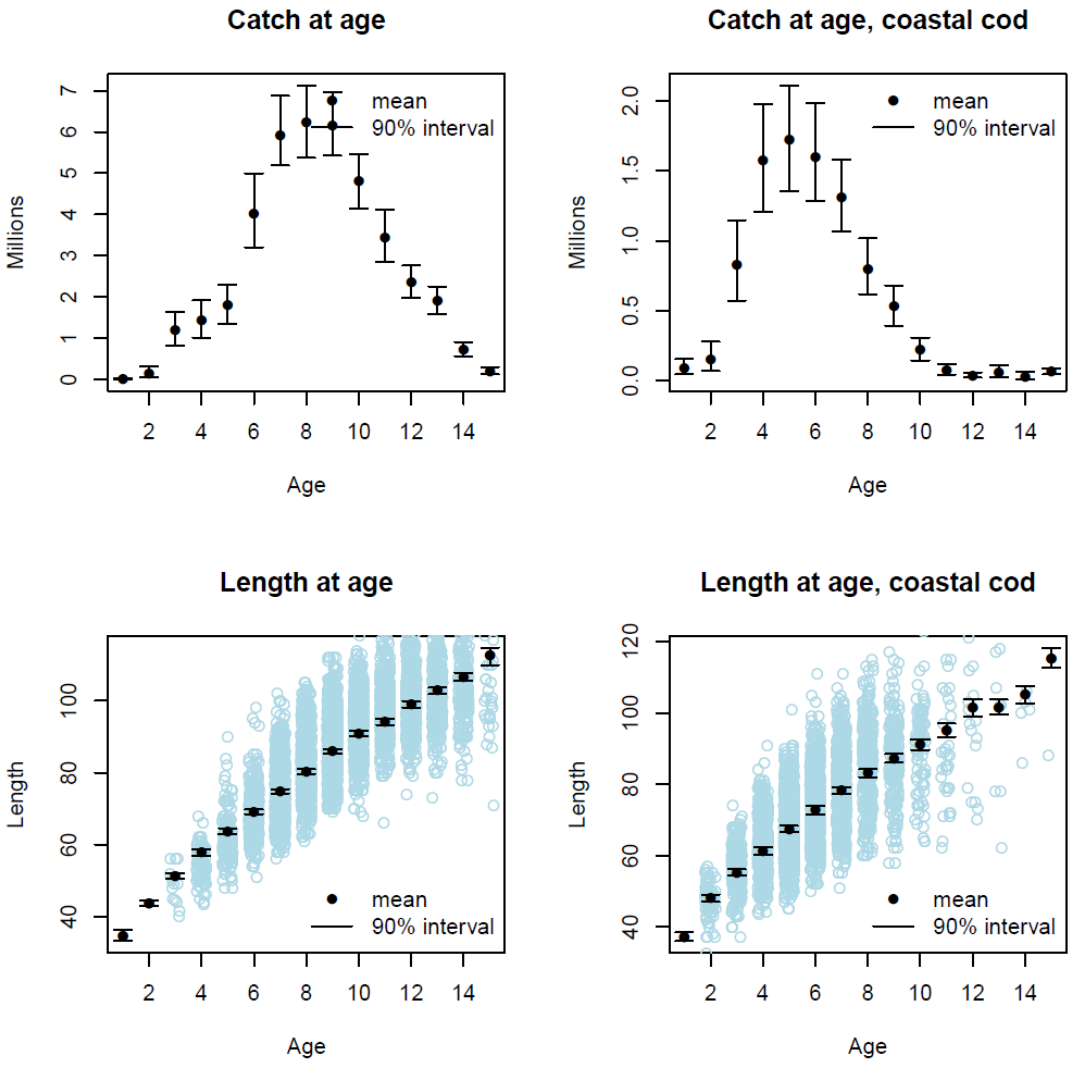

Figure 2.3a. ECA-output for 2018 commercial catches by Norway in the coastal statistical areas (Figure 2.5c). Left panels NEA cod. Right panels coastal cod.

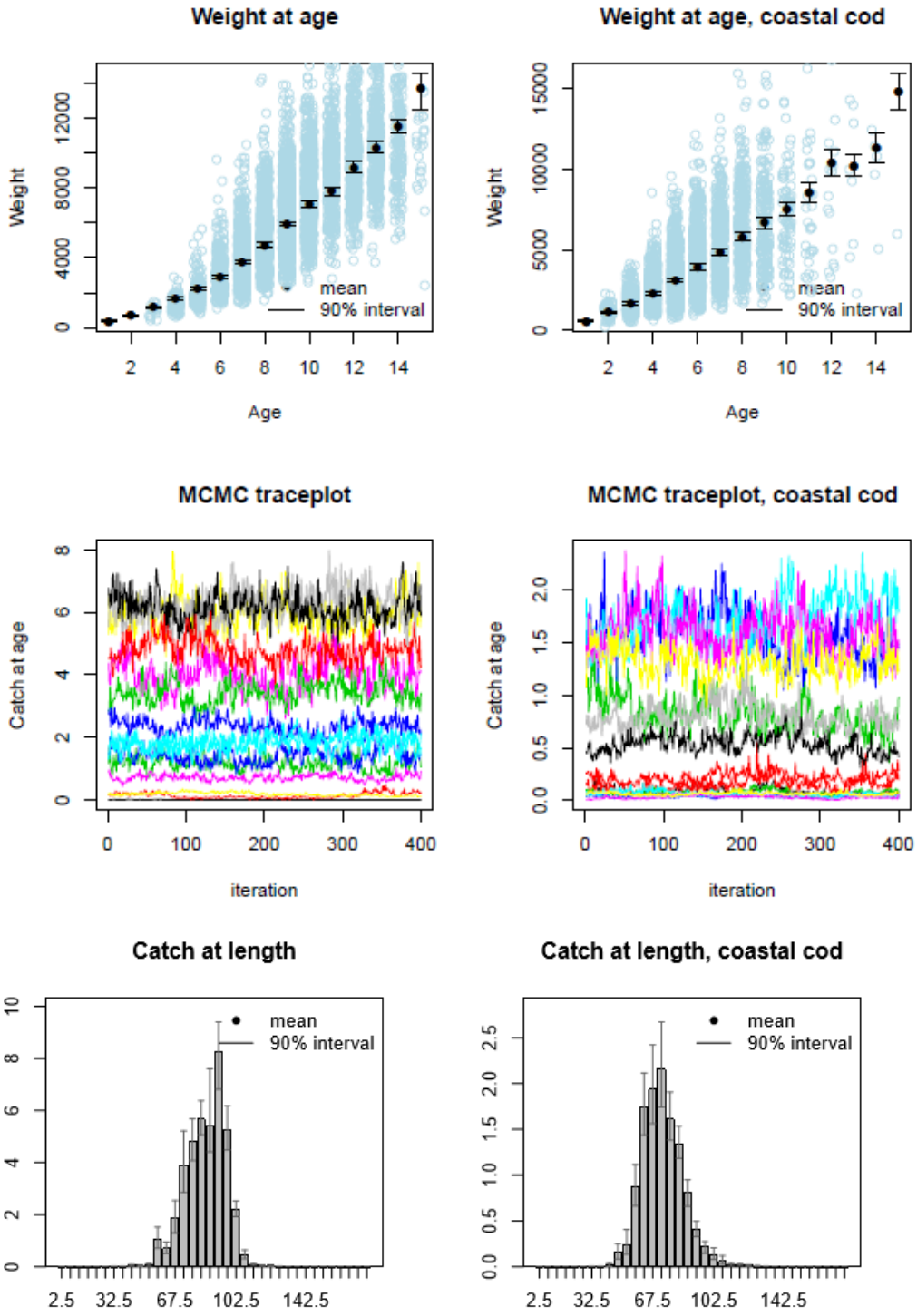

Figure 2.3b. ECA-output for 2018 commercial catches by Norway in the coastal statistical areas (Figure 2.5c). Left panels NEA cod. Right panels coastal cod.

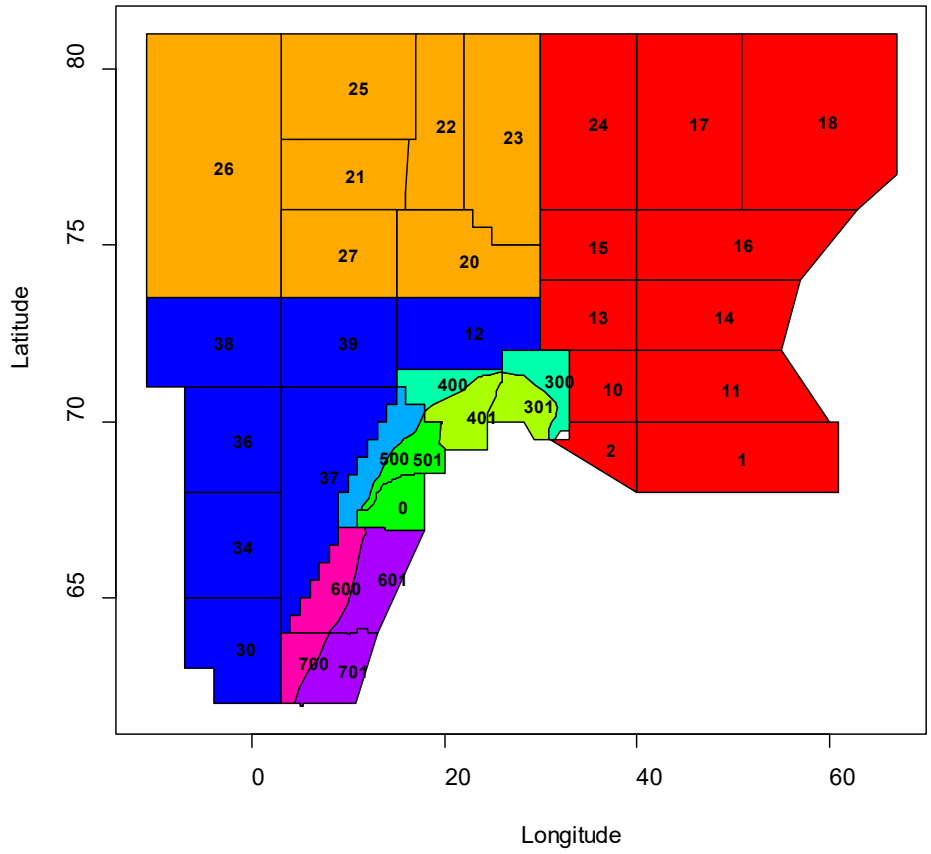

Figure 2.4. Norwegian statistical rectangles. The colors indicate area units used by the ECA-model for combining cod samples. Coastal cod are only estimated in coastal areas (0 and 300–701).

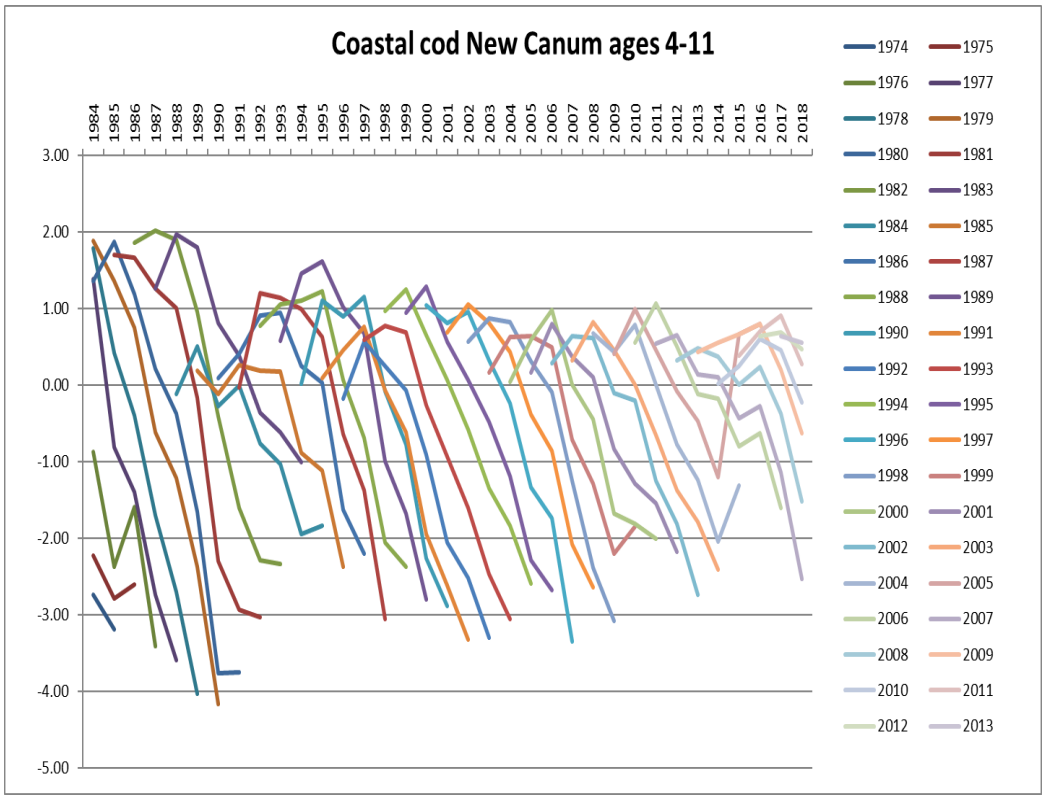

Figure 2.5a. Log catch numbers-at-age by cohort (series names) and catch years (x-axis). ECA estimates.

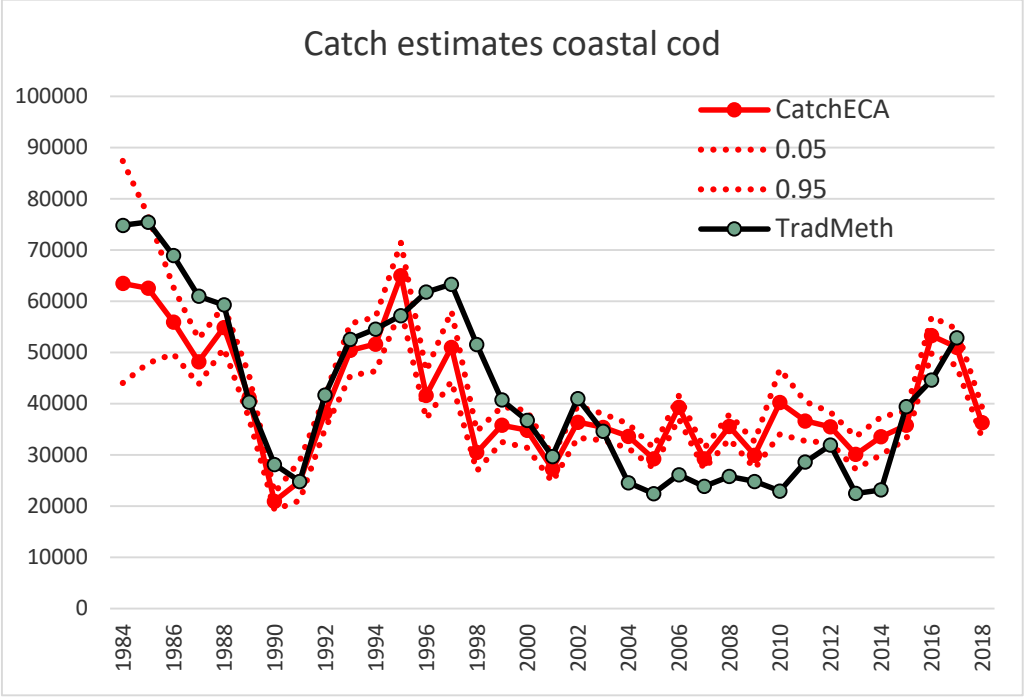

Figure 2.5b. Catches (tonnes) of coastal cod from the ECA analysis (with 5 and 95-percentiles), compared to the traditional estimates.

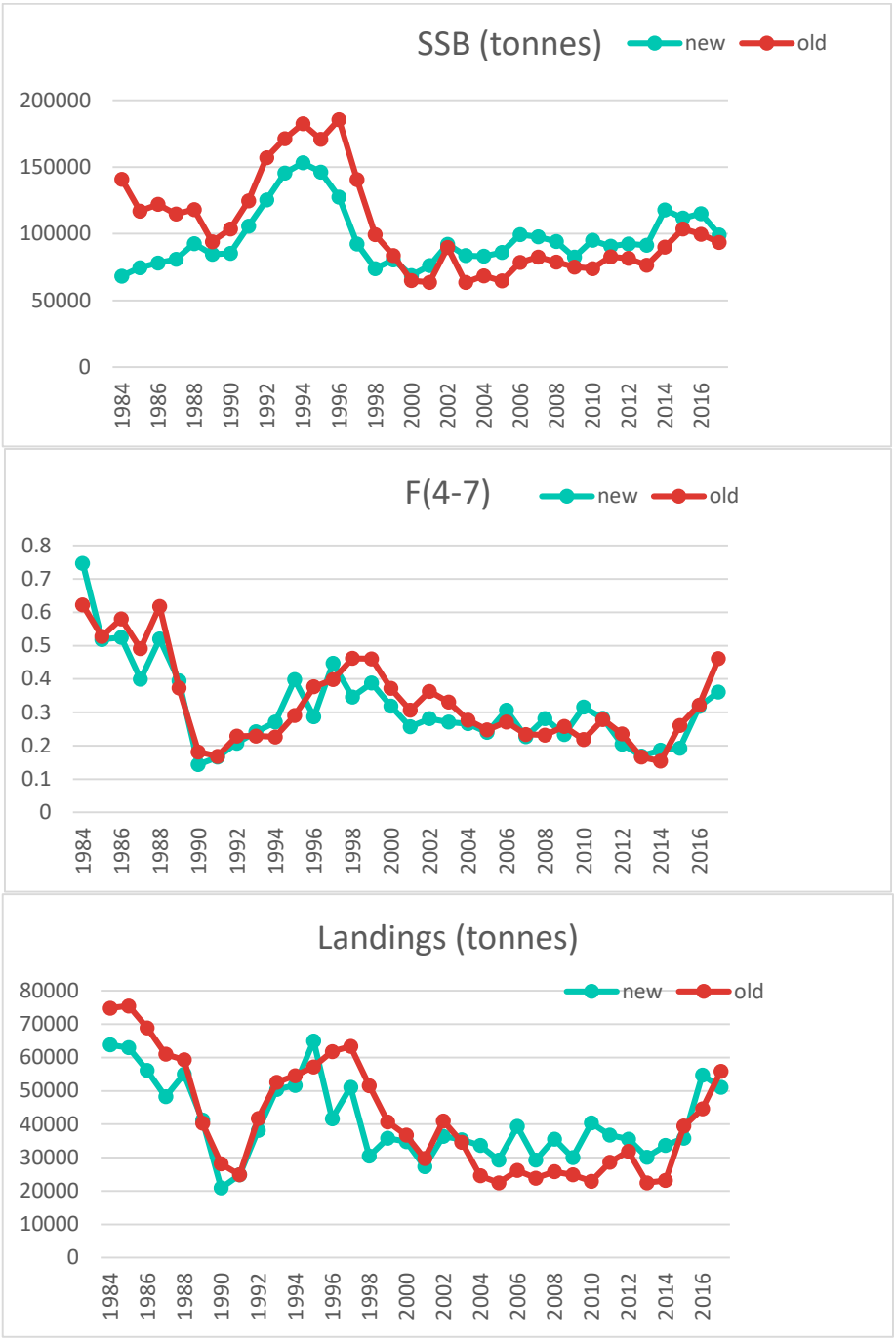

Figure 2.5c. XSA run (1984-2017) with Traditional estimates of catch-at-age as input (old), as used in 2018 AFWG, and run with ECA-estimates of catch-at-age as input (new), both runs tuned by the coastal survey data 1995-2017, ages 2-10+ (NOcoast-Aco-4Q).

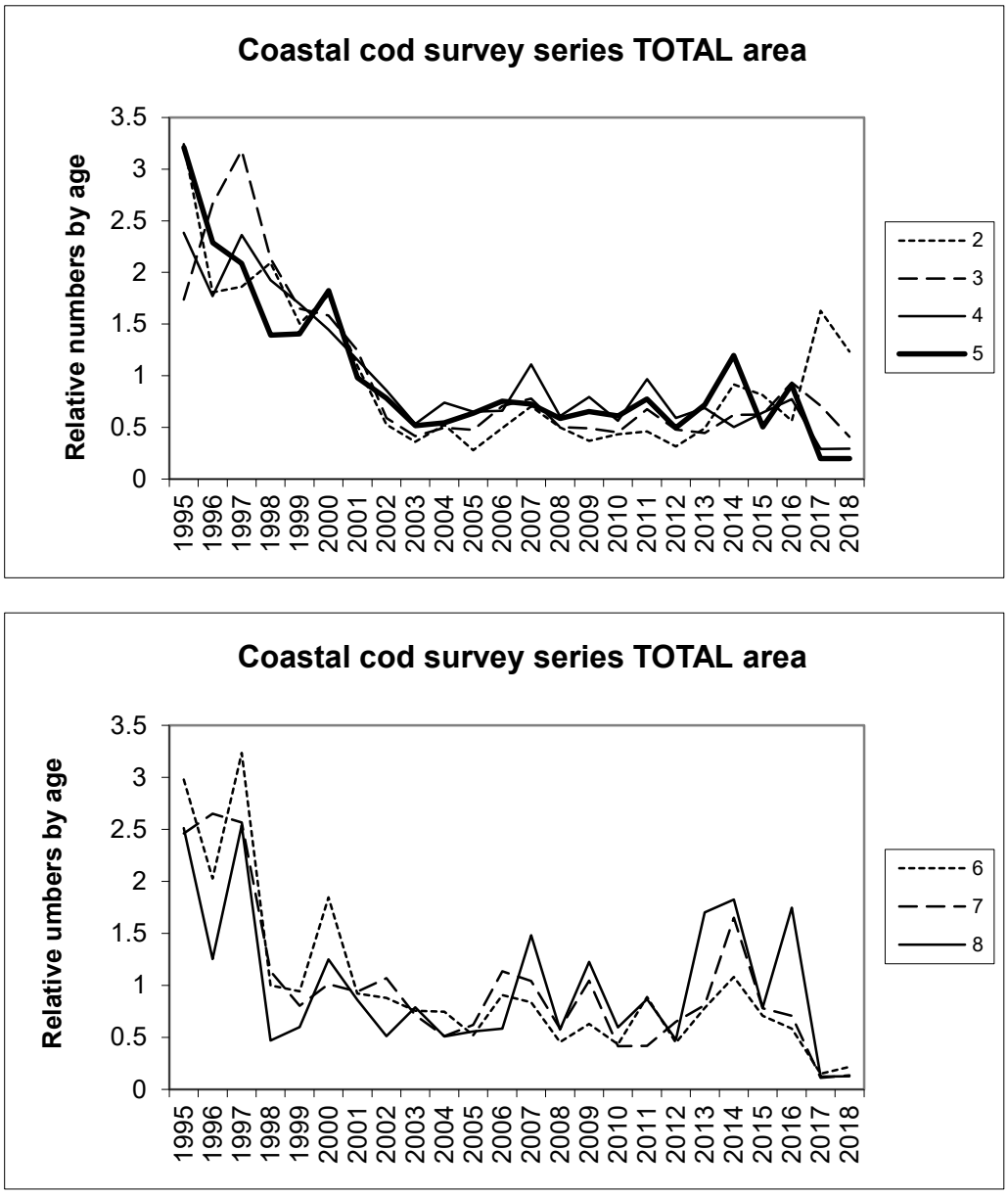

Figure 2.6. Coastal cod survey. Abundance at age relative to time-series average in total survey. Upper: ages 2–5, Lower: ages 6–8.

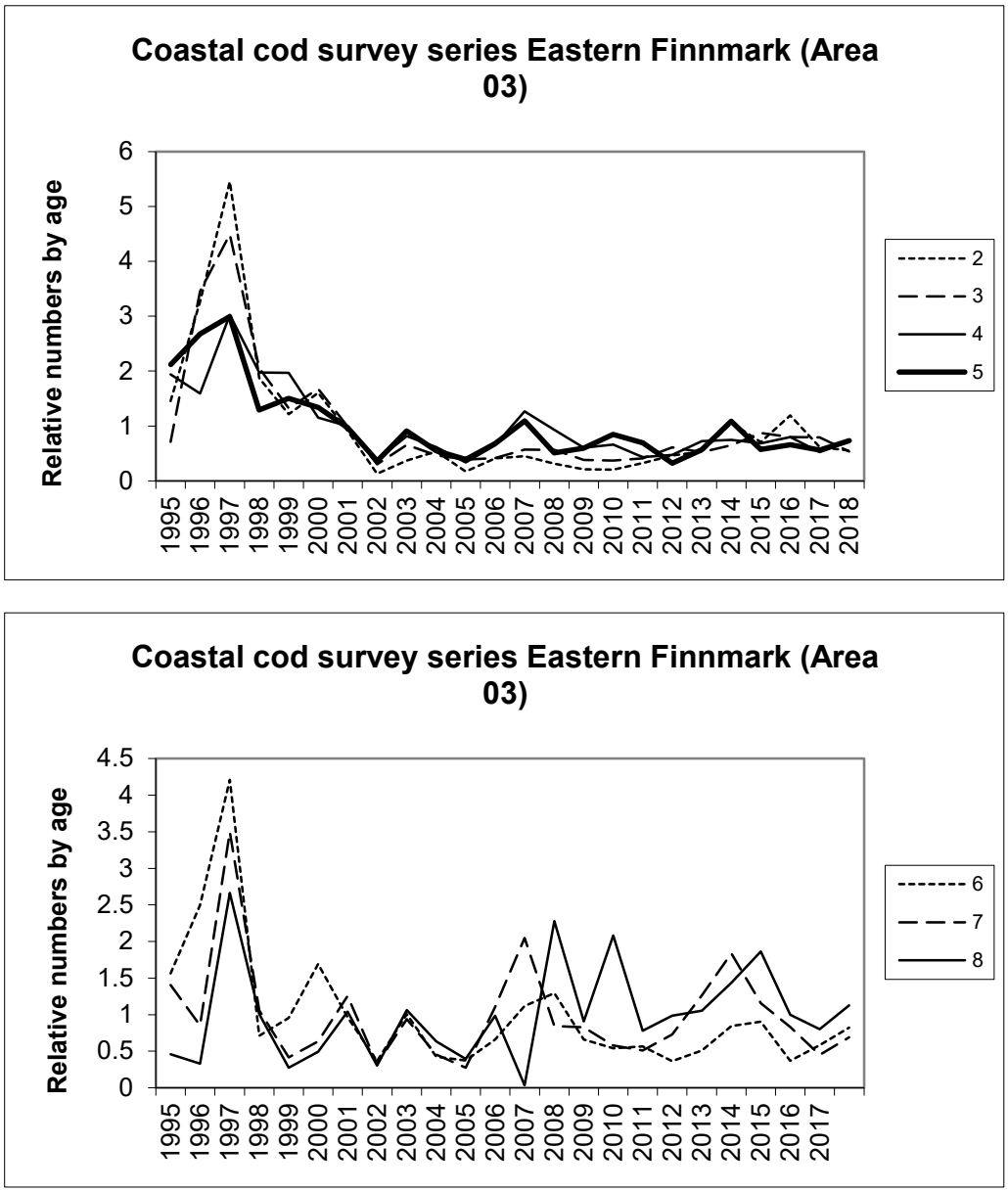

Figure 2.7. Coastal cod survey. Abundance at age relative to time-series average in statistical area 03. Upper: ages 2–5, Lower: ages 6–8.

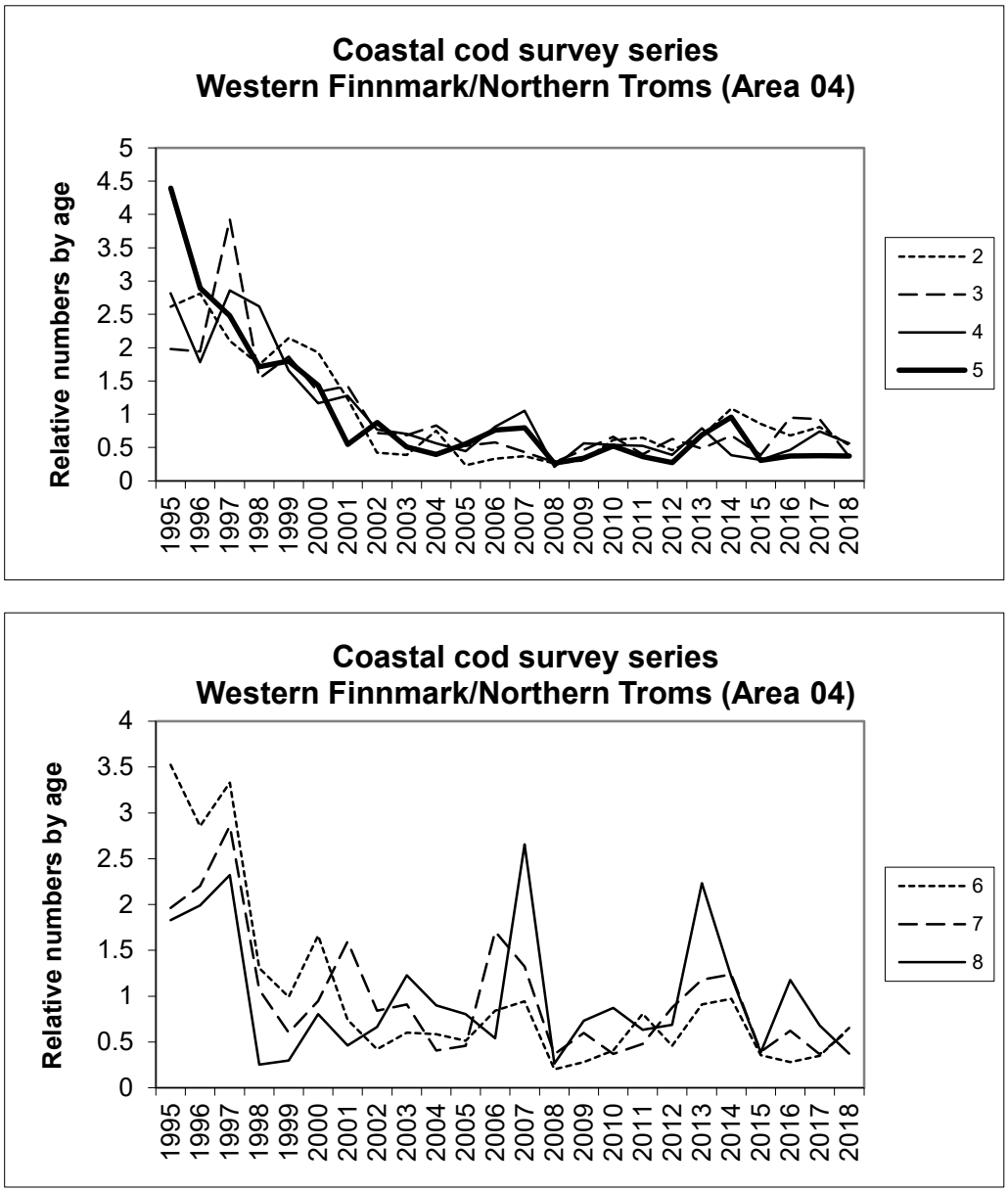

Figure 2.8. Coastal cod survey. Abundance at age relative to time-series average in statistical area 04. Upper: ages 2–5, Lower: ages 6–8

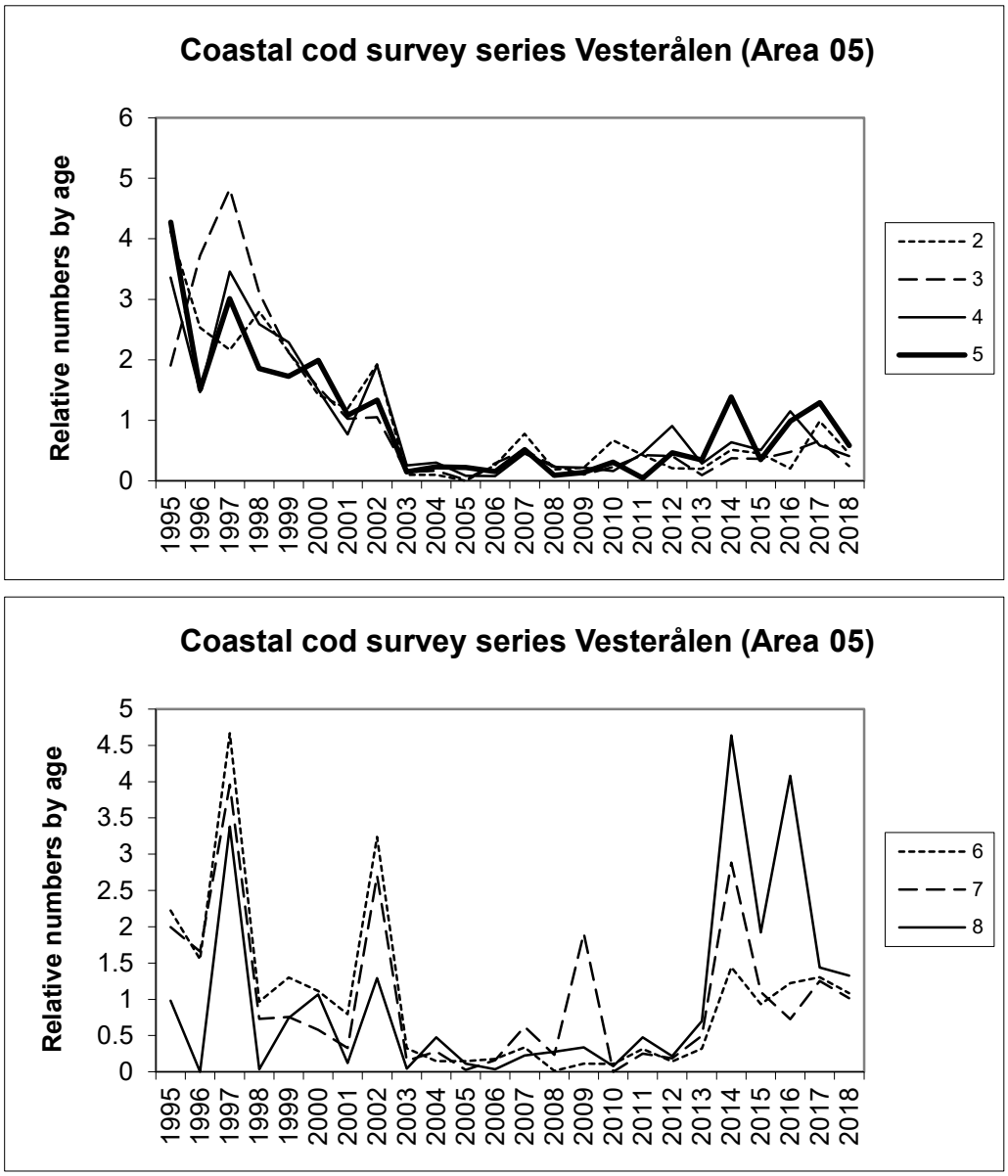

Figure 2.9. Coastal cod survey. Abundance at age relative to time-series average in statistical area 05. Upper: ages 2–5, Lower: ages 6–8.

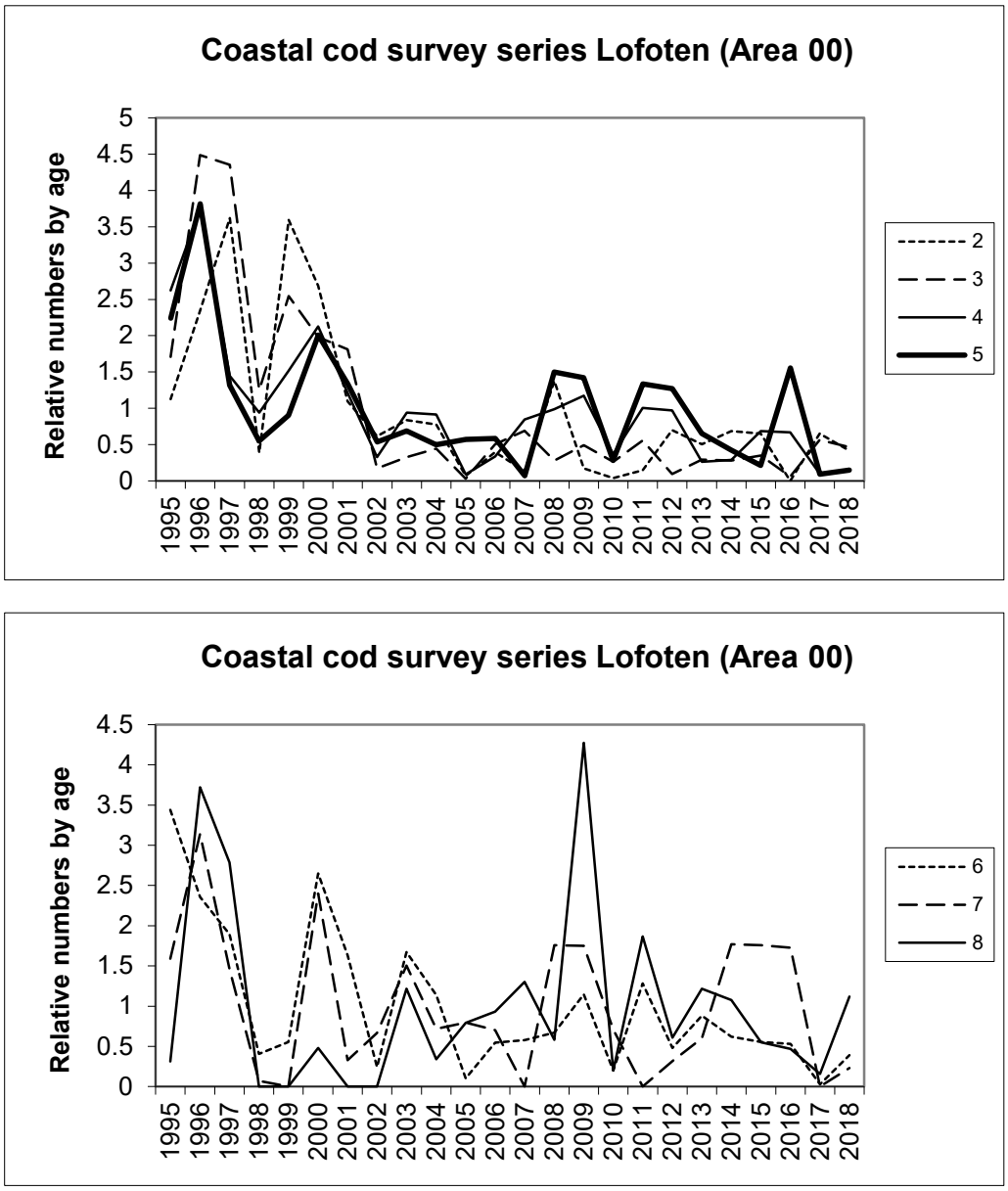

Figure 2.10. Coastal cod survey. Abundance at age relative to time-series average in statistical area 00. Upper: ages 2–5, Lower: ages 6–8.

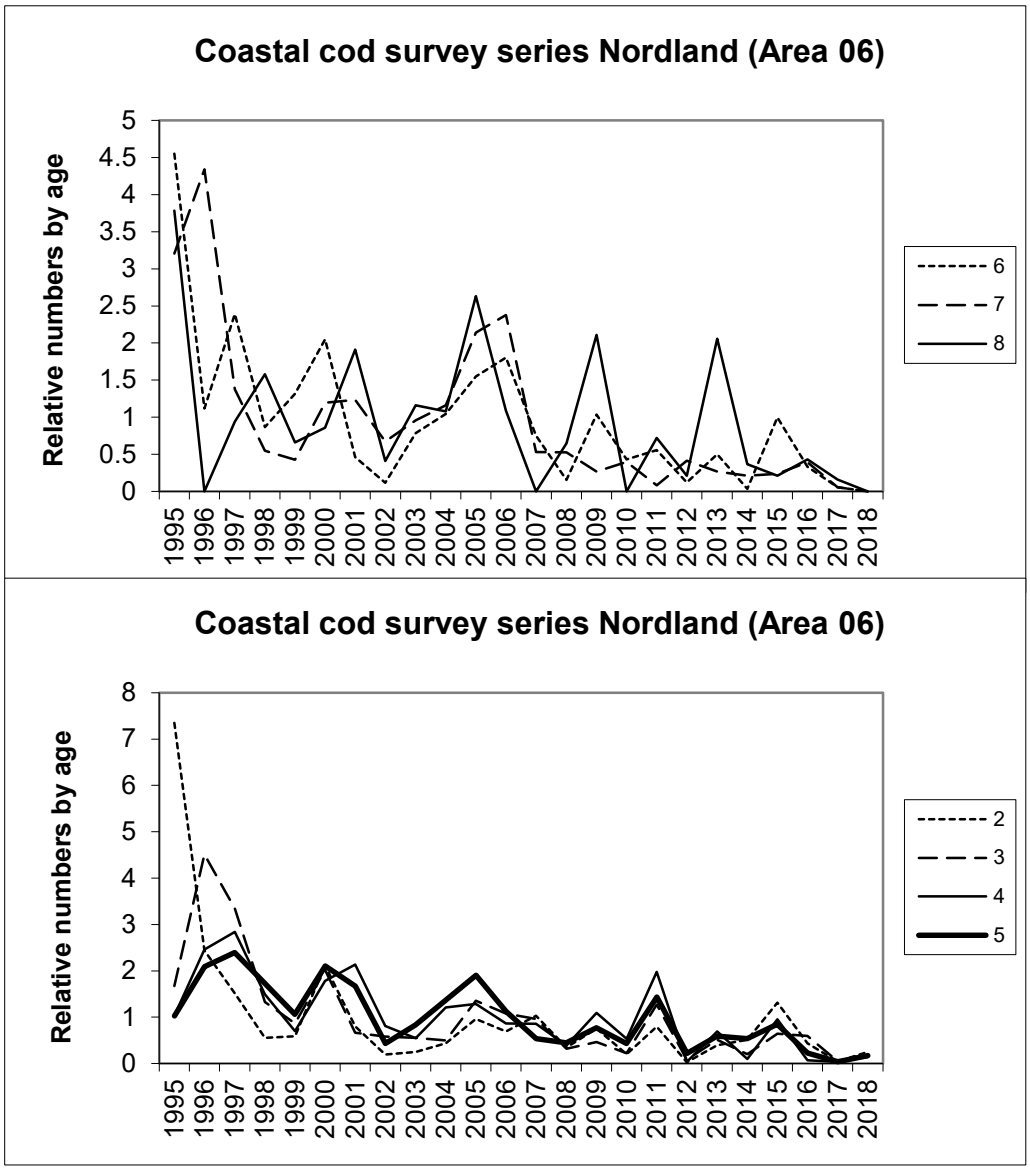

Figure 2.11 Coastal cod survey. Abundance at age relative to time-series average in statistical area 06. Upper: ages 2–5, Lower: ages 6–8.

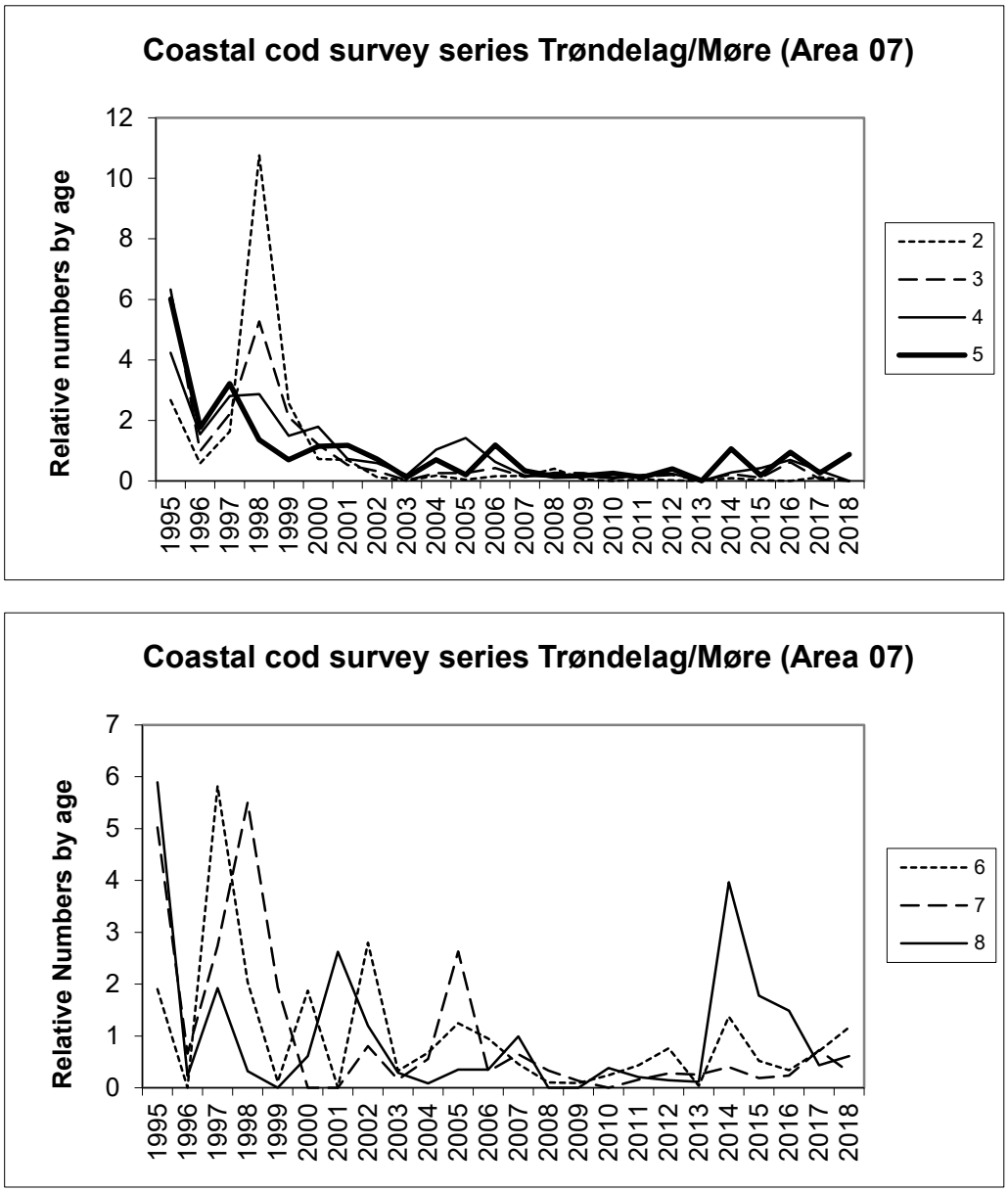

Figure 2.12. Coastal cod survey. Abundance-at-age relative to time-series average in statistical area 07. Some important areas at Møre was not covered in 2013. Upper: ages 2–5, Lower: ages 6–8.

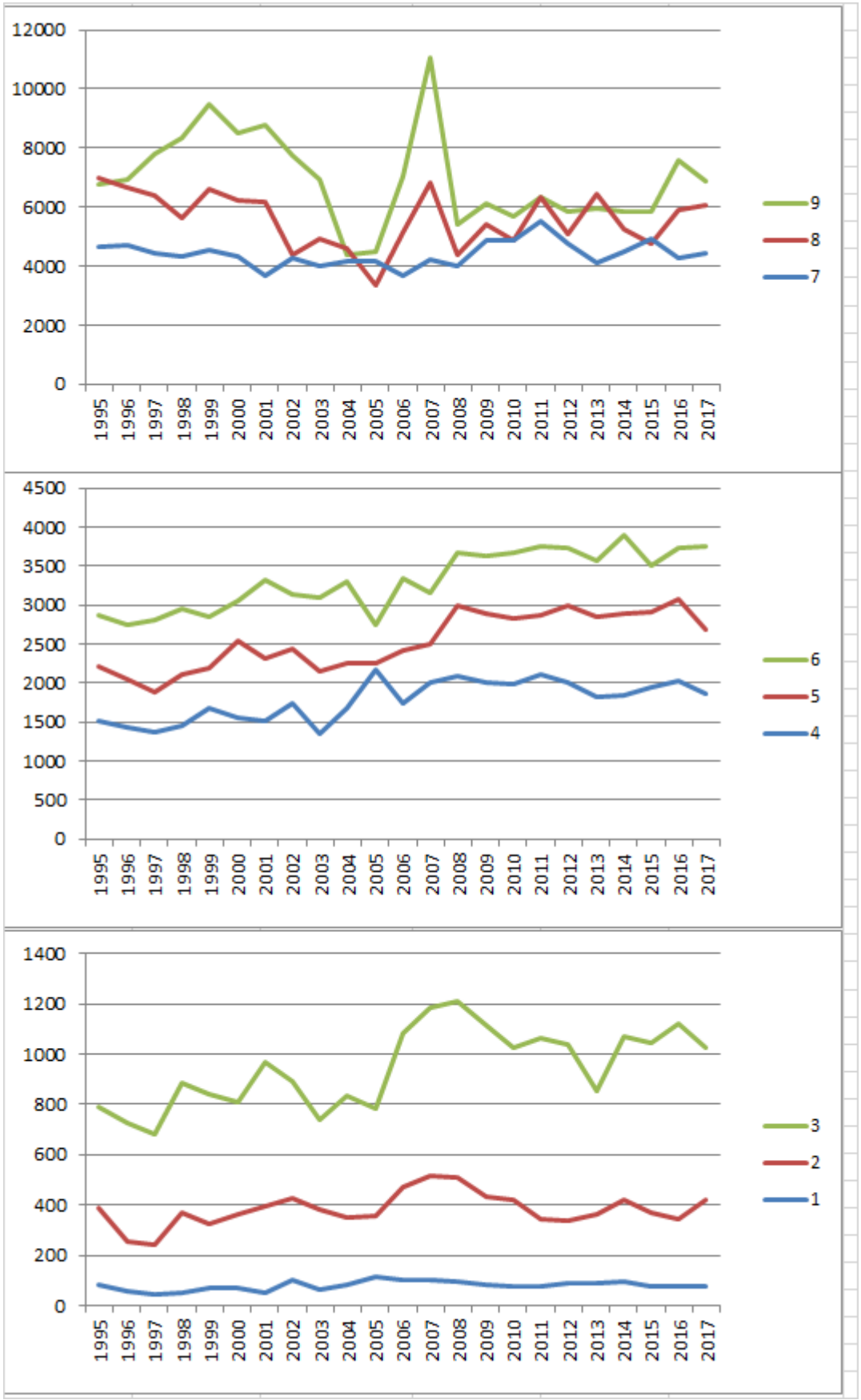

Figure 2.13a. Mean weights at age in the coastal survey

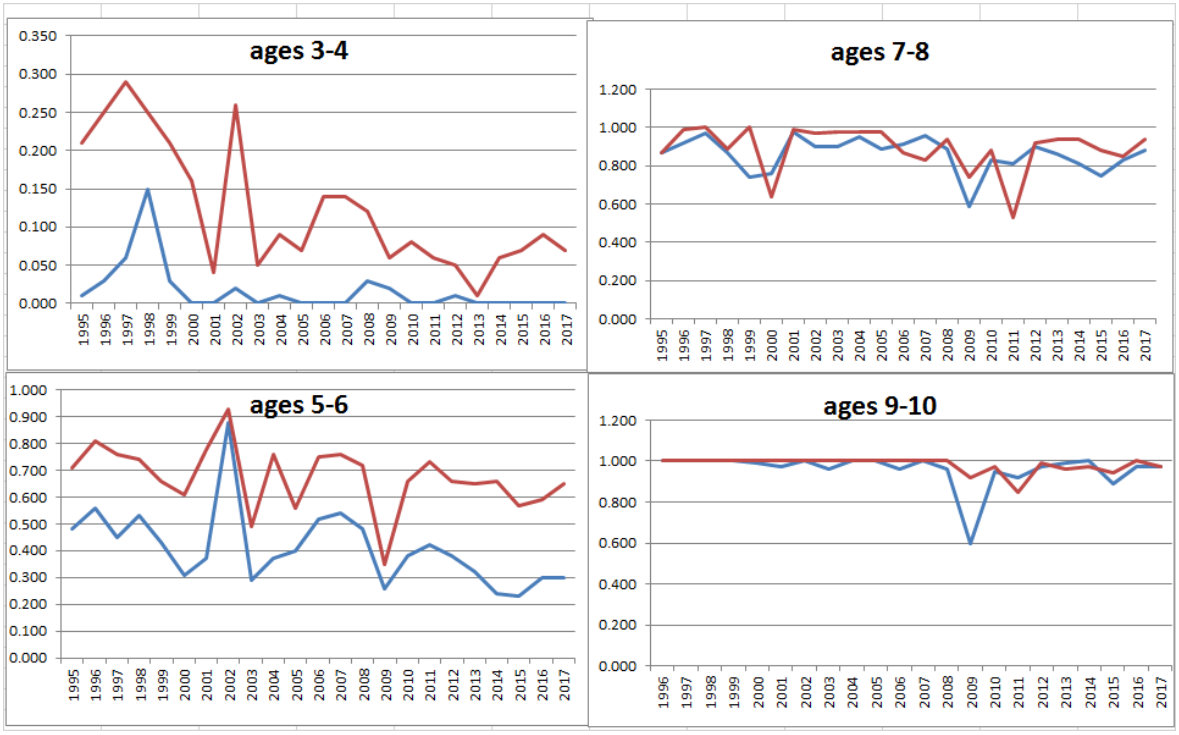

Figure 2.13b. Proportions mature-at-age as observed in the surveys. Ages 3, 5, 7 and 9 in blue, ages 4, 6, 8, and 10 in red.

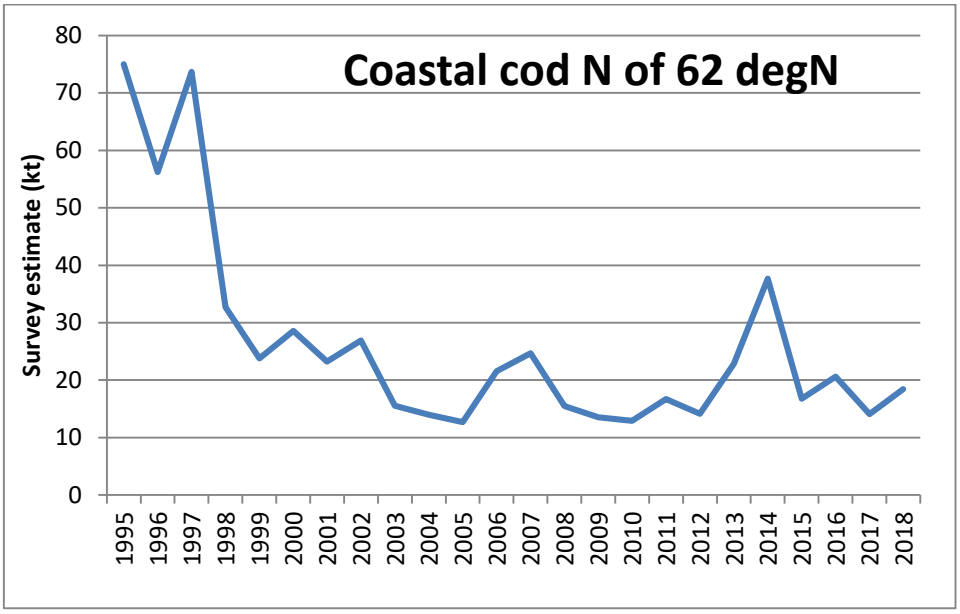

Figure 2.14. Survey SSB calculated by maturity observed in the surveys (red) and by maturity used in the VPA.

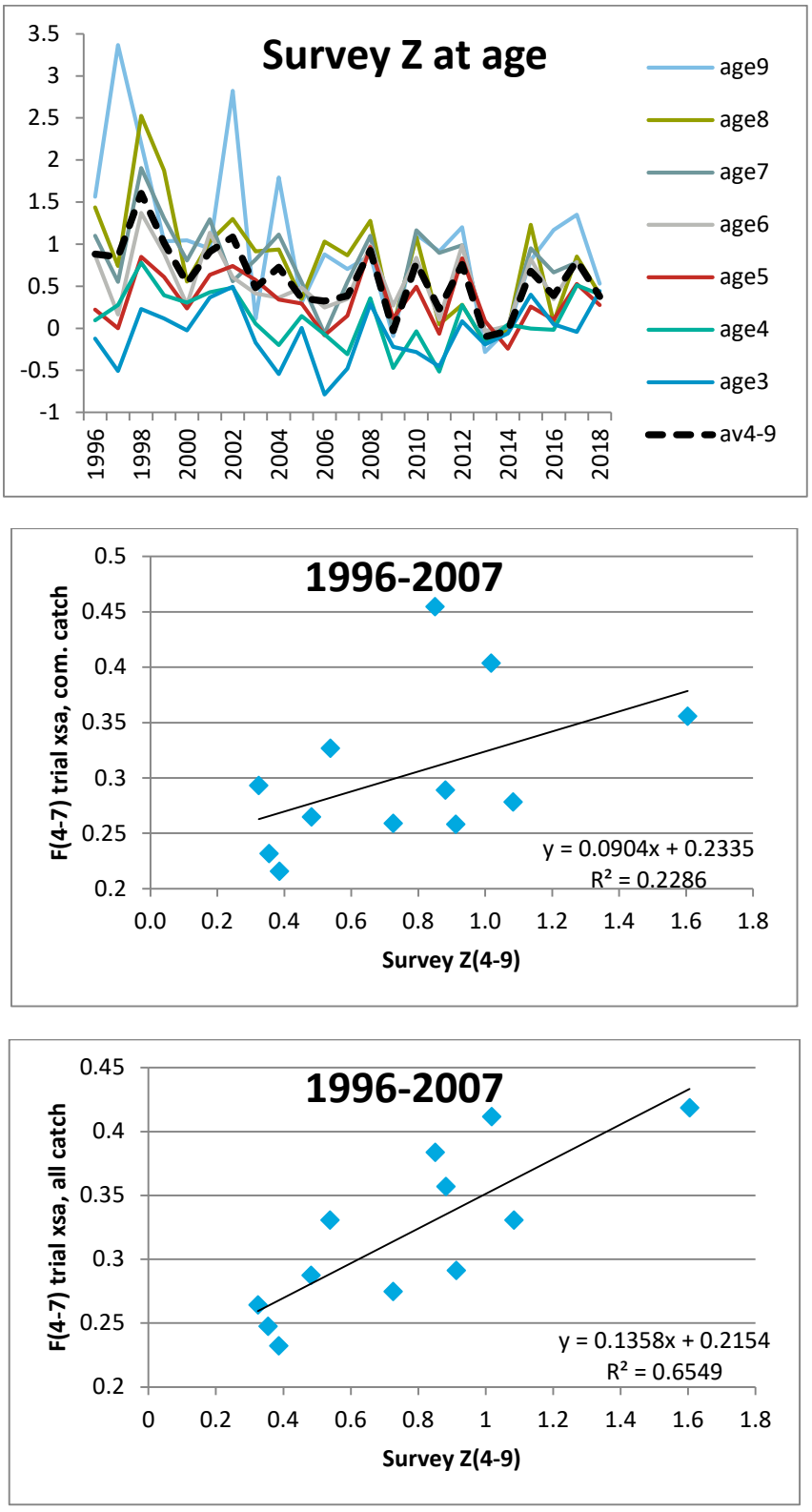

Figure 2.15. Survey mortality Z (upper) and relation to VPA values of $F_{(4-7)}$ over the period 1996–2007 for a trial XSA based on commercial catch (middle) and a trial XSA based on all catch (bottom).

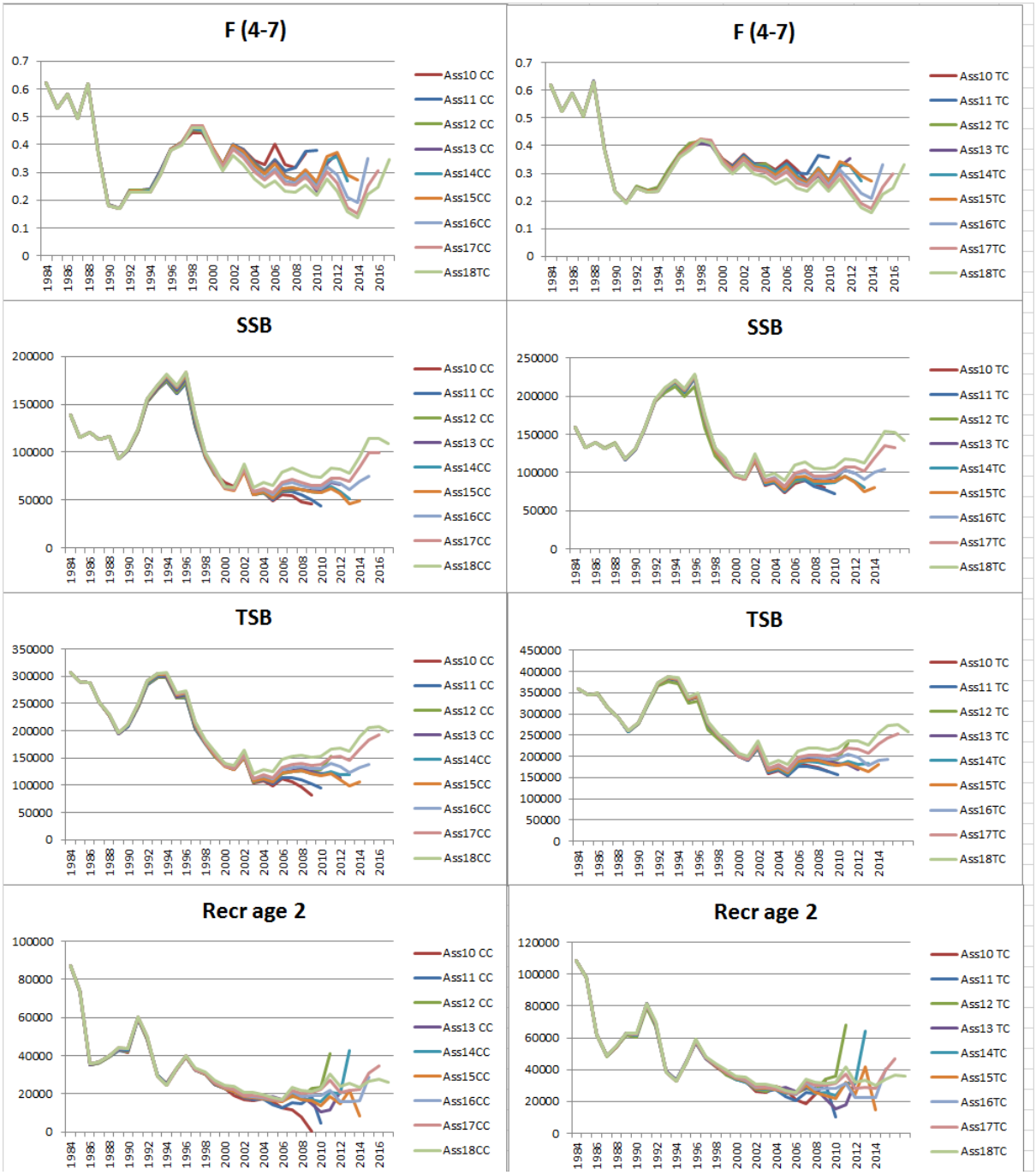

Figure 2.16. Comparisons of SVPA outputs in current assessment (Ass18) with the assessments in the years 2010-2017, for analyses based on commercial catch (left) and total catch (right). In all assessments the recruit estimate for the final year is highly uncertain. (2019 assessment not included).

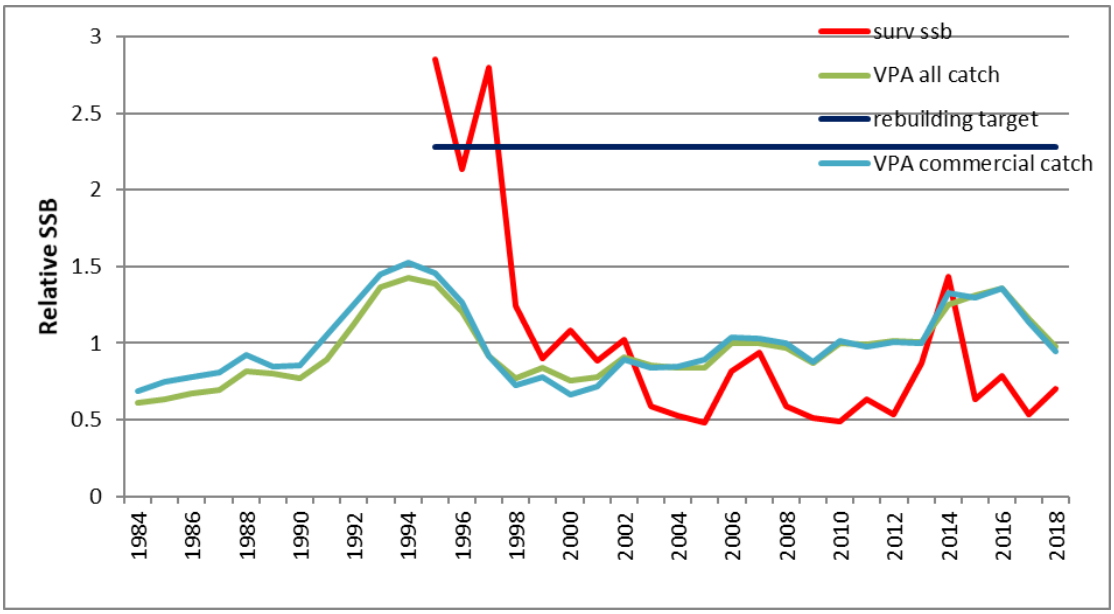

Figure 2.17. Coastal cod. Trends in spawning biomass. Each series are shown relative to its 1995–2017 average. The red line is survey SSB calculated with the same maturity ogive as in the VPA.

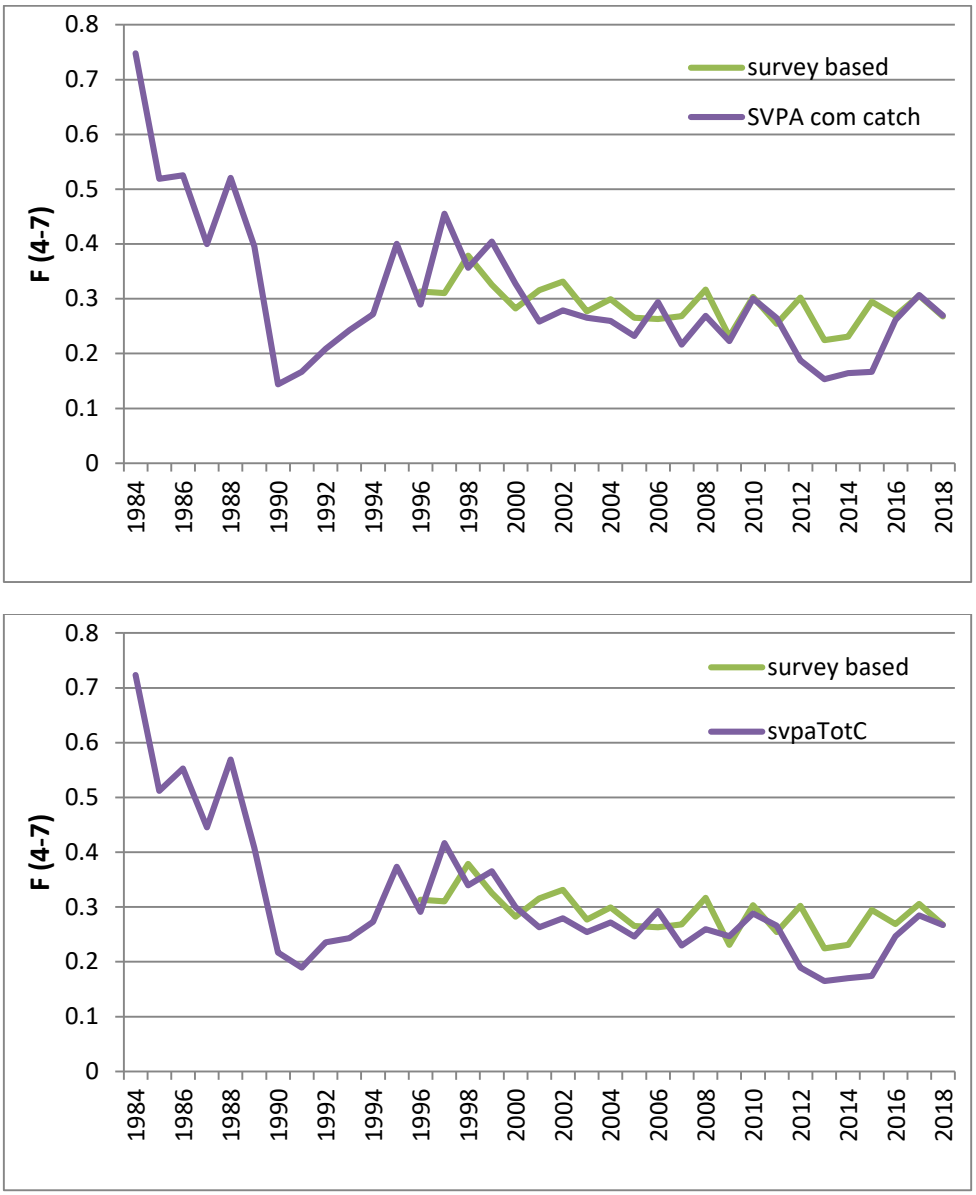

Figure 2.18. Time-series of F-estimates corresponding to commercial catch-at-age (upper) and total catch-at-age (lower). SVPA is in both cases a traditional VPA using the 2018 estimate of survey F as terminal F.