

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

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. The corresponding catches in tonnes are presented in Table 3.1. 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). Thus further analysis is still required. Since the new catch-at-age series is not completed yet the assessment is based on the old catch estimation method. The remaining catch analysis should be completed and an inter-benchmark process or a new benchmark should be set up.

2.1 Stock status summary

SSB observed in the survey declined considerably in the late 90-ies and has remained low since then. The same pattern is seen in the recruitment. Fishing pressure (F) increased in 2015 and 2016, after a declining trend over the period 2000-2014. The abundance indices from the coastal surveys in autumn 2013 and 2014 showed some increase compared to previous years. The 2015 and 2016 survey showed a decline to a level similar to those in the 2002–2012 period

2.2 Fisheries

Coastal cod is fished throughout the year and within nearly all the distribution area (inside the 12 n.mile zone in the Norwegian statistical areas 03, 04, 05, 00, 06, 07, Figures 2.1–2.3). The main fishery for coastal cod 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 2010-2014 the average % share between gear types in the estimated coastal cod commercial landings was around 49% for gillnet, 23% for Danish seine, 26% for longline/handline and 2% for bottom trawl. In 2015, there was some increase for Danish seine (34%) and decrease for gillnet (40%).

Similar percentages by gear was observed in 2016; 41% for gillnet, 32% for Danish seine, 25% for longline/handline and 2% for bottom trawl.

Recreational fisheries take an important fraction of the 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)

Traditional calculation method:

The commercial catches of Norwegian Coastal cod (NCC) have been calculated back to 1984 (Table 2.1a). For this period, the estimated landings have been between 22 000 and 75 000 t. The commercial landings of NCC in 2016 are estimated to 44 610 t (Table 2.1a, Figure 2.3). This is the highest catch estimate since 1999. Table 2.1b shows the estimated catch by gears, area and quarters in 2016.

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.

The basis for estimating coastal cod catches is the total landings of cod inside the 12-n. mile zone 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. Tables 2.2a, b show the sampling of the cod fishery by quarters and areas in 2016 and 2015. The sampling level in 2016 was similar to 2015, but in some important areas a large fraction of the quarter 1 samples was taken in January. Since the NEA cod spawners did not arrive into these areas before February, the analysis for January had to be done separately from the rest of quarter 1. Table 2.3 compares the number of fish sampled by quarters for the period 1985–2016. Within the 12-nautical mile the total number of age samples in 2016 was 300. A total of 14615 fish were aged. 5655 of these otoliths were classified as coastal cod. (Table 2.2a, b). This is the highest number of coastal cod otoliths observed in the time series and represents 39% of all cod otoliths sampled within the coastal cod area.

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 sampling level is now like the level prior to 2010 (Table 2.3). Still there are too few samples in quarter 3 (Table 2.2b).

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 2015 and 2016. The total cod catch in quarter 1 was considerably larger in 2016. The corresponding fractions of coastal cod in cod catches are also shown.

New calculation method considered at benchmark:

The ECA-model (Hirst *et al.* 2012) has been extended to use the information from otolith typing to estimate catch-at-age for both stocks within the same model, also providing measures of uncertainty. The model also estimates numbers at length with measures of uncertainty. The user specifies the grouping of samples (number of area groups, gear groups and season groups). Based on the data within each group the model generates probability distributions based on bootstrapping and tabulates the mean values and the specified percentiles (like 5 and 95). An example of model outputs is shown in Figures 2.5.1a and b. When doing the analysis on mixed samples of NEA cod and coastal cod in coastal areas, the area grouping and season grouping was considered more critical than the grouping on gears. For this purpose 6 coastal area groups were defined (Figure 2.5c), 4 seasons and 3 gear groups (gillnet, bottom trawl and others). Others includes Danish seine, longline and handline. In years with less complete sampling 2 season groups were used. The analyses of NEA cod outside the coastal cod area are usually done with 3 area groups, 4 seasons and 5 gear groups.

A new time-series of catch-at-age produced by this model was presented to the WKARCT. The internal consistency was considered reasonable (Figure 2.5d). The data were accepted as relevant information for describing the stock dynamics. The reasons for the differences between the old and new series (Figure 2.5e) are not clear and needs to be further explored. The largest discrepancy between the new and old time-series (Figure 2.5f) are for the areas 401 and 501 (Figure 2.5c), that are merged in the ECA analysis. A better geographical resolution will possibly improve the ECA analysis. A part of the observed differences could be related to catches not specified by area in the early part of the time-series. Further analyses are required before replacing the traditional catch-at-age series with the ECA-results.

The ECA-estimate of coastal cod in 2015 is somewhat lower than the traditional estimate. For the period 2003-2014 the ECA estimates are consistently above the traditional (Fig 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. 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.

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 the new regulations “fjord-lines” are drawn along the coast to close the fjords for direct cod fishing with vessels larger than 15 meters. A box closed to all fishing gears except handline and fishing rod is 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.

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 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.

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 northeast Arctic cod is higher.

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: Since the spawning biomass index in the 2011 autumn survey was higher than the 2010 value, the rebuilding plan in operation, 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 regulations for the closed spawning area near Henningsvær-Svolvær were in 2012 relaxed by allowing vessels less than 11m to fish. This was continued in 2013–2016. 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 quite low.

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 long line 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.

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 2.5–2.14, Figures 2.6–2.12)

The results of the 2016 survey (Mehl *et al.* 2016) 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 estimate of total biomass (Table 2.9) is slightly higher than the 2015 estimate. The uncertainty of the survey estimates is considered to be 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 2287 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 2.13a)

Table 2.8 and Figure 2.13a 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 the 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 Assessment

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

The estimated commercial catch-at-age (2–10+) for the period 1984–2016 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 (Anfinssen, 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. Before the 2010 assessment a warning about errors in the SURBA software was received, and the program was not used.

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 2014 survey mortality to a VPA $F(4-7)$ (Table 2.16). A selection pattern for 2014 was estimated as the average pattern over the years 2013–2015 in the trial XSA, and F s 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 2015 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 2016 survey estimate of spawning biomass (20.6 kt) is above the 2015 survey estimate, but just marginally above the 2002–2015-average (19.0 kt, Tables 2.9 and 2.11, Figure 2.17). The survey based estimate of the F_{2016} is 0.30, both when relating to commercial catch and when relating to total catch data. The text table below compares those with corresponding values earlier years. The table also compares the SSB-results of SVPA-runs aimed at those F s used as terminal F s. The high catch in 2015 and 2016 has in the current assessment caused some upward stock revision for the recent years.

A corresponding downward revision of F is observed, in particular for 2013 and 2014.

	Ass Yr	F 08	F 09	F 10	F 11	F 12	F 13	F 14	F 15	F 16	SSB 08	SSB 09	SSB 10	SSB 11	SSB 12	SSB 13	SSB 14	SSB 15	SSB 16
Com catch	10	0.32	0.37								48	46							
	11	0.32	0.38	0.38							56	50	44						
	12	0.27	0.28	0.26	0.33						61	59	58	70					
	13	0.27	0.29	0.23	0.33	0.37					61	60	60	68	66				
	14	0.27	0.31	0.26	0.34	0.36	0.27				61	59	58	64	59	51			
	15	0.27	0.31	0.27	0.36	0.37	0.29	0.27			61	59	57	63	57	47	49		

	16	0.26	0.29	0.25	0.32	0.29	0.21	0.19	0.35		66	63	62	69	67	61	70	75	
	17	0.25	0.28	0.24	0.30	0.26	0.18	0.15	0.25	0.30	68	66	65	73	73	70	84	99	100
Total catch	10	0.27	0.31								85	80							
	11	0.30	0.37	0.37							82	77	73						
	12	0.26	0.29	0.26	0.31						88	88	88	106					
	13	0.26	0.29	0.24	0.33	0.35					89	91	93	103	99				
	14	0.27	0.32	0.28	0.33	0.33	0.27				86	86	87	94	88	80			
	15	0.27	0.31	0.27	0.34	0.33	0.29	0.27			89	88	89	95	87	75	81		
	16	0.26	0.30	0.26	0.31	0.28	0.23	0.21	0.33		93	93	94	103	99	91	101	105	
	17	0.25	0.30	0.25	0.30	0.25	0.19	0.17	0.25	0.30	95	95	97	107	107	101	118	135	132

Some further comparisons are shown in Figures 2.16. The recruitment estimate for the final year is highly uncertain in all assessments. Figure 2.17 shows the SSB-series from VPA and survey, both scaled to their average over the years 1995–2016. Figure 2.18 compares the various time-series of F. The Fs show reasonable agreement.

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 90-ies.

2.6.3 Catches in 2017

No catch predictions have been made. By the end of the winter/ spring fishery in 2017 the remaining Coastal cod + NEA cod quota for the autumn 2017 fishery is similar to what it was in 2015 and 2016. The abundance of Northeast arctic cod in coastal areas were somewhat lower than in the previous five years.

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 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 (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 the 2015 and 2016 estimates are considerably higher. For most years since 2004 the regulations seem to have reduced the catches compared to pre-2004 level but have not been sufficient to cause persistent further reductions. The high catch in 2015 and 2016 seems to be mainly caused by high catches in January in southern Troms and northern Nordland (Fig 1.16), where coastal cod were feeding on aggregations of herring. This fishery occurred before the NEAcod spawning migration reached those areas. Such concentrations of coastal cod were in 2015 rather unexpected, and illustrate 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%) after 2004 compared to before.

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 F2009	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 than the previous.

The VPA analysis presented indicate some reduction of F over the period 1999-2014, followed by increased F in 2015 and 2016. This development of F seems to be largely caused by the large but uncertain catch estimates for 2015 and 2016.

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 tons¹. Importantly, this rebuilding target will be redefined on the basis of relevant scientific information. Such information could, for instance, include a

¹The average survey index in the years 1995-1998

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 the 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 at 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.

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.

² Ages 4-7

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	829	3478	6954	7278	6004	4964	2161	819	624	74824
1985	396	7848	7367	8699	7085	3066	705	433	264	75451
1986	4095	4095	12662	8906	5750	3868	1270	342	407	68905
1987	170	940	8236	12430	4427	2649	1127	313	149	60972
1988	110	1921	3343	6451	6626	4687	1461	497	333	59294
1989	41	1159	1434	2299	5197	2720	949	236	86	40285
1990	7	349	1233	1330	1129	3456	773	141	73	28127
1991	125	607	1452	3114	1873	1297	873	132	94	24822
1992	40	665	3160	4422	2992	1945	898	837	279	41690
1993	4	369	1706	2343	2684	3072	1871	627	690	52557
1994	332	573	1693	4302	2467	3337	1514	777	798	54562
1995	810	896	2345	5188	5546	3270	1455	557	433	57207
1996	1193	2376	2480	4930	4647	4160	2082	898	543	61776
1997	1326	3438	3150	2258	2490	3935	3312	959	684	63319
1998	554	2819	4786	4023	2272	1546	1826	975	343	51572
1999	252	1322	2346	4263	2773	1602	751	774	320	40732
2000	156	971	3664	3807	2671	1104	326	132	152	36715
2001	44	505	1837	2974	1998	1409	542	187	119	29699
2002	192	893	2331	2822	2742	1538	915	325	377	40994
2003	81	1107	2094	2506	2158	1374	598	258	99	34635
2004	12	306	924	1713	1820	1444	609	226	264	24547
2005	15	474	1299	1828	1436	1115	513	188	143	22432
2006	71	315	1656	1695	1695	1246	671	326	224	26134
2007	88	515	1396	1846	1252	824	391	256	196	23841
2008	92	670	1438	1635	1232	862	440	215	170	25777
2009	3	238	1052	1280	1388	1065	545	172	276	24821
2010	14	710	1617	1895	1040	703	420	198	175	22925
2011	30	632	1907	1777	1526	1133	487	230	315	28594
2012	22	445	1079	1478	1734	1267	587	338	456	31907
2013	90	539	1614	1232	1152	673	503	245	217	22464
2014	23	817	1233	1639	1005	669	427	366	191	23169
2015	220	938	1748	1844	2100	1431	754	483	677	39455
2016	299	1612	1777	2075	1799	1848	933	531	706	44610

Table 2.1b. Estimated commercial catch of coastal cod in 2016 by gear and area (t).

YEAR		2016				
Area	03	04	00	05	06/07	Total
Gillnet	1552	3508	4956	5 015	3 330	18361
L.line/Jig	4 524	2275	1859	1519	961	11139
Danish seine	3526	6312	1679	2496	281	14294
Trawl	430	293	0	88	5	816
Total	10032	12388	8495	9118	4577	44610

Table 2.1c. 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	88124
1985	3558	10438	9733	10444	7732	3291	835	512	264	88851
1986	4722	7128	15330	10565	6889	4303	1521	481	407	82405
1987	278	2912	12244	14611	5076	3080	1236	351	149	74472
1988	744	3328	4910	8159	8714	5237	1590	591	333	72894
1989	459	1984	2917	4057	6610	3238	1057	270	86	53985
1990	408	1843	2485	2012	3838	3906	846	141	73	42627
1991	1308	3305	4448	4456	2681	1880	977	203	94	40122
1992	469	1946	5509	5913	3622	2459	1744	921	279	57790
1993	51	1645	2994	3156	3530	3768	2073	995	690	67357
1994	389	1274	3416	5017	3755	4008	1907	901	798	69262
1995	818	1228	3149	6639	7131	4050	1868	737	433	71907
1996	1214	2967	2989	5547	6144	5533	2543	1125	543	76276
1997	1377	4145	4173	3021	3225	5124	4000	1091	684	77819
1998	803	3956	7113	5339	2857	1956	2155	1230	343	66172
1999	301	1788	3791	6202	3693	1959	949	995	320	54632
2000	219	1525	4817	5322	3715	1448	453	241	152	50315
2001	44	848	2572	4020	2962	2282	740	321	119	43099
2002	248	1191	3161	3877	3681	2134	1250	490	377	54594
2003	166	1449	2758	3422	3076	1824	842	584	99	48535
2004	38	560	1407	2637	2919	2271	967	388	264	37947
2005	36	744	1957	2686	2289	1830	936	364	143	35632
2006	90	551	2672	2562	2678	1858	986	453	224	39134
2007	137	861	2155	2805	1858	1355	718	413	196	36841
2008	107	1065	2181	2473	1882	1262	701	349	170	38577
2009	3	322	1628	2007	2251	1665	825	262	276	37521
2010	21	1103	2512	2945	1616	1092	652	308	272	35625
2011	43	912	2754	2566	2203	1636	704	333	455	41294
2012	30	622	1509	2066	2425	1771	821	472	638	44607
2013	140	843	2526	1928	1803	1054	788	384	340	35164

2014	36	1265	1908	2537	1556	1036	662	567	296	35869
2015	291	1240	2311	2438	2777	1892	997	638	895	52155
2016	384	2071	2283	2666	2311	2374	1198	682	906	57310

Table 2.1d. 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
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

Table 2.2a. Sampling from cod fisheries in 2016 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 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 2.2b. Sampling from cod fisheries in 2015 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 2015 QUARTER	03	04	00	05	06+07	Tot
1	10	20	29	16	52	127
2	13	11	11	13	29	77
3	7	0	0	5	10	22
4	8	2	50	7	7	74
Total samples	38	33	90	41	98	300
Total otoliths	2496	2824	3950	2684	2358	14492
Coastal cod type otoliths	306	122	277	351	1146	2202

Table 2.3 Number of otoliths sampled by quarter from commercial catches in the period 1985-2016.
Cc=coastal cod, NEAc=northeast Arctic cod.

	QUART	1	QUART	2	QUART	3	QUART	4		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
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

Table 2.4. Landings in tonnes of cod (CC+NEAC) within the 12 nautical mile by area and quarter 2015-2016 (upper 2 tables). Landings of coastal cod within 12 nautical mile by area and quarter 2015-2016 (middle 2 tables). Proportion coastal cod in landings within 12 nautical miles by area and quarter 2015-2016 (lower 2 tables).

2016		CC+	NEAC				2015		CC+	NEAC			
Q/Area	03	04	00	05	06-07	Total	Q/Area	03	04	00	05	06-07	Total
1	17512	42048	42800	96200	5092	203654	1	9370	31027	39716	49763	4284	134161
2	21977	27919	7460	14138	1262	72756	2	17501	21721	16364	7157	1064	63807
3	3289	2331	324	1036	497	7476	3	3372	1730	464	504	412	6482
4	11125	3128	166	1260	316	15994	4	4491	1939	143	1343	268	8183
Total	53903	75426	50749	112634	7167	299880	Total	34733	56416	56688	58767	6029	212633
2016		CC					2015		CC				
Q/Area	03	04	00	05	06-07	Total	Q/Area	03	04	00	05	06-07	Total
1	3490	8601	7940	7697	3762	31491	1	1516	3630	2146	8729	3201	19222
2	1072	530	146	117	221	2088	2	3363	2303	2294	612	926	9499
3	1051	1638	270	501	327	3790	3	1698	1469	457	504	403	4531
4	4419	1620	139	803	267	7253	4	2816	1679	124	1314	268	6201
Total	10032	12388	8495	9118	4577	44610	Total	9393	9082	5022	11159	4798	39455
2016		FR.	CC				2015		FR.	CC			
Q/Area	03	04	00	05	06-07	Total	Q/Area	03	04	00	05	06-07	Total
1	0.20	0.20	0.19	0.08	0.74	0.15	1	0.16	0.12	0.05	0.18	0.75	0.14
2	0.05	0.02	0.02	0.01	0.17	0.03	2	0.19	0.11	0.14	0.09	0.87	0.15
3	0.32	0.70	0.83	0.48	0.66	0.51	3	0.50	0.85	0.98	1.00	0.98	0.70
4	0.40	0.52	0.84	0.64	0.85	0.45	4	0.63	0.87	0.87	0.98	1.00	0.76
Total	0.19	0.16	0.17	0.08	0.64	0.15	Total	0.27	0.16	0.09	0.19	0.80	0.19

Table 2.5. Coastal cod. Acoustic abundance indices by subareas and in total in 2016 (in thousands). Age 1 is not split between coastal cod and NEA cod.

AREA	AGE (YEAR CLASS)										SUM
	1 (15)	2 (14)	3 (13)	4 (12)	5 (11)	6 (10)	7 (09)	8 (08)	9 (07)	10+ (06+)	
03	2360	1967	1309	967	556	179	175	91	58	106	7767
04	1806	1677	1955	946	689	350	325	268	69	122	8208
05	459	136	520	1022	699	550	174	471	15	121	4167
00	49		41	475	783	203	241	33	6	3	1834
06	177	434	722	62	162	138	86	41	22	10	1855
07	6		303	289	220	36	21	51	15	111	1050
Total	4857	4214	4850	3760	3108	1455	1022	955	187	474	24881

Table 2.6. Coastal cod. Acoustic abundance indices by age 1995–2016 (in thousands). Age 1 is not split between coastal cod and NEA cod. Fjords in area 07 not covered in 2013.

YEAR	AGE										SUM
	1	2	3	4	5	6	7	8	9	10+	
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
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

Table 2.7. Coastal cod. Mean length (cm) at age 1995–2016.

Year	AGE									
	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

Table 2.8. Coastal cod. Mean weight (grammes) at age 1995–2016.

YEAR	AGE									
	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

Table 2.9. Coastal cod. Acoustic biomass indices (tonnes) in 1995–2016. 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

Table 2.10. Coastal cod. Maturity-at-age as determined from maturity stages observed in the surveys over the period 1995 – 2016. Age 1 is not split between coastal cod and NEA cod.

YEAR	1	2	3	4	5	AGE 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

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

YEAR	AGE										SUM
	1	2	3	4	5	6	7	8	9	10+	
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

Table 2.12. Proportion coastal cod among sampled cod during the coastal survey by age and statistical areas in the years 2005–2015. 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	
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
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

YEAR	AREA/AGE	2	3	4	5	6	7	8	9	10+
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	0.57	0.58	1.00
2013	4	0.98	0.94	0.90	0.87	0.77	0.76	0.89	0.80	1.00
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
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

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	6.980	9.723
1985	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.980	9.723
1986	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.980	9.723
1987	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.980	9.723
1988	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.980	9.723
1989	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.980	9.723
1990	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.980	9.723
1991	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.980	9.723
1992	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.980	9.723
1993	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.980	9.723
1994	0.321	0.758	1.479	2.137	2.814	4.722	6.685	6.980	9.723

1995	0.298	0.700	1.338	1.973	2.649	4.164	7.051	6.413	14.326
1996	0.270	0.717	1.435	2.044	2.694	4.817	6.280	11.365	15.670
1997	0.232	0.677	1.363	1.903	2.816	3.833	5.849	9.600	13.037
1998	0.323	0.834	1.366	2.075	3.013	4.255	5.305	8.350	18.016
1999	0.318	0.804	1.559	2.042	2.798	4.678	7.151	8.959	18.340
2000	0.346	0.777	1.458	2.296	2.735	4.048	7.011	9.224	12.277
2001	0.347	0.878	1.543	2.213	2.862	3.321	4.849	7.339	11.542
2002	0.430	0.880	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	3.290	4.124	4.718	4.976	6.358
2005	0.407	0.846	1.748	2.200	2.693	3.817	3.797	5.344	14.829
2006	0.490	1.125	1.812	2.559	3.579	3.964	4.822	7.332	14.650
2007	0.518	1.185	2.011	2.500	3.160	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	5.400	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	6.570
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	7.670
2014	0.423	1.071	1.845	2.886	3.905	4.495	5.249	5.871	8.762
2015	0.370	1.045	1.940	2.910	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
CWT	2	3	4	5	6	7	8	9	10+
1984	0.248	0.619	1.149	1.734	2.325	3.486	4.845	5.608	8.84
1985	0.214	0.712	1.415	2.036	2.737	4.012	6.116	6.46	10.755
1986	0.227	0.525	1.08	1.706	2.256	3.353	4.838	5.838	7.053
1987	0.331	0.673	1.12	1.693	2.359	3.743	5.326	6.129	11.623
1988	0.246	0.634	1.17	1.727	2.328	3.256	4.7	5.45	8.202
1989	0.3	0.661	1.836	2.17	2.448	4.391	4.899	6.661	11.608
1990	0.345	1.174	1.515	1.678	2.708	3.898	6.515	7.299	13.924
1991	0.164	0.922	1.608	2.108	2.507	3.469	4.976	5.734	11.059
1992	0.168	0.556	1.359	2.267	2.957	3.903	5.317	4.558	7.032
1993	0.241	0.645	1.71	2.591	3.588	4.366	5.899	6.494	7.509
1994	0.254	0.805	1.476	2.097	3.287	4.095	5.592	7.217	8.331
1995	0.302	0.71	1.335	1.842	2.467	4.191	5.778	6.376	9.903
1996	0.274	0.921	1.464	1.979	2.516	3.461	4.866	5.391	8.854
1997	0.277	0.97	1.554	1.97	2.897	3.716	4.829	6.349	9.267
1998	0.376	0.978	1.518	2.281	3.125	3.9	5.52	6.333	9.337
1999	0.467	1.155	1.633	2.171	3.249	4.095	5.013	6.018	6.255
2000	0.515	1.305	2.272	2.555	3.283	4.504	5.4	6.379	6.42
2001	0.164	0.952	1.637	2.881	3.424	4.038	5.397	7.208	6.881
2002	0.491	1.179	1.8	2.485	3.86	4.76	5.195	5.507	9.183
2003	0.944	1.552	2.146	3.082	3.594	4.953	5.736	6.477	9.686
2004	0.824	1.374	1.877	2.679	3.365	4.013	4.847	5.554	6.343
2005	0.82	1.317	2.094	2.795	3.493	4.087	4.836	6.264	5.115
2006	1.274	1.599	1.894	2.687	3.562	4.029	5.182	5.905	6.213

2007	1.241	1.744	2.143	2.718	4.098	4.884	5.939	6.89	8.098
2008	0.977	1.882	2.444	3.747	4.165	4.989	5.992	6.143	8.229
2009	1.219	1.47	2.348	3.331	4.251	4.824	5.807	6.776	8.571
2010	0.813	1.576	2.344	3.114	4	5.025	4.911	5.873	6.809
2011	0.575	1.5	2.238	3.165	4.05	4.878	5.533	5.898	6.277
2012	0.727	1.518	2.267	3.415	4.287	5.029	5.781	7.968	8.404
2013	1.018	1.596	2.228	3.02	4.071	4.931	5.645	6.143	8.499
2014	0.86	1.496	2.632	3.229	4.162	5.029	5.424	6.193	6.569
2015	0.435	1.326	2.246	3.193	3.985	4.987	5.953	6.418	7.677
2016	0.437	1.424	2.201	3.268	4.208	5.027	6.058	6.841	7.583
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
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
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
2016	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.

Lowestoft VPA Version 3.1

20/04/2017 14:19

Extended Survivors Analysis

Norwegian Coastal Cod COMBSEX PLUSGROUP

CPUE data from file coast-9.txt

Catch data for 33 years, 1984 to 2016. Ages 2 to 10.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
Norw. Coast. survey	1995	2016	0	8	0.75	0.85

Time series weights :

Tapered time weighting applied

Power = 3 over 20 years

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 >= 8

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 200 iterations

Total absolute residual between iterations

199 and 200 = .00079

Final year F values

Age	2	3	4	5	6	7	8	9
Iteration **	0.0155	0.1	0.1431	0.2758	0.5159	0.6434	0.4701	0.5786
Iteration **	0.0155	0.1	0.143	0.2758	0.5158	0.6432	0.47	0.5783

Regression weights

	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1
--	-------	------	-------	-------	-------	-------	------	-------	---	---

Fishing mortalities

Age	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
2	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.02
3	0.04	0.04	0.02	0.05	0.04	0.03	0.04	0.05	0.06	0.10
4	0.15	0.16	0.09	0.14	0.18	0.09	0.12	0.13	0.15	0.14
5	0.28	0.26	0.21	0.22	0.23	0.21	0.15	0.18	0.29	0.28
6	0.26	0.31	0.37	0.27	0.28	0.36	0.25	0.17	0.37	0.52
7	0.35	0.29	0.47	0.32	0.53	0.40	0.23	0.22	0.39	0.64
8	0.22	0.32	0.30	0.35	0.38	0.59	0.27	0.23	0.41	0.47
9	0.37	0.18	0.20	0.17	0.32	0.50	0.52	0.32	0.44	0.58

XSA population numbers (Thousands)

AGE

YEAR	2	3	4	5	6	7	8	9
2007	21900	13500	11200	8360	6010	3080	2190	912
2008	20700	17900	10600	7930	5170	3790	1780	1440
2009	20100	16800	14000	7350	5020	3120	2320	1060
2010	21000	16500	13600	10500	4860	2850	1590	1410
2011	23500	17200	12800	9640	6900	3040	1700	923
2012	17500	19200	13500	8780	6280	4270	1460	950
2013	21400	14300	15300	10100	5850	3580	2350	664
2014	23300	17500	11200	11100	7140	3750	2320	1470
2015	23100	19000	13600	8060	7580	4940	2470	1510
2016	21500	18700	14700	9510	4930	4310	2750	1340

Estimated population abundance at 1st Jan 2017

0	17300	13900	10500	5910	2410	1850	1410
---	-------	-------	-------	------	------	------	------

Taper weighted geometric mean of the VPA populations:

20700	16800	13100	9340	6070	3690	2010	1090
-------	-------	-------	------	------	------	------	------

Standard error of the weighted Log(VPA populations) :

0.1154	0.1236	0.1299	0.1418	0.1599	0.1639	0.2048	0.2812
--------	--------	--------	--------	--------	--------	--------	--------

Log catchability residuals.

Fleet : Norw. Coast. survey

Age	1995	1996
2	99.99	99.99

3	99.99	99.99
4	99.99	99.99
5	99.99	99.99
6	99.99	99.99
7	99.99	99.99
8	99.99	99.99

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
2	0.28	0.2	0.28	0.39	0.22	0.04	-0.1	0.15	-0.04	0.13
3	2.57	1.81	1.45	1.53	1.05	0.14	0.12	0.1	0.09	0.36
4	1.2	0.83	0.68	0.59	0.49	0.18	0	0.22	-0.12	0.14
5	1.38	0.74	0.61	0.82	0.28	0.05	-0.08	-0.11	0.18	0.2
6	1.78	0.59	0.52	0.93	0.19	0.29	0.16	0.07	-0.19	0.45
7	0.59	0.77	0.22	0.41	0.33	0.35	0.22	-0.24	0.17	0.49
8	0.06	-1.11	-0.06	0.24	-0.05	-0.2	0.02	-0.07	-0.05	-0.22

Age	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
2	-0.04	-0.15	-0.15	-0.11	-0.11	0.03	-0.03	0.11	0.09	0.08
3	0.44	-0.58	-0.41	-0.35	0.14	-0.39	-0.19	-0.07	-0.04	0.43
4	0.57	-0.01	-0.03	-0.29	0.28	-0.27	-0.2	-0.17	-0.08	-0.09
5	0.28	-0.13	0.1	-0.3	0.01	-0.32	-0.19	0.24	-0.14	0.1
6	0.25	-0.27	0.09	-0.34	0.01	-0.49	0.09	0.08	-0.11	0.13
7	0.48	-0.35	0.43	-0.53	-0.53	-0.38	0.02	0.53	-0.3	0.03
8	0.03	-0.32	0.07	-0.14	-0.06	-0.08	0.24	0.42	-0.17	0.23

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		-1.0054	-0.8355	-0.775	-0.7977	-0.7474
S.E(Log q)		0.2578	0.2277	0.2728	0.4014	0.215

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	0.41	1.84	6.56	0.49	20	0.12	-1.71
3	1.47	-0.452	-2.6	0.08	20	0.43	-1.37

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	1.29	-0.357	-1.41	0.13	20	0.35	-1.01
5	0.77	0.599	2.74	0.4	20	0.18	-0.84
6	0.8	0.474	2.37	0.36	20	0.23	-0.77
7	1.04	-0.049	0.51	0.13	20	0.44	-0.8
8	0.67	1.692	3.01	0.72	20	0.13	-0.75

Fleet disaggregated estimates of survivors :

Age 2 Catchability dependent on age and year class strength

Year class = 2014

Norw. Coast. survey

Age 2
Survivors 18812

Raw Weights 10.94

Fleet	Estimated	Int	Ext	Var	N	Scaled	Estimated
	Survivors	s.e	s.e	Ratio		Weights	F
Norw. Coast. survey	18812	0.3	0	0	1	0.141	0.014
P shrinkage mean	16824	0.12				0.846	0.016
F shrinkage mean	46147	1				0.013	0.006

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
17316	0.11	0.1	3	0.901	0.016

Age 3 Catchability dependent on age and year class strength

Year class = 2013

Norw. Coast. survey

Age 3
Survivors 21330 15103

Raw Weights 3.963 9.944

Fleet	Estimated	Int	Ext	Var	N	Scaled	Estimated
	Survivors	s.e	s.e	Ratio		Weights	F
Norw. Coast. survey	16664	0.254	0.156	0.61	2	0.187	0.084
P shrinkage mean	13145	0.13				0.799	0.105
F shrinkage mean	25946	1				0.013	0.055

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
13869	0.11	0.13	4	1.147	0.1

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

Year class = 2012

Norw. Coast. survey

Age 4	3	2						
Survivors	9594	10055	11655					
Raw Weights	9.63	4.042	9.069					
Fleet	Estimated		Int	Ext	Var	N	Scaled	Estimated
	Survivors		s.e	s.e	Ratio		Weights	F
Norw. Coast. survey		10455	0.192	0.064	0.33	3	0.958	0.143
F shrinkage mean		10521	1				0.042	0.142

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
10458	0.19	0.05	4	0.27	0.143

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

Year class = 2011

Norw. Coast. survey

Age 5	4	3	2					
Survivors	6516	5444	5524	5748				
Raw Weights	8.433	7.228	3.044	6.756				
Fleet	Estimated		Int	Ext	Var	N	Scaled	Estimated
	Survivors		s.e	s.e	Ratio		Weights	F
Norw. Coast. survey		5872	0.163	0.044	0.27	4	0.962	0.277
F shrinkage mean		7048	1				0.038	0.236

Weighted prediction :

Survivors	Int	Ext	N	Var	F
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at end of year	s.e	s.e		Ratio
5913	0.16	0.04	5	0.257 0.276

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

Year class = 2010

Norw. Coast. survey

Age 6	5	4	3	2				
Survivors	2736	2097	2034	1999	2495			
Raw Weights	6.633	4.955	4.341	1.743	4.068			
Fleet	Estimated		Int	Ext	Var	N	Scaled	Estimated
	Survivors		s.e	s.e	Ratio		Weights	F
Norw. Coast. survey		2326	0.146	0.065	0.45	5	0.956	0.53
F shrinkage mean		5280	1				0.044	0.269

Weighted prediction :

Survivors		Int	Ext	N	Var	F
at end of year		s.e	s.e		Ratio	
2412	0.15	0.1	6	0.654	0.516	

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

Year class = 2009

Norw. Coast. survey

Age 7	6	5	4	3	2			
Survivors	1917	1655	2359	1520	1257	1652		
Raw Weights	3.013	4.05	3.379	2.964	1.232	2.779		
Fleet	Estimated		Int	Ext	Var	N	Scaled	Estimated
	Survivors		s.e	s.e	Ratio		Weights	F
Norw. Coast. survey		1757	0.14	0.079	0.56	6	0.946	0.669
F shrinkage mean		4698	1				0.054	0.304

Weighted prediction :

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

1853 0.14 0.12 7 0.817 0.643

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 2008

Norw. Coast. survey

Age 8	7	6	5	4	3	2		
Survivors	1763	1040	1527	1162	1076	1624	1257	
Raw Weights	6.944	2.435	3.975	3.414	3.07	1.266	2.777	
Fleet	Estimated		Int	Ext	Var	N	Scaled	Estimated
	Survivors		s.e	s.e	Ratio		Weights	F
Norw. Coast. survey		1381	0.131	0.084	0.64	7	0.96	0.477
F shrinkage mean		2223	1				0.04	0.322

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
1407	0.13	0.08	8	0.635	0.47

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 8

Year class = 2007

Norw. Coast. survey

Age 9	8	7	6	5	4	3	2	
Survivors	0	515	1043	673	443	809	433	528
Raw Weights	0	4.124	1.704	2.566	2.06	1.682	0.649	1.472
Fleet	Estimated		Int	Ext	Var	N	Scaled	Estimated
	Survivors		s.e	s.e	Ratio		Weights	F
Norw. Coast. survey		604	0.133	0.112	0.84	7	0.934	0.585
F shrinkage mean		780	1				0.066	0.48

Weighted prediction :

Survivors	Int	Ext	N	Var	F
at end of year	s.e	s.e		Ratio	
614	0.14	0.1	8	0.736	0.578

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).

Year	2	3	4	5	6	7	8	9
1984	0.011	0.074	0.217	0.334	0.628	1.309	1.072	0.845
1985	0.006	0.130	0.223	0.462	0.637	0.788	0.633	0.636
1986	0.135	0.077	0.319	0.460	0.643	0.900	0.934	0.741
1987	0.005	0.041	0.220	0.598	0.438	0.708	0.733	0.625
1988	0.003	0.073	0.203	0.268	0.762	1.238	1.184	0.873
1989	0.001	0.040	0.071	0.209	0.361	0.852	0.931	0.593
1990	0.000	0.011	0.054	0.088	0.150	0.435	0.628	0.327
1991	0.002	0.019	0.056	0.188	0.171	0.258	0.184	0.201
1992	0.001	0.015	0.128	0.241	0.277	0.270	0.287	0.270
1993	0.000	0.010	0.048	0.131	0.226	0.512	0.453	0.333
1994	0.015	0.026	0.057	0.165	0.199	0.487	0.514	0.343
1995	0.027	0.051	0.143	0.250	0.332	0.441	0.406	0.360
1996	0.033	0.104	0.194	0.501	0.372	0.448	0.564	0.475
1997	0.046	0.127	0.195	0.272	0.512	0.626	0.796	0.556
1998	0.020	0.129	0.262	0.410	0.484	0.708	0.680	0.575
1999	0.011	0.060	0.151	0.395	0.555	0.769	0.944	0.702
2000	0.007	0.052	0.236	0.389	0.463	0.448	0.340	0.411
2001	0.002	0.029	0.131	0.306	0.364	0.477	0.414	0.333
2002	0.011	0.055	0.184	0.304	0.517	0.532	0.662	0.471
2003	0.005	0.081	0.176	0.308	0.403	0.535	0.405	0.391
2004	0.001	0.022	0.090	0.213	0.386	0.521	0.482	0.262
2005	0.001	0.035	0.120	0.257	0.279	0.434	0.352	0.266
2006	0.005	0.025	0.165	0.227	0.404	0.416	0.510	0.397
2007	0.004	0.043	0.148	0.280	0.262	0.350	0.220	0.371
2008	0.005	0.042	0.163	0.259	0.305	0.290	0.320	0.181
2009	0.000	0.016	0.087	0.214	0.365	0.473	0.300	0.198
2010	0.001	0.049	0.141	0.222	0.270	0.318	0.345	0.169
2011	0.001	0.041	0.179	0.228	0.280	0.532	0.381	0.322
2012	0.001	0.026	0.092	0.206	0.364	0.398	0.588	0.500
2013	0.005	0.043	0.124	0.145	0.245	0.233	0.270	0.524
2014	0.001	0.053	0.130	0.179	0.169	0.220	0.228	0.322
2016	0.011	0.056	0.154	0.291	0.366	0.386	0.413	0.436

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

RUN TITLE COMBSEX PLUSGROUP : NORWEGIAN COASTAL COD

At 25/04/2017 9:48

TABLE 16 SUMMARY (WITHOUT SOP CORRECTION)

TERMINAL FS DERIVED USING XSA (WITH F SHRINKAGE)

	RECRUITS	TOTALBIO	TOTSPBIO	LANDING	YIELD/SSB	FBAR 4- 7
1984	87969	310218	140805	74824	0.5314	0.622
1985	74746	294114	116959	75451	0.6451	0.5274
1986	35838	290950	122061	68905	0.5645	0.5804
1987	37121	255440	114768	60972	0.5313	0.4911
1988	40398	231678	118152	59294	0.5018	0.6179
1989	44432	197891	94030	40285	0.4284	0.3732
1990	44362	212892	103462	28127	0.2719	0.1817
1991	60794	249844	124526	24822	0.1993	0.1682
1992	50609	293575	156906	41690	0.2657	0.229
1993	29852	307505	171043	52557	0.3073	0.2293
1994	24769	308320	182081	54562	0.2997	0.2271
1995	33404	270414	170329	57207	0.3359	0.2914
1996	40169	274494	184927	61776	0.3341	0.3784
1997	32923	216758	139641	63319	0.4534	0.4014
1998	31137	182062	99070	51572	0.5206	0.466
1999	26293	160003	82023	40732	0.4966	0.4675
2000	23731	137129	63437	36715	0.5788	0.3839
2001	22688	131545	61542	29699	0.4826	0.3194
2002	19456	157243	83620	40994	0.4902	0.3841
2003	19439	113686	59297	34635	0.5841	0.3554
2004	18616	119677	62717	24547	0.3914	0.3023
2005	17199	114576	57700	22432	0.3888	0.2725
2006	16531	133556	69415	26134	0.3765	0.303
2007	21910	138174	71590	23841	0.333	0.2598
2008	20652	140584	68707	25777	0.3752	0.2541
2009	20111	137255	66049	24821	0.3758	0.2847
2010	21028	138184	65609	22925	0.3494	0.2379
2011	23464	148796	73575	28594	0.3886	0.3048
2012	17478	145468	72287	31907	0.4414	0.2649
2013	21420	135698	67175	22464	0.3344	0.1868
2014	23274	153382	78310	23169	0.2959	0.1742
2015	23108	165070	89432	39455	0.4412	0.2991
2016	21478	163094	84176	44610	0.53	0.3945
ARITH.						
MEAN	31709	194826	100467	41176	0.4195	0.3404
0 UNITS		(TONNES)	(TONNES)	(TONNES)		
	(THOUSANDS)					

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	0.3745	0.3523
1997	0.850	0.3701	0.3488
1998	1.604	0.4773	0.4323
1999	1.018	0.3939	0.3673
2000	0.538	0.3257	0.3142
2001	0.912	0.3789	0.3556
2002	1.084	0.4033	0.3747
2003	0.482	0.3177	0.3080
2004	0.725	0.3524	0.3350
2005	0.355	0.2997	0.2939
2006	0.324	0.2954	0.2905
2007	0.386	0.3041	0.2974
2008	0.925	0.3807	0.3570
2009	-0.030	0.2451	0.2513
2010	0.776	0.3596	0.3406
2011	0.229	0.2819	0.2800
2012	0.760	0.3573	0.3388
2013	-0.102	0.2348	0.2433
2014	-0.031	0.2448	0.2511
2015	0.677	0.3456	0.3297
2016	0.389	0.3046	0.2977

Table 2.17. Norwegian Coastal Cod. Stock summary for SVPA based on commercial catch-at-age and survey derived F in terminal year (2016)

AT 22/04/2017 13:42						
TABLE 16 SUMMARY (WITHOUT SOP CORRECTION)						
TRADITIONAL VPA USING FILE INPUT FOR TERMINAL F						
	RECRUITS	TOTBIO	TOTSPBIO	LANDI	YIELD/SS B	F(4-7)
		AGE 2				
1984	87089	306315	138848	74824	0.5389	0.6214
1985	74276	290729	115486	75451	0.6533	0.5287
1986	35639	287660	120478	68905	0.5719	0.5815
1987	36890	252676	113267	60972	0.5383	0.4928
1988	40101	229274	116645	59294	0.5083	0.6163
1989	44095	196319	93201	40285	0.4322	0.3722
1990	44012	211384	102759	28127	0.2737	0.1817
1991	60247	248064	123726	24822	0.2006	0.1686
1992	50134	291347	155828	41690	0.2675	0.2296
1993	29551	305042	169817	52557	0.3095	0.2296
1994	24565	305758	180706	54562	0.3019	0.2276
1995	33141	268011	168889	57207	0.3387	0.2924
1996	39859	271894	183183	61776	0.3372	0.3796
1997	32696	214674	138257	63319	0.458	0.4023
1998	30902	180404	98122	51572	0.5256	0.4665
1999	26100	158600	81265	40732	0.5012	0.4667
2000	23559	136046	62943	36715	0.5833	0.3842
2001	22563	130524	61056	29699	0.4864	0.3198
2002	19338	156118	83032	40994	0.4937	0.3839
2003	19338	112869	58847	34635	0.5886	0.3553
2004	18492	118897	62300	24547	0.394	0.3023
2005	17076	113882	57364	22432	0.391	0.2726
2006	16402	132721	69014	26134	0.3787	0.3026
2007	21775	137331	71212	23841	0.3348	0.2599
2008	20514	139715	68349	25777	0.3771	0.2544
2009	20912	136745	65635	24821	0.3782	0.2848
2010	22364	138655	65196	22925	0.3516	0.2385
2011	27210	151687	73282	28594	0.3902	0.3029
2012	20708	152421	72882	31907	0.4378	0.2601
2013	22104	145940	69608	22464	0.3227	0.1750
2014	22279	167125	84408	23169	0.2745	0.1521
2015	30905	182749	99240	39455	0.3976	0.2512
2016	34716	192363	99611	44610	0.4478	0.3046
ARITH.						
MEAN	32411	195877	100741	41176	0.4177	0.3352

Table 2.18. Norwegian Coastal Cod. Stock summary for SVPA based on total catch-at-age and survey derived F in terminal year (2016).

At 24/04/2017 11:35

TABLE 16 SUMMARY (WITHOUT SOP CORRECTION)

	TRADITIONAL VPA USING FILE INPUT FOR TERMINAL F					
	RECRUITS	TOTBIO AGE 2	TOTSPB	LADINGS	Y/SSB	FBAR 4- 7
1984	108413	359107	159502	88124	0.5525	0.6177
1985	97535	344532	132867	88851	0.6687	0.5249
1986	62544	347937	138826	82405	0.5936	0.5904
1987	48958	314026	131617	74472	0.5658	0.5081
1988	54324	291758	137992	72894	0.5282	0.6315
1989	62948	259414	117284	53985	0.4603	0.381
1990	62539	279439	130835	42627	0.3258	0.2356
1991	81086	325452	158046	40122	0.2539	0.1931
1992	69603	373216	194608	57790	0.297	0.2466
1993	38556	387459	210625	67357	0.3198	0.2332
1994	32562	383761	220533	69262	0.3141	0.2365
1995	44789	338216	209256	71907	0.3436	0.2947
1996	58502	346069	227881	76276	0.3347	0.3605
1997	47413	279657	172883	77819	0.4501	0.3897
1998	43015	249873	130811	66172	0.5059	0.4247
1999	38458	228098	115165	54632	0.4744	0.4183
2000	35120	200943	94360	50315	0.5332	0.345
2001	33793	193686	91226	43099	0.4724	0.3095
2002	29250	227365	118607	54594	0.4603	0.3515
2003	29168	171397	89604	48535	0.5417	0.314
2004	28468	179860	92923	37947	0.4084	0.3056
2005	26251	168185	81948	35632	0.4348	0.2806
2006	24748	196572	99364	39134	0.3938	0.3044
2007	32513	202695	102488	36841	0.3595	0.2668
2008	30337	202495	95267	38577	0.4049	0.2523
2009	29830	200245	94633	37521	0.3965	0.2987
2010	31124	204462	97311	35625	0.3661	0.2506
2011	37501	219147	107440	41294	0.3843	0.299
2012	27952	217864	106537	44607	0.4187	0.2477
2013	28871	206654	101526	35164	0.3464	0.1922
2014	28360	229076	118590	35869	0.3025	0.1745
2015	39834	244131	135588	52155	0.3847	0.2511
2016	46796	252369	132154	57310	0.4337	0.2977
ARITH.						
MEAN	45187	261368	131767	54816	0.4252	0.3342

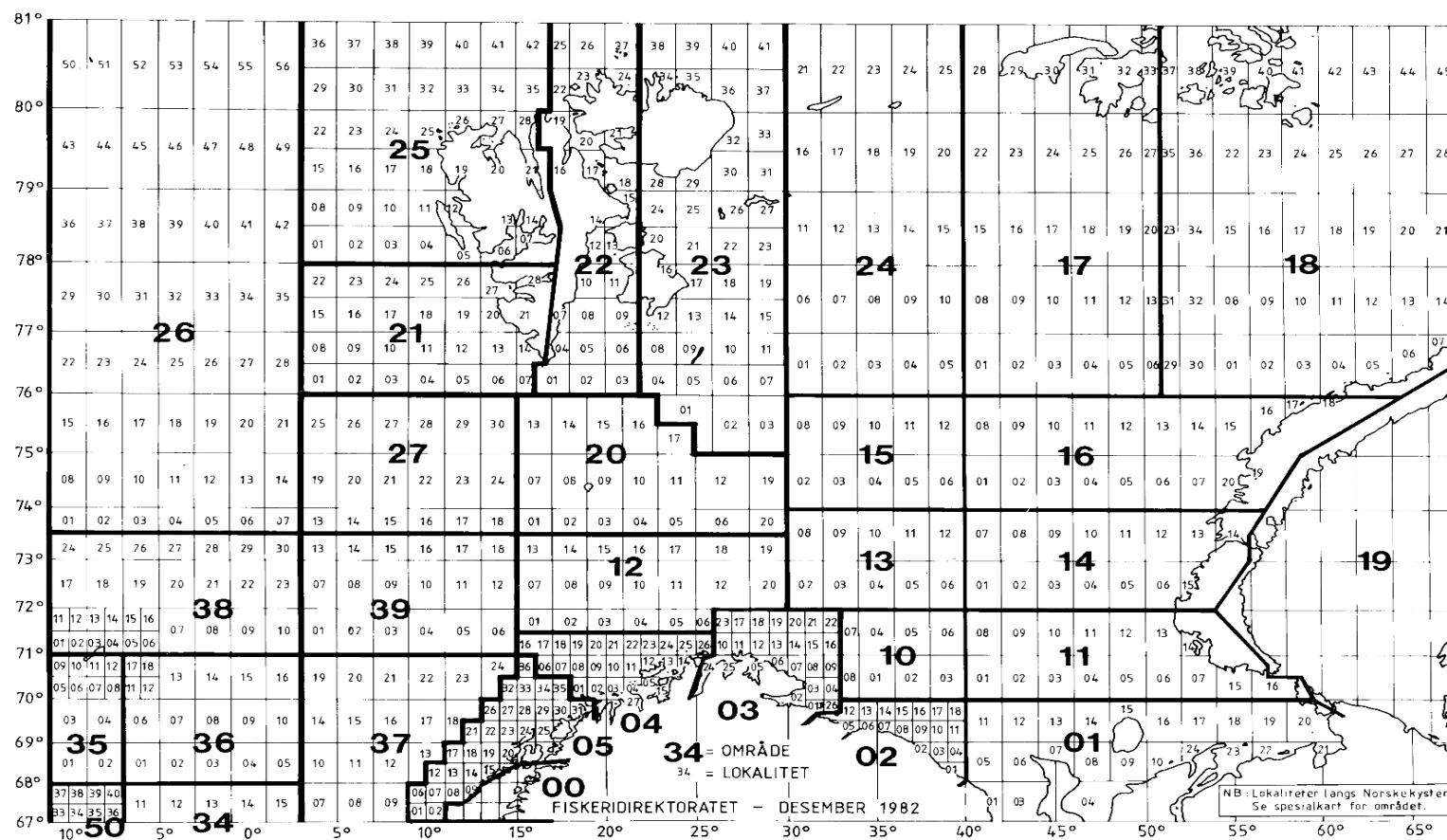


Figure 2.1a. Norwegian statistical rectangles in the Barents Sea. Coastal cod catches are estimated from the total cod catch taken inside 12 n.mile in areas 03 and 04. The same areas are also referred to in the survey results (sec. 2.3).

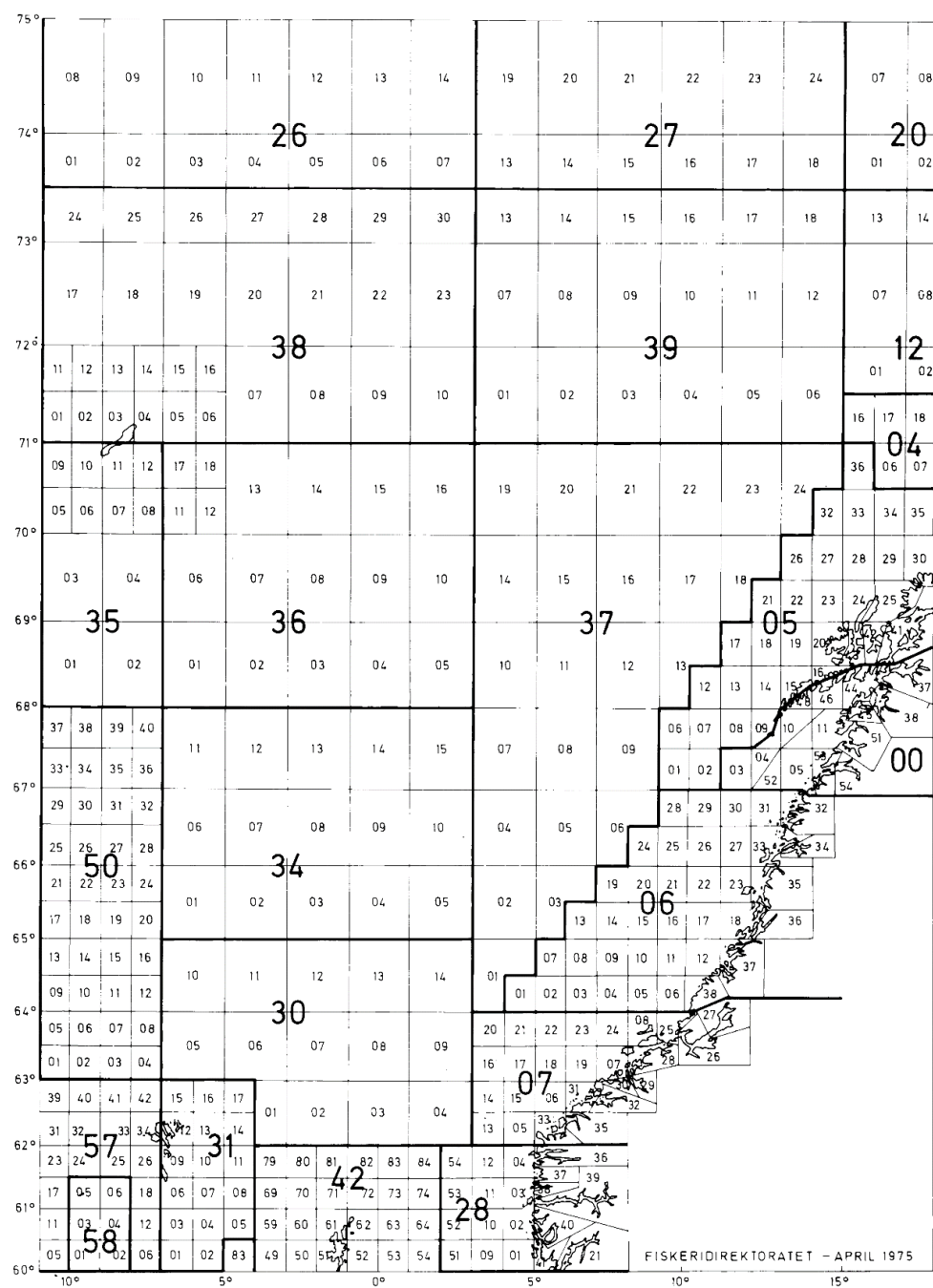


Figure 2.1b. Norwegian statistical rectangles in the Norwegian Sea. Coastal cod catches are estimated from the total cod catch taken inside 12 n.mile in areas 05, 00, 06 and 07. The same areas are also referred to in the survey results (sec. 2.3).

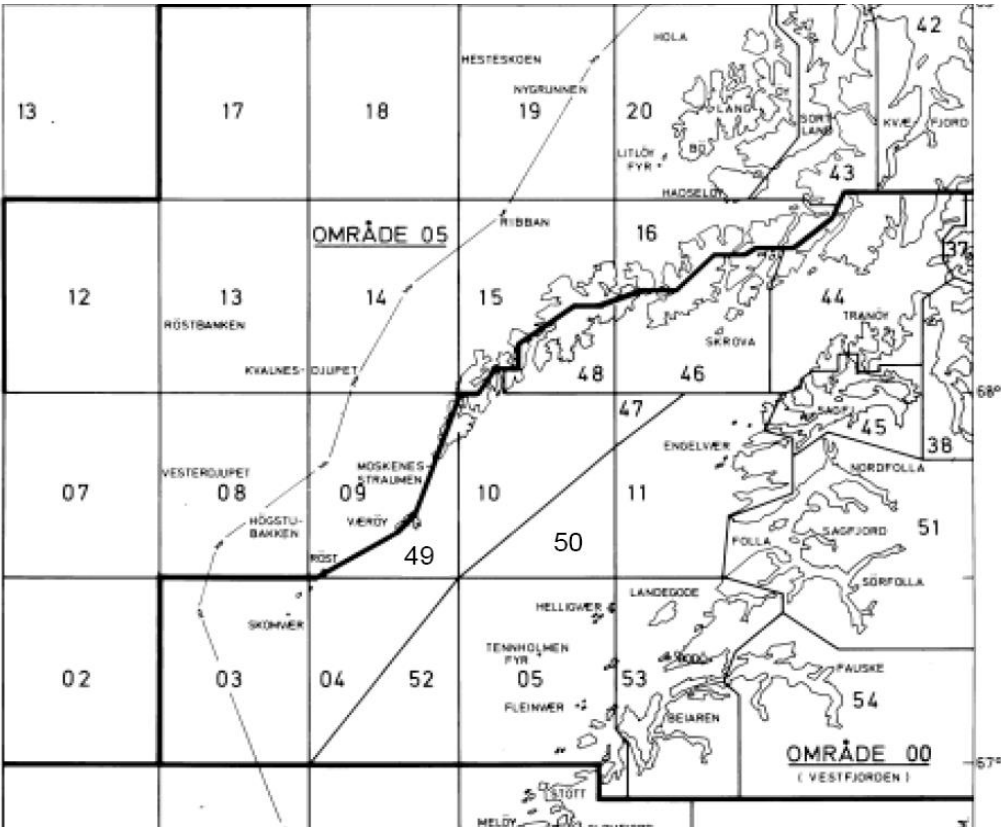


Figure 2.2. Map showing Vestfjorden, the Norwegian statistical area 00 (“OMRÅDE 00”) with the southwestern location 03 and 04 and the northeastern locations 46 and 48.

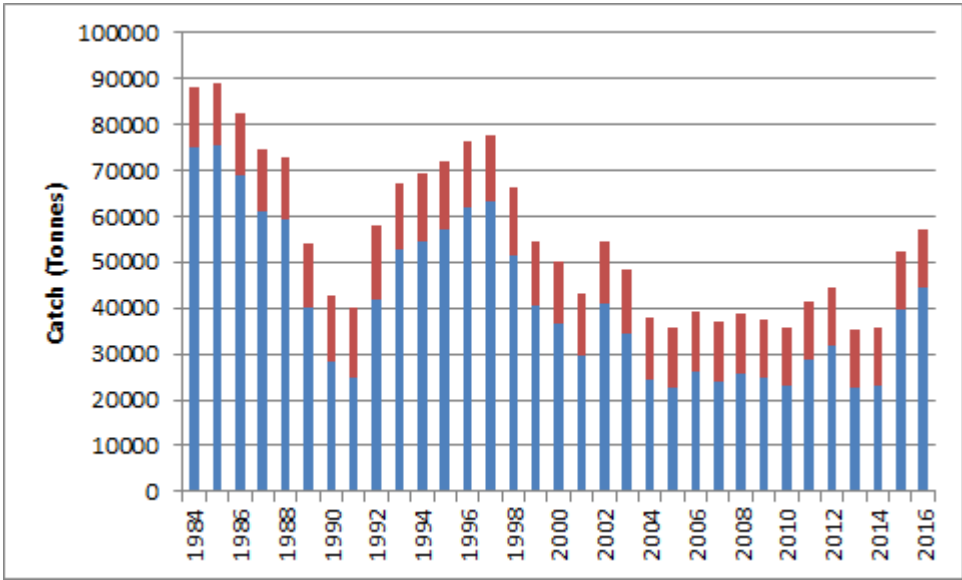


Figure 2.3. Estimated catch of Norwegian coastal cod. Commercial catch in blue and recreational catches in red

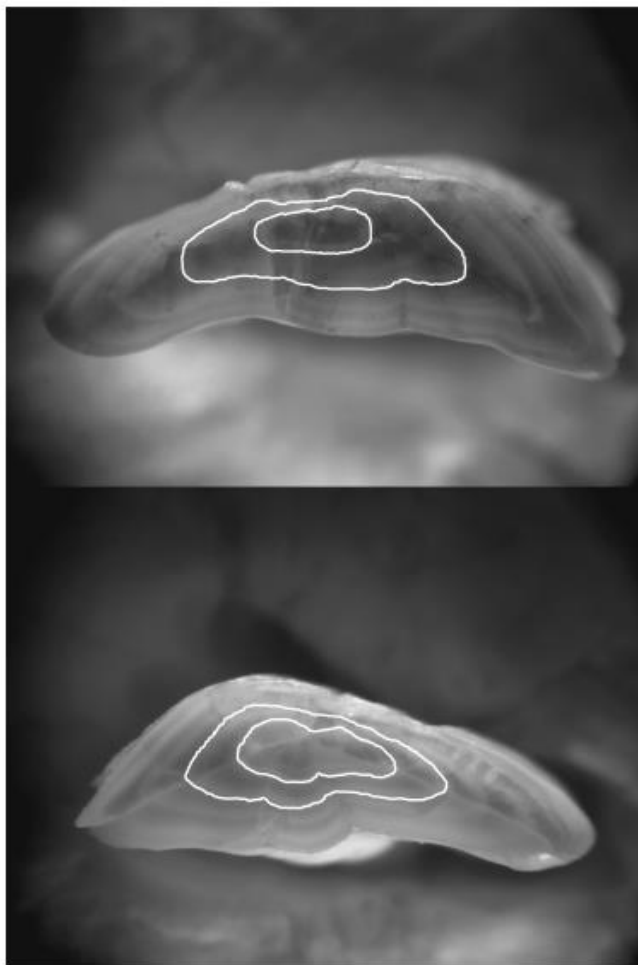


Figure 2.4. An image of a coastal cod otolith (top) and a northeast Arctic cod otolith (bottom). The two first translucent zones are highlighted. (from Berg *et al.* 2005)

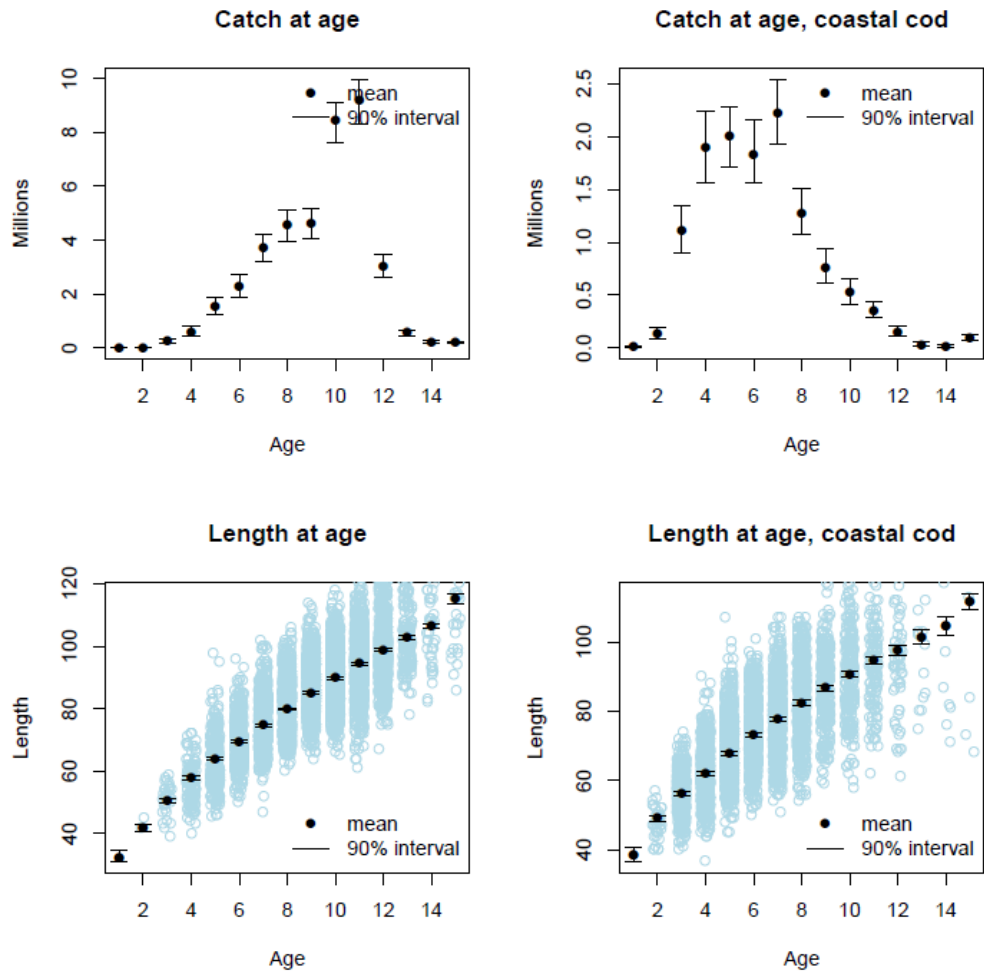


Figure 2.5a. ECA-output for 2015 commercial catches by Norway in the coastal statistical areas (Figure 2.5c). Left panels NEA cod. Right panels coastal cod.

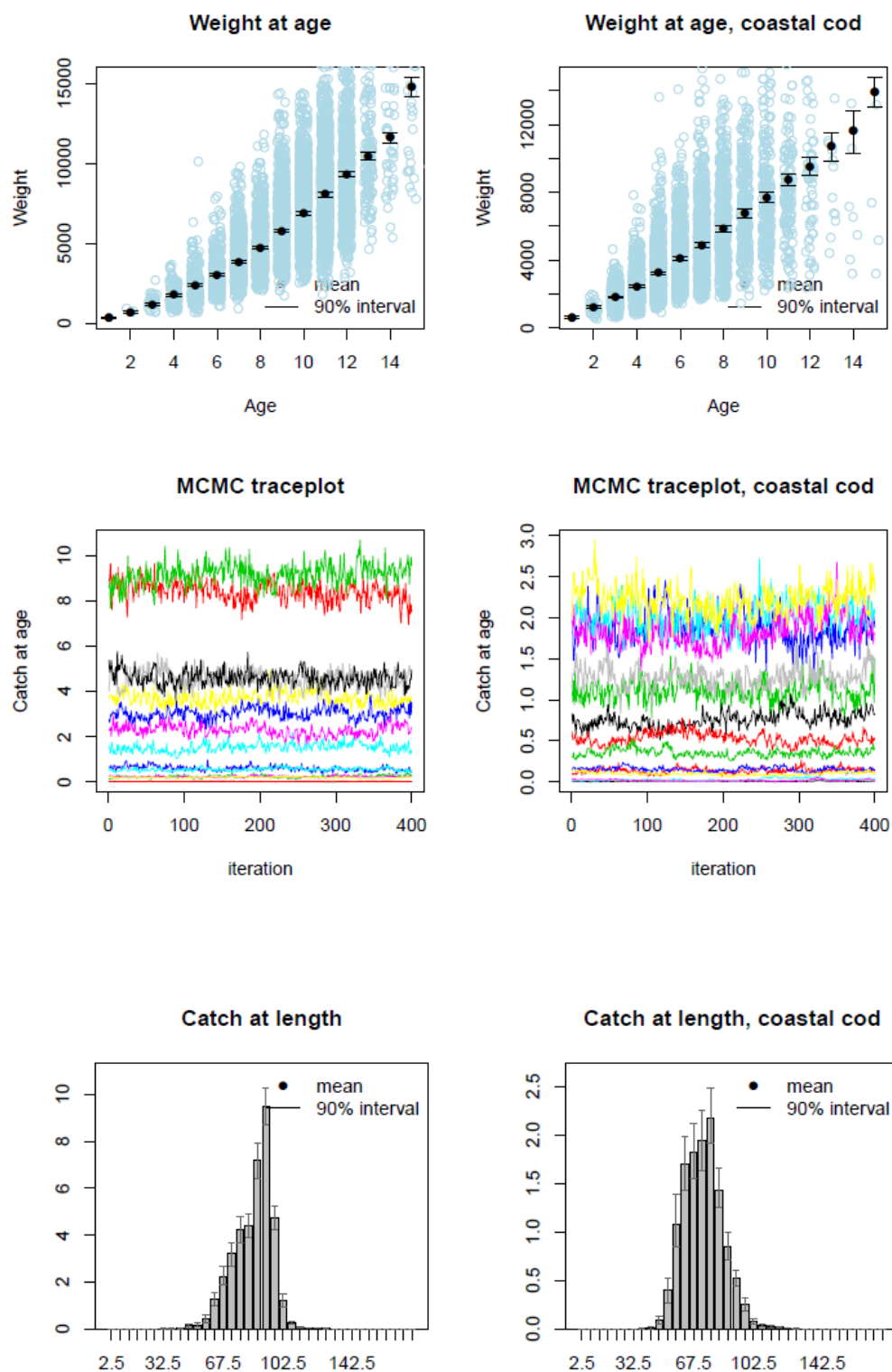


Figure 2.5b. ECA-output for 2016 commercial catches by Norway in the coastal statistical areas (Figure 2.5c). Left panels NEA cod. Right panels coastal cod.

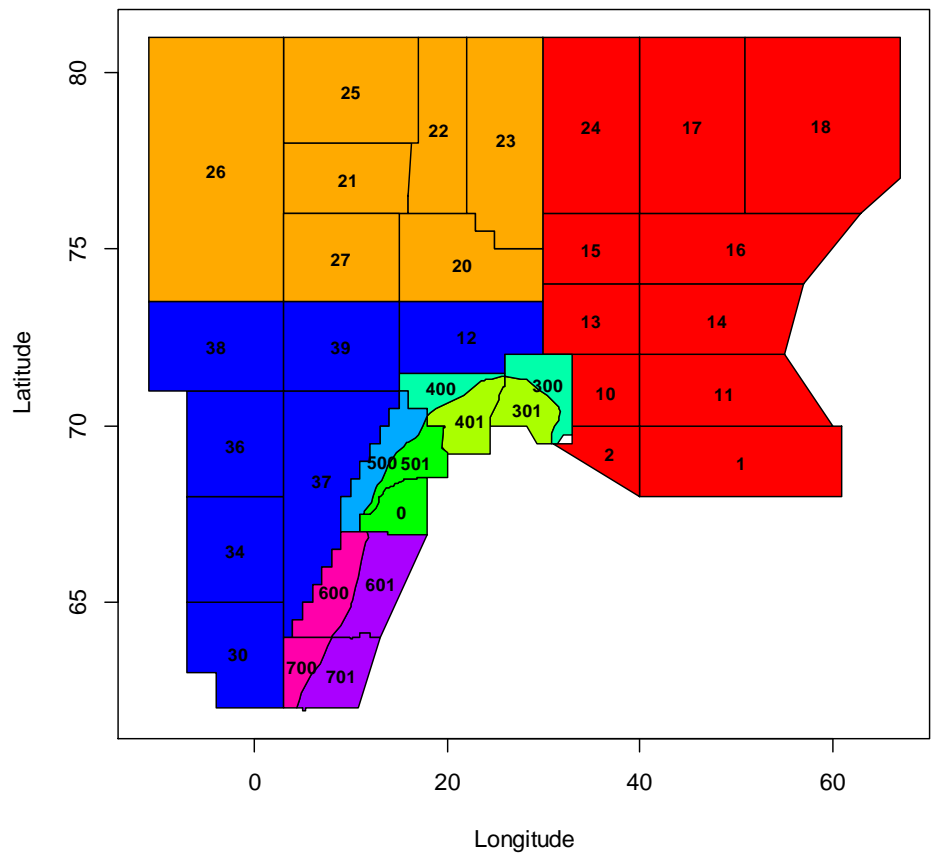


Figure 2.5c. Norwegian statistical rectangles. The colors indicate area units used by the ECA-model for combining cod samples. Coastal cod are only estimated in coastal areas (0 and 300-701).

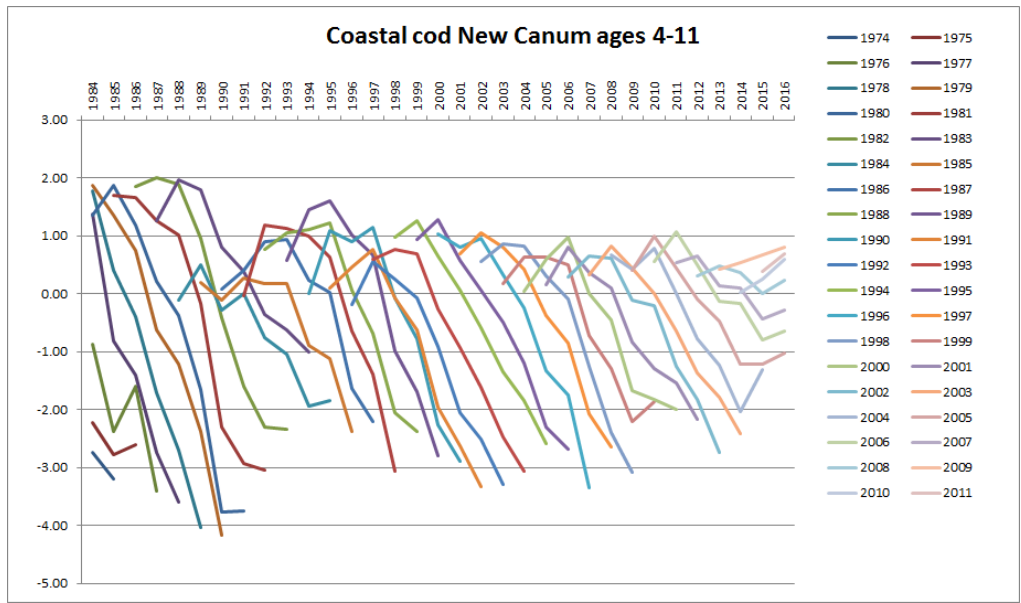


Figure 2.5d. Log catch numbers-at-age by cohort (series names) and catch years (x-axis). ECA estimates.

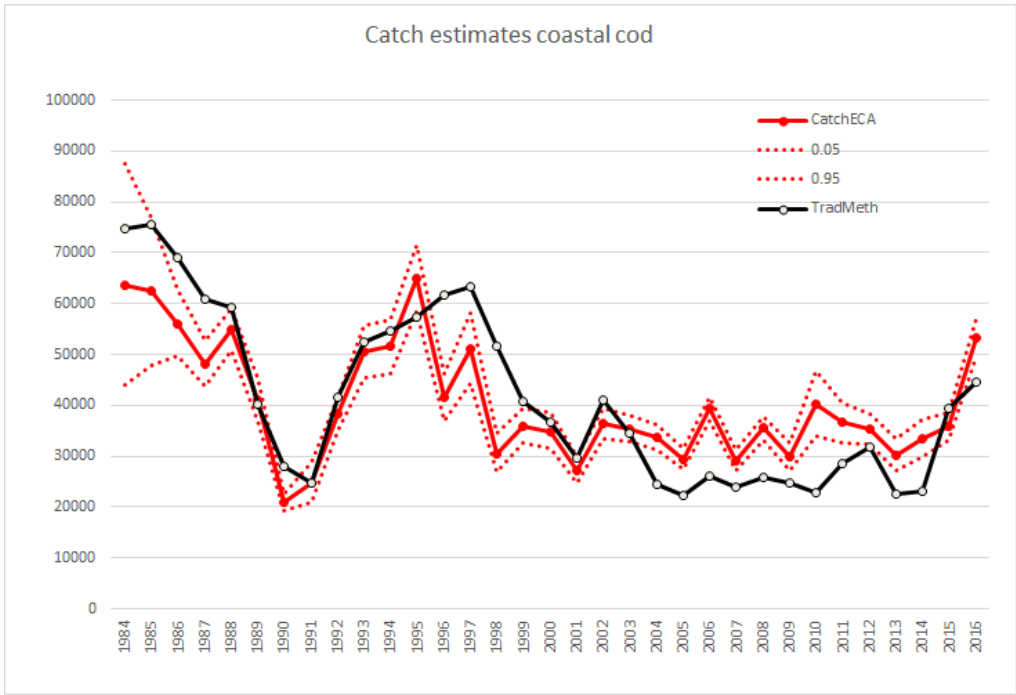


Figure 2.5e. Catches (tonnes) of coastal cod from the ECA analysis, compared to the traditional estimates.

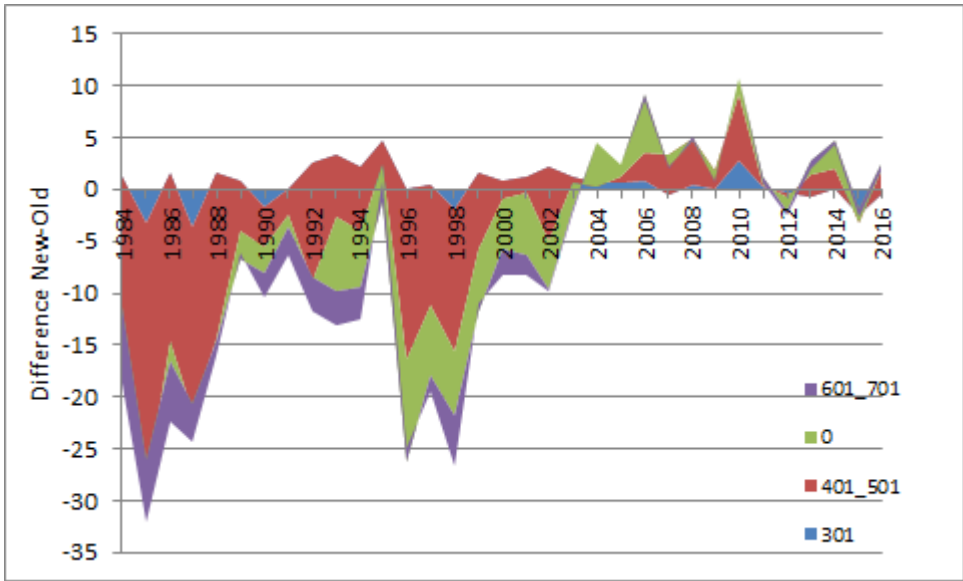


Figure 2.5f. Difference in catch estimate ('000 tonnes) between ECA estimates within 12 n.mile and traditional estimates. The colors represent different statistical areas (see figure 2.5c).

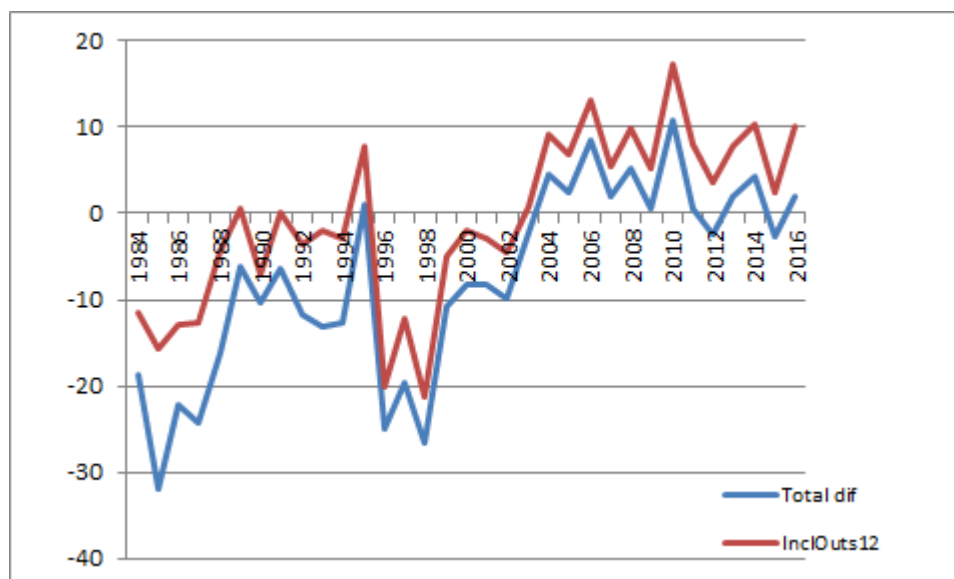


Figure 2.5g. Blue line: Difference in catch estimate ('000 tonnes) between ECA estimates within 12 n.mile and traditional estimates. Red line: Difference between total ECA estimates including some areas outside 12 n.mile (see figure 2.5c), and traditional estimates.

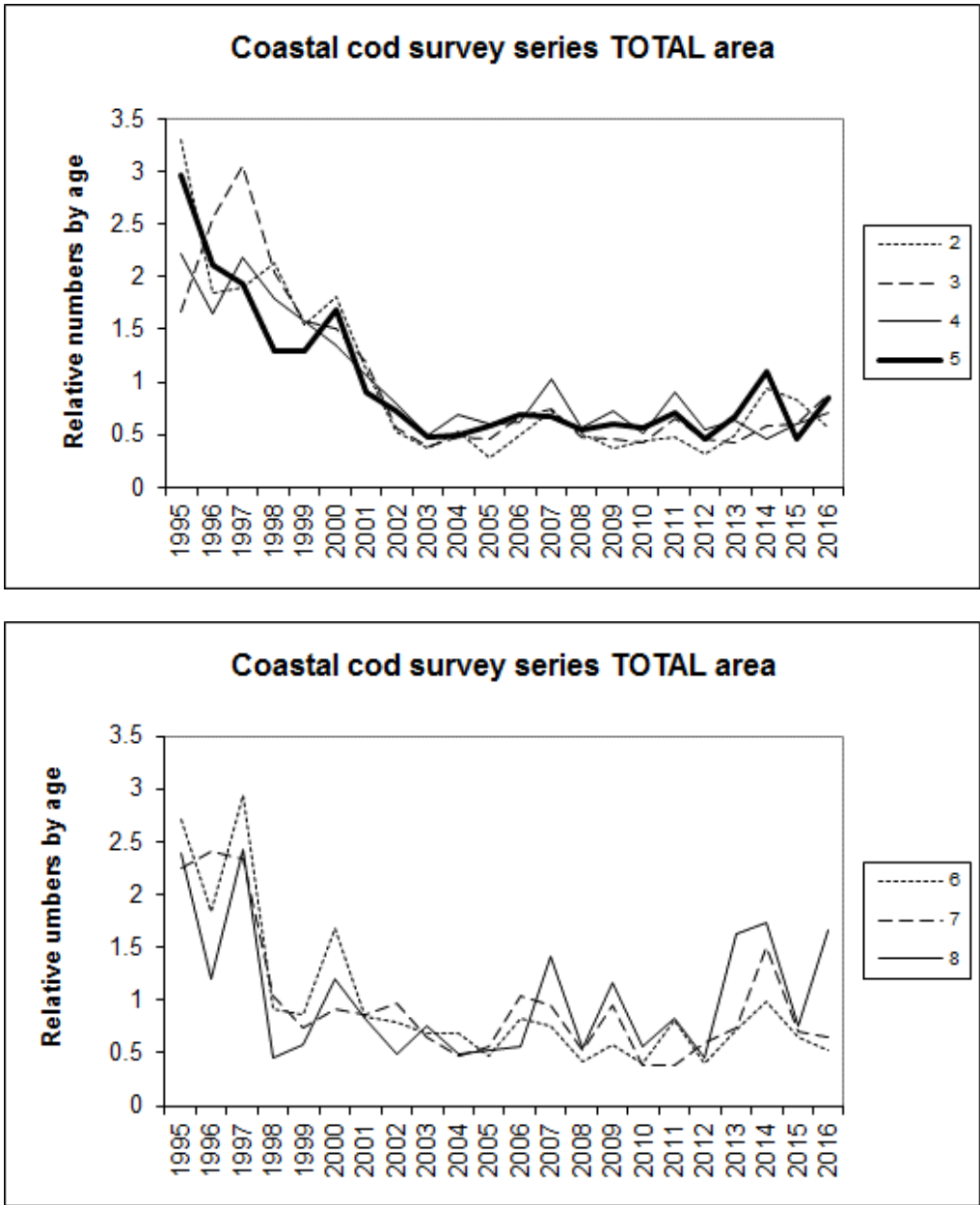


Figure 2.6. Coastal cod survey. Abundance at age relative to time-series average in total survey. Upper: ages 2-5, Lower: ages 6-8.

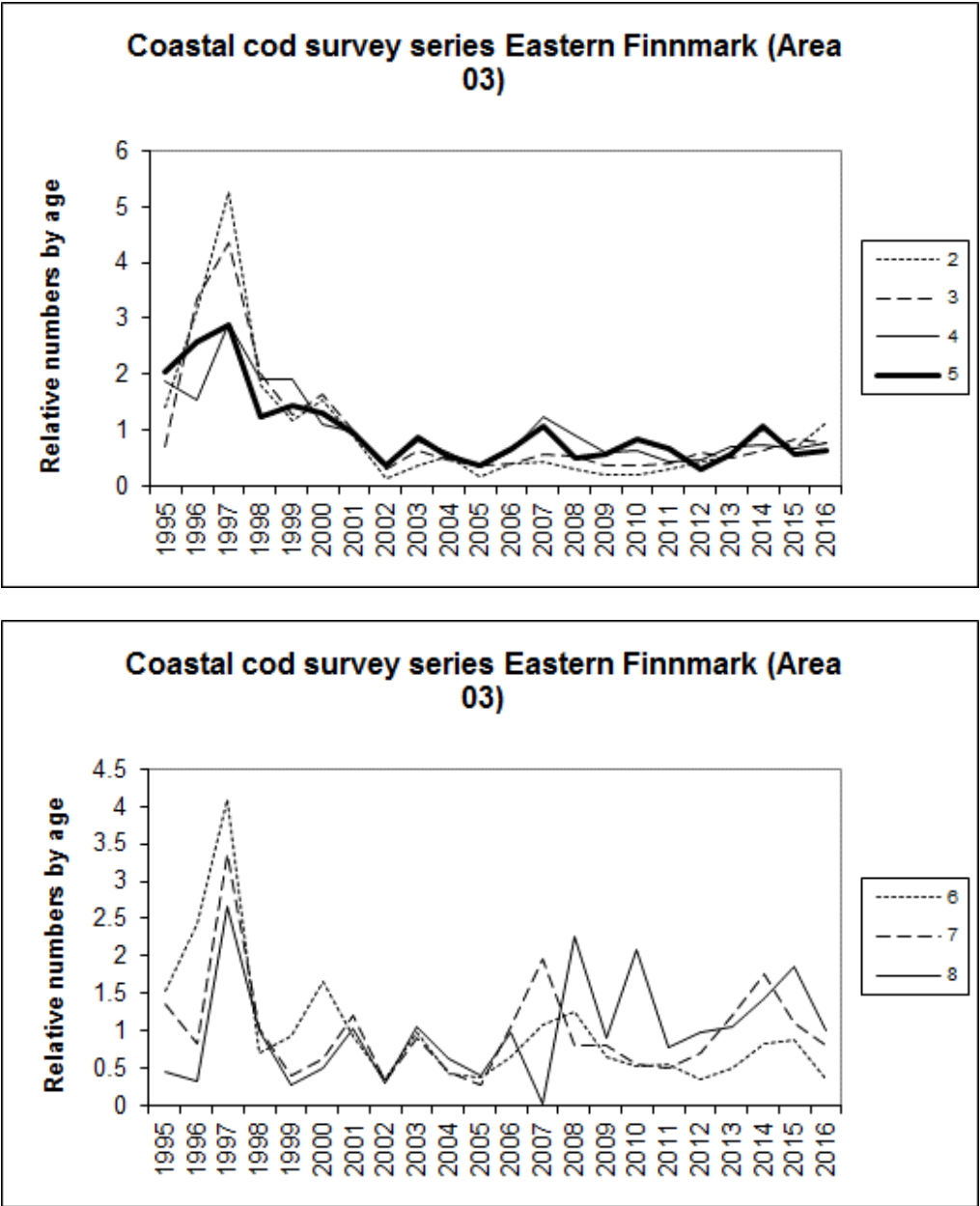


Figure 2.7. Coastal cod survey. Abundance at age relative to time-series average in statistical area 03. Upper: ages 2-5, Lower: ages 6-8.

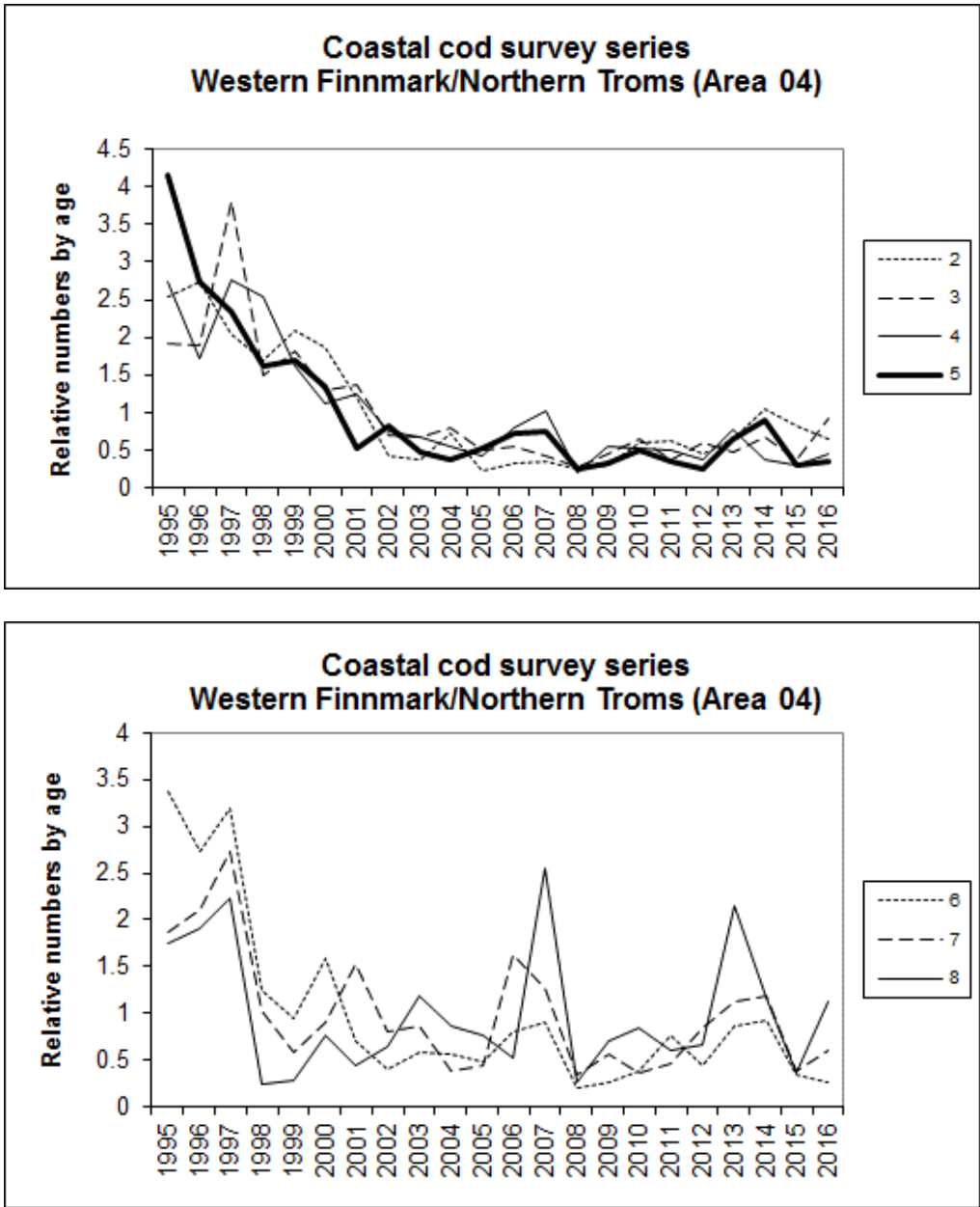


Figure 2.8. Coastal cod survey. Abundance at age relative to time-series average in statistical area 04. Upper: ages 2-5, Lower: ages 6-8.

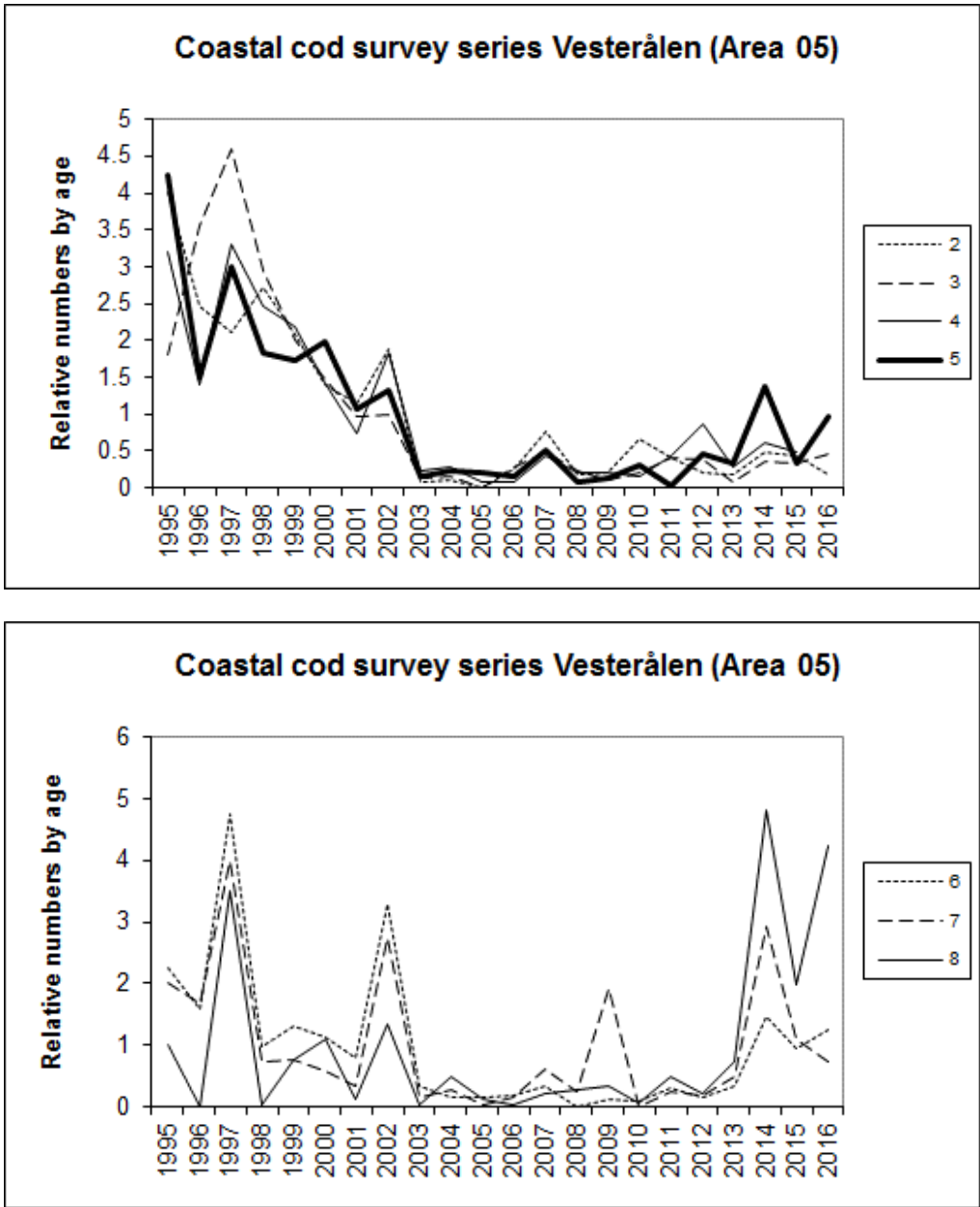


Figure 2.9. Coastal cod survey. Abundance at age relative to time-series average in statistical area 05. Upper: ages 2-5, Lower: ages 6-8.

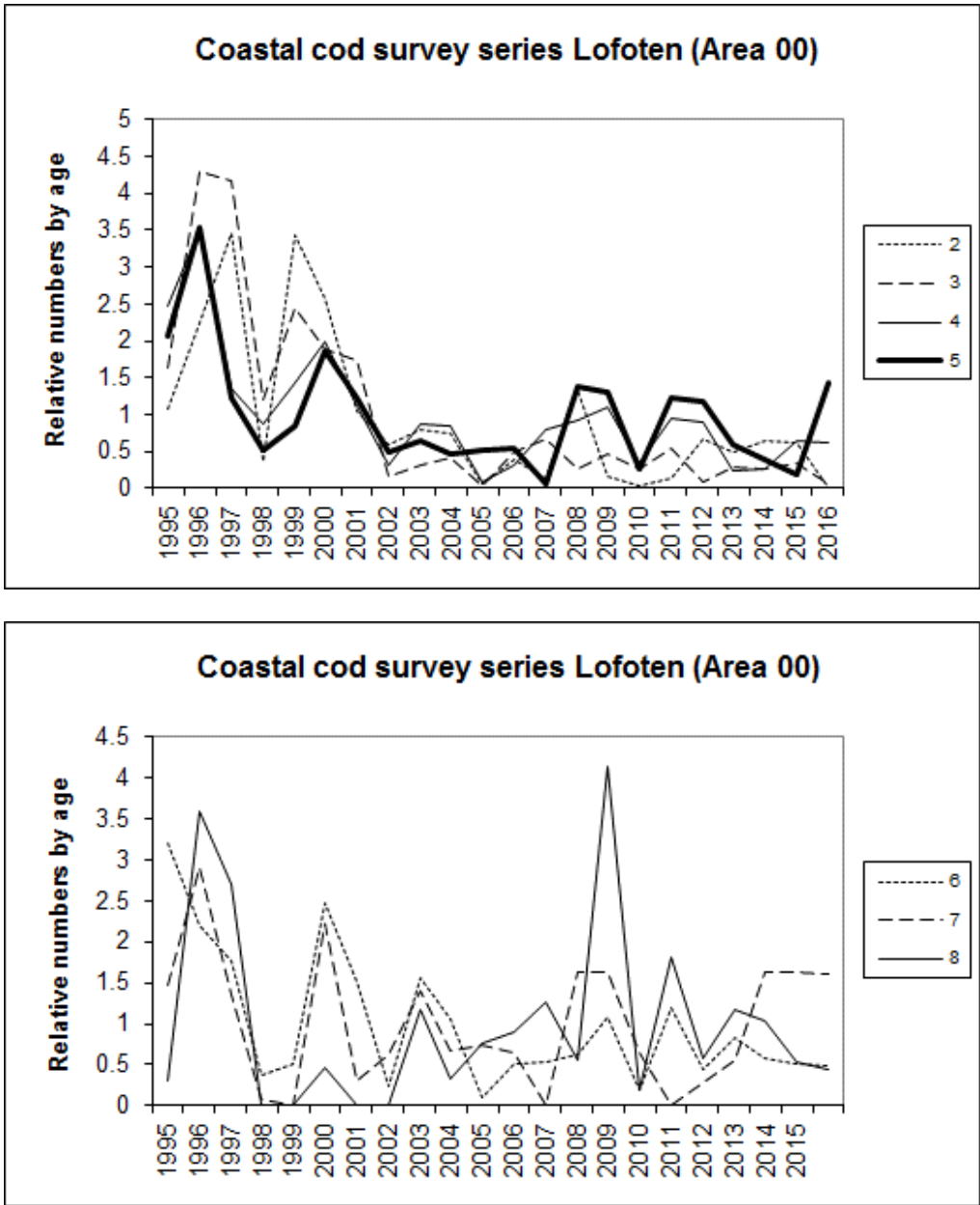


Figure 2.10. Coastal cod survey. Abundance at age relative to time-series average in statistical area 00. Upper: ages 2-5, Lower: ages 6-8.

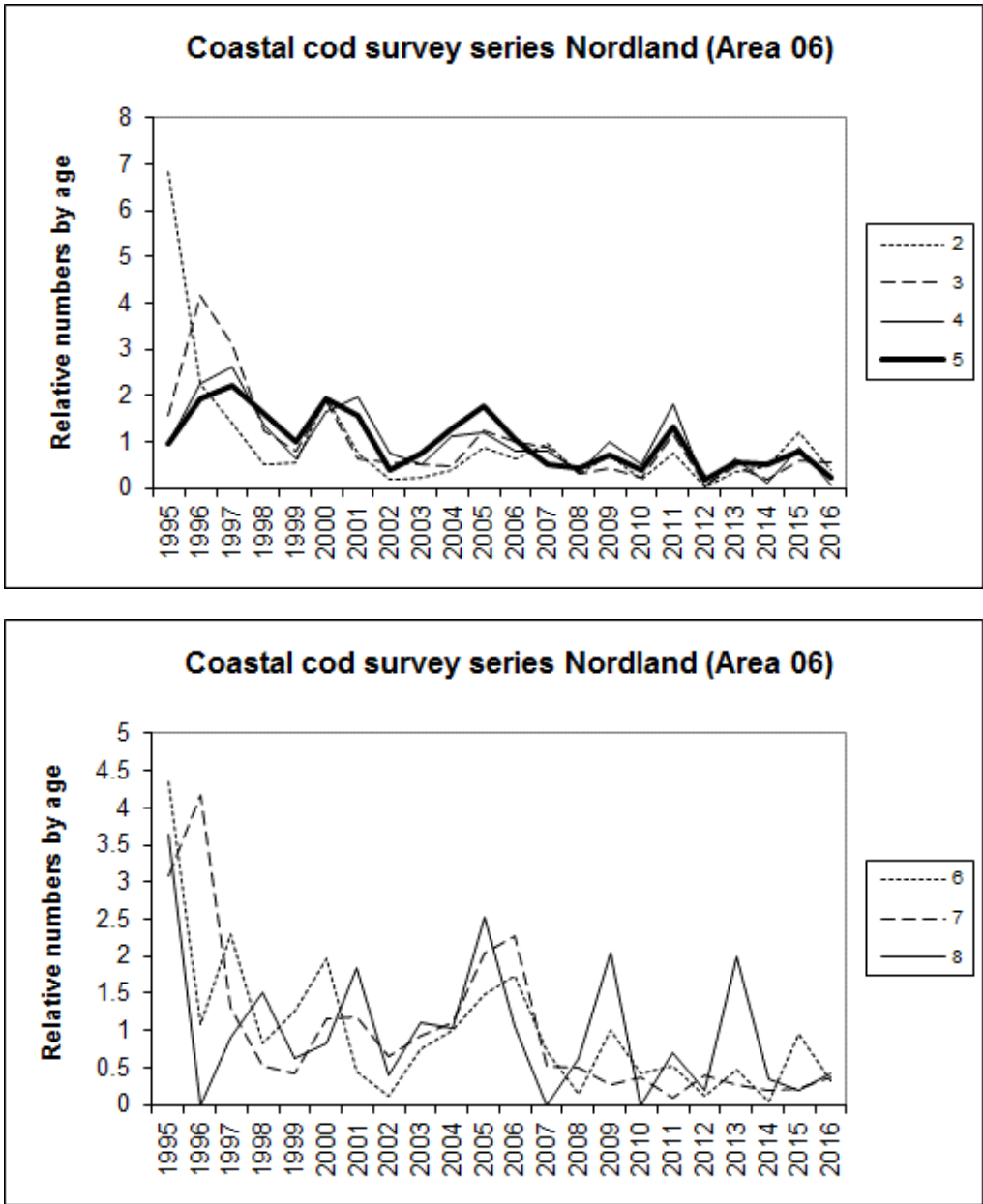


Figure 2.11 Coastal cod survey. Abundance at age relative to time-series average in statistical area 06. Upper: ages 2-5, Lower: ages 6-8.

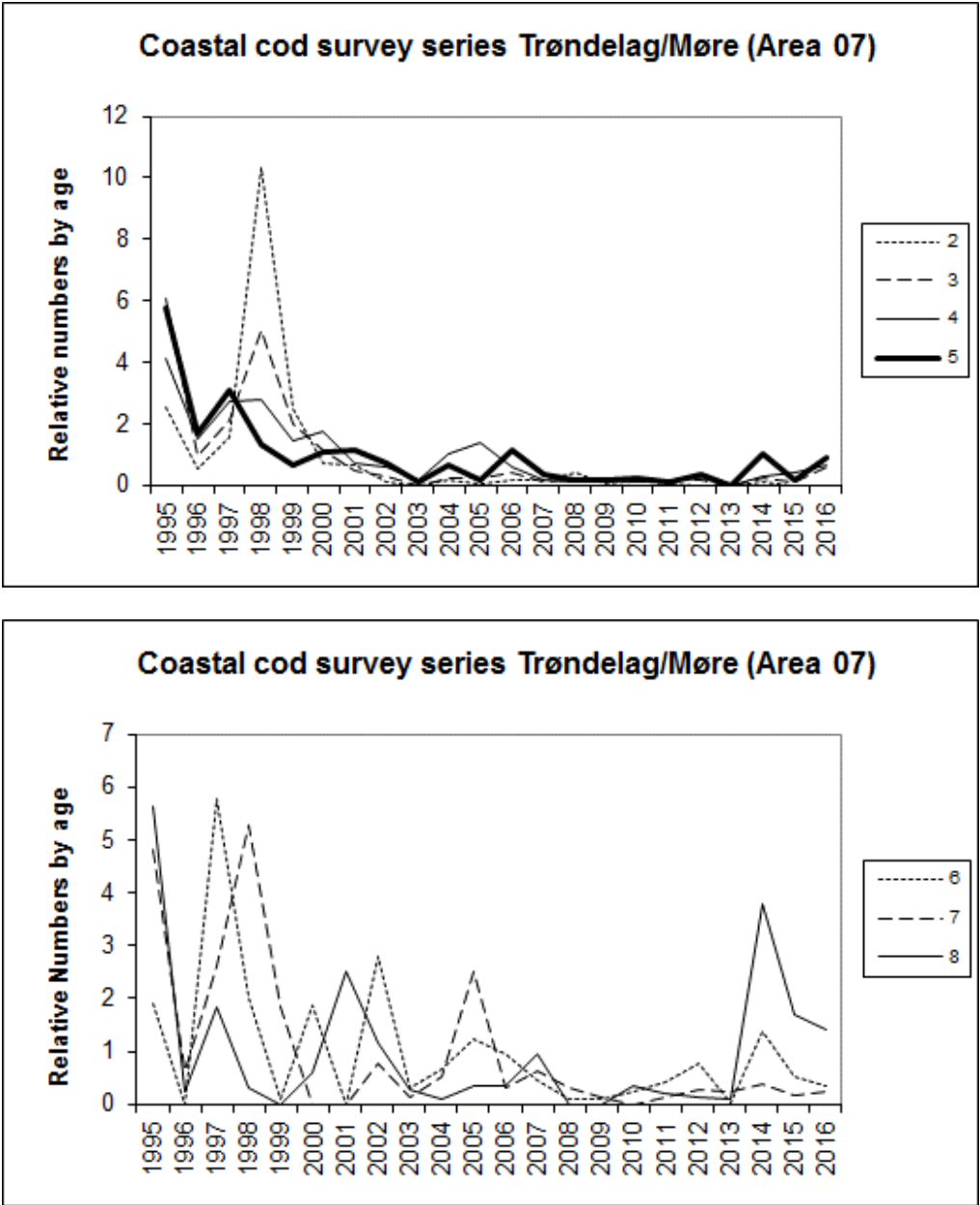


Figure 2.12. Coastal cod survey. Abundance at age relative to time-series average in statistical area 07. Some important areas at Møre was not covered in 2013. Upper: ages 2-5, Lower: ages 6-8.

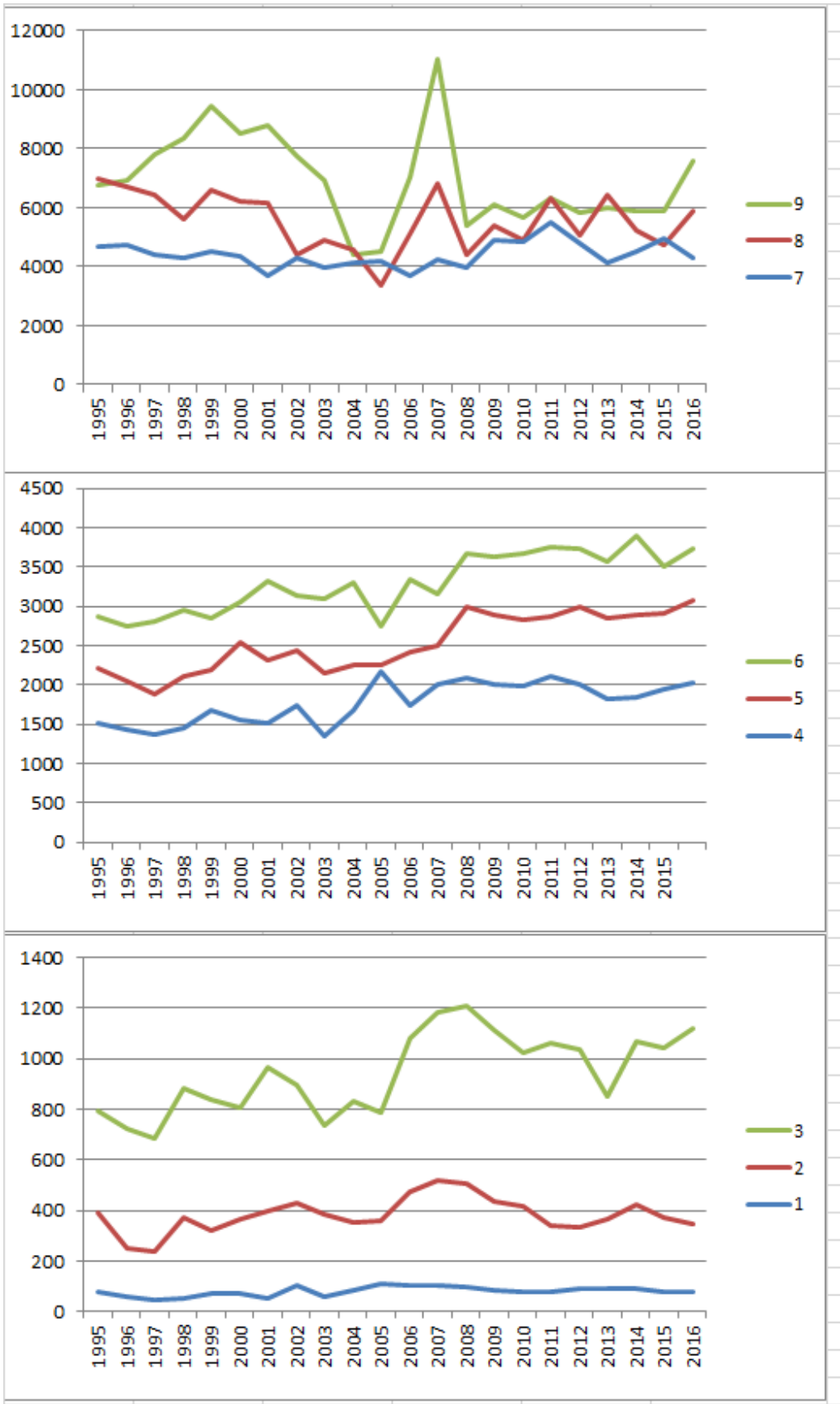


Figure 2.13a. Mean weights at age in the coastal survey

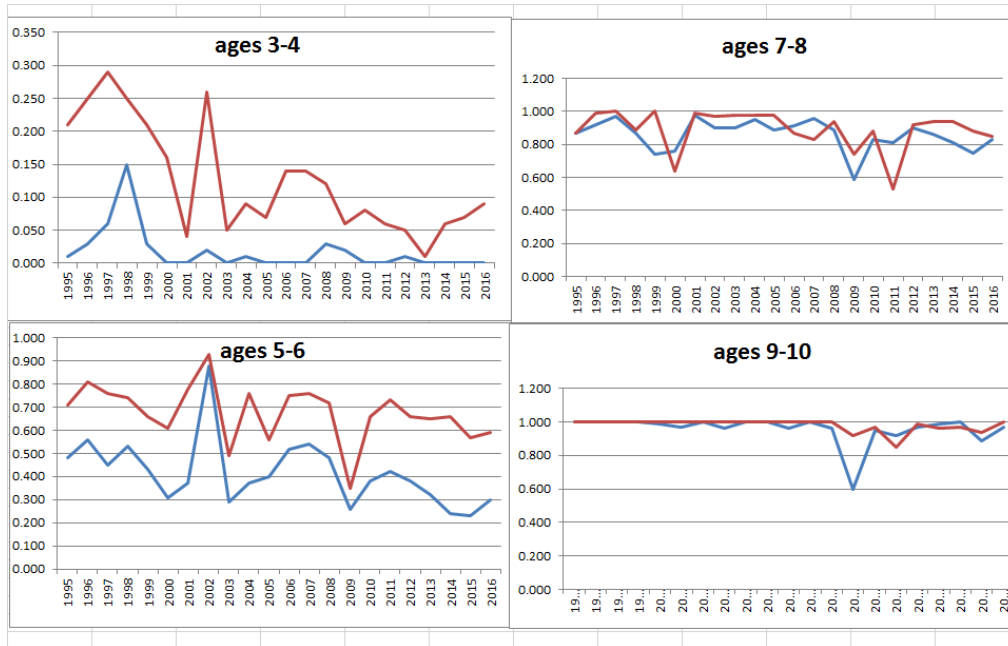


Figure 2.13b. Proportions mature at age as observed in the surveys (red), and as estimated by back-calculation from spawning zones recorded from otoliths (blue) sampled in the commercial fishery in the spawning season.

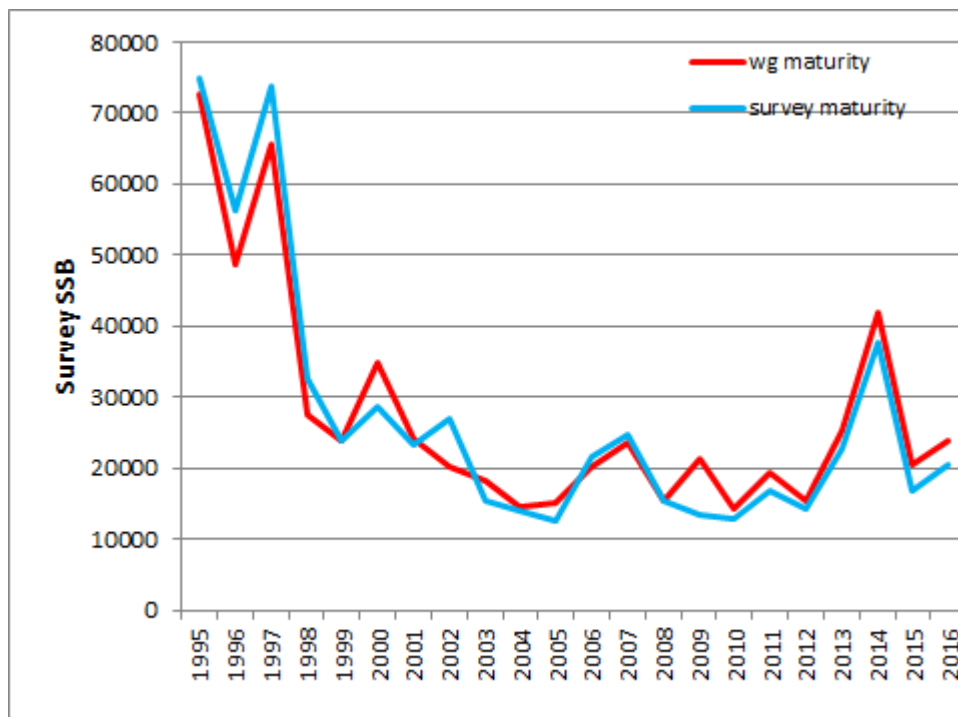


Figure 2.14. Survey SSB calculated by maturity observed in the surveys (red) and by maturity used in the VPA.

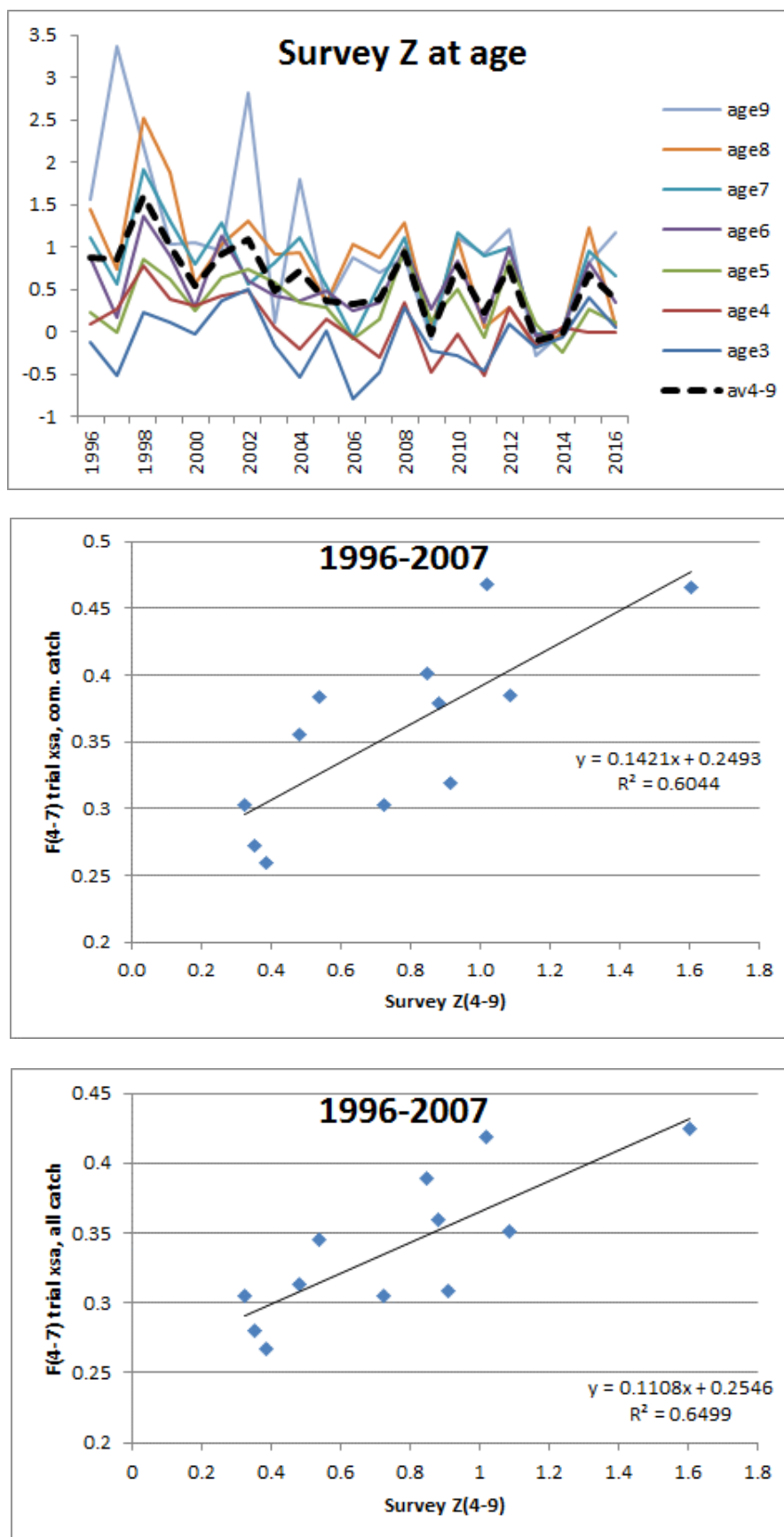


Figure 2.15. Survey mortality Z (upper) and relation to VPA values of F(4-7) over the period 1996-2007 for a trial XSA based on commercial catch (middle) and a trial XSA based on all catch (bottom).

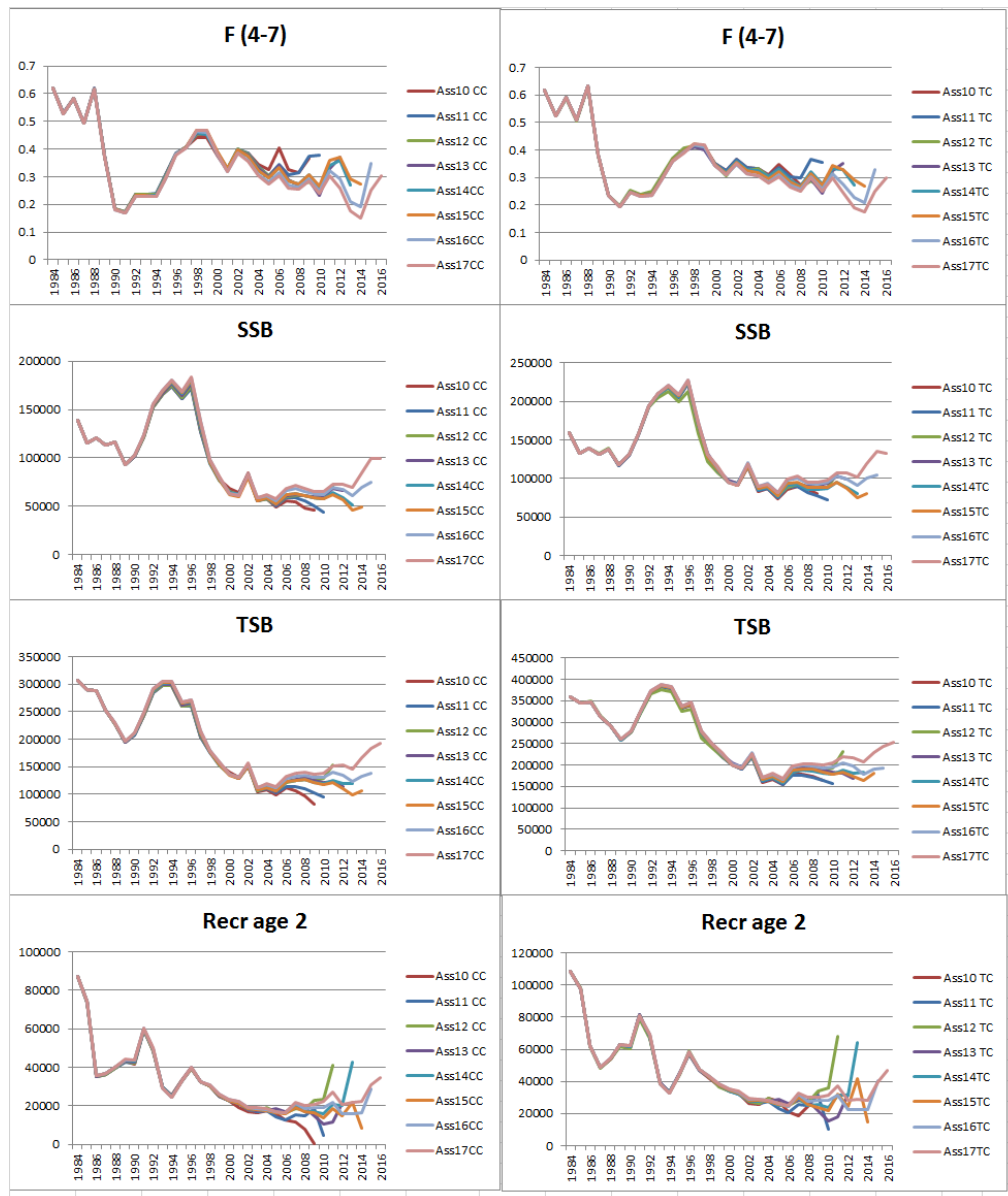


Figure 2.16. Comparisons of SVPA outputs in current assessment (Ass17) with the assessments in 2016, 2015, 2014, 2013, 2012, 2011 and 2010 for analyses based on commercial catch (left) and total catch (right). In all assessments the recruit estimate for the final year is highly uncertain.

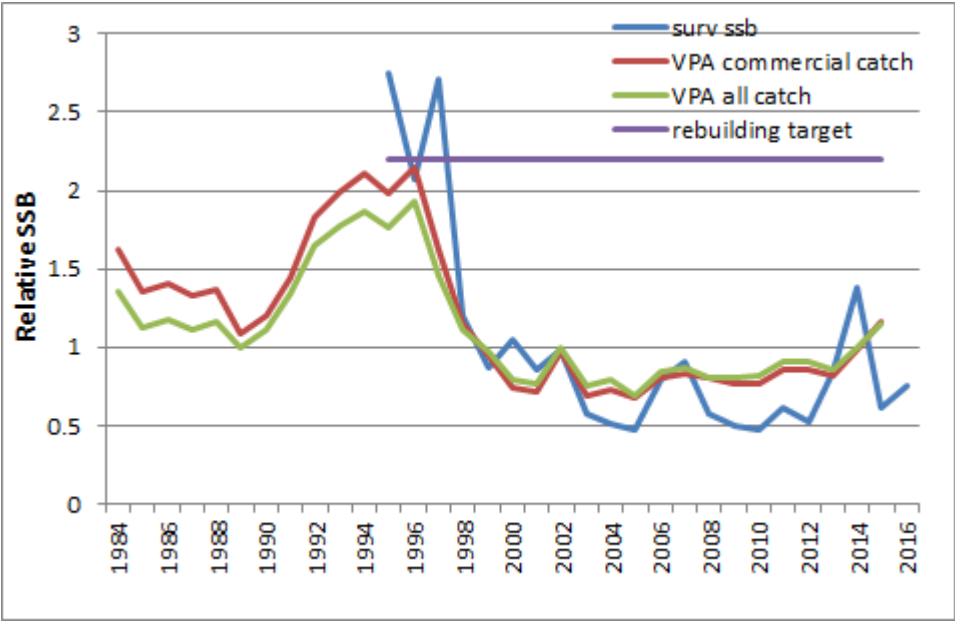


Figure 2.17. Coastal cod. Trends in spawning biomass. Each series are shown relative to its 1995 – 2016 average. The survey SSB is calculated with the same maturity ogive as in the VPA.

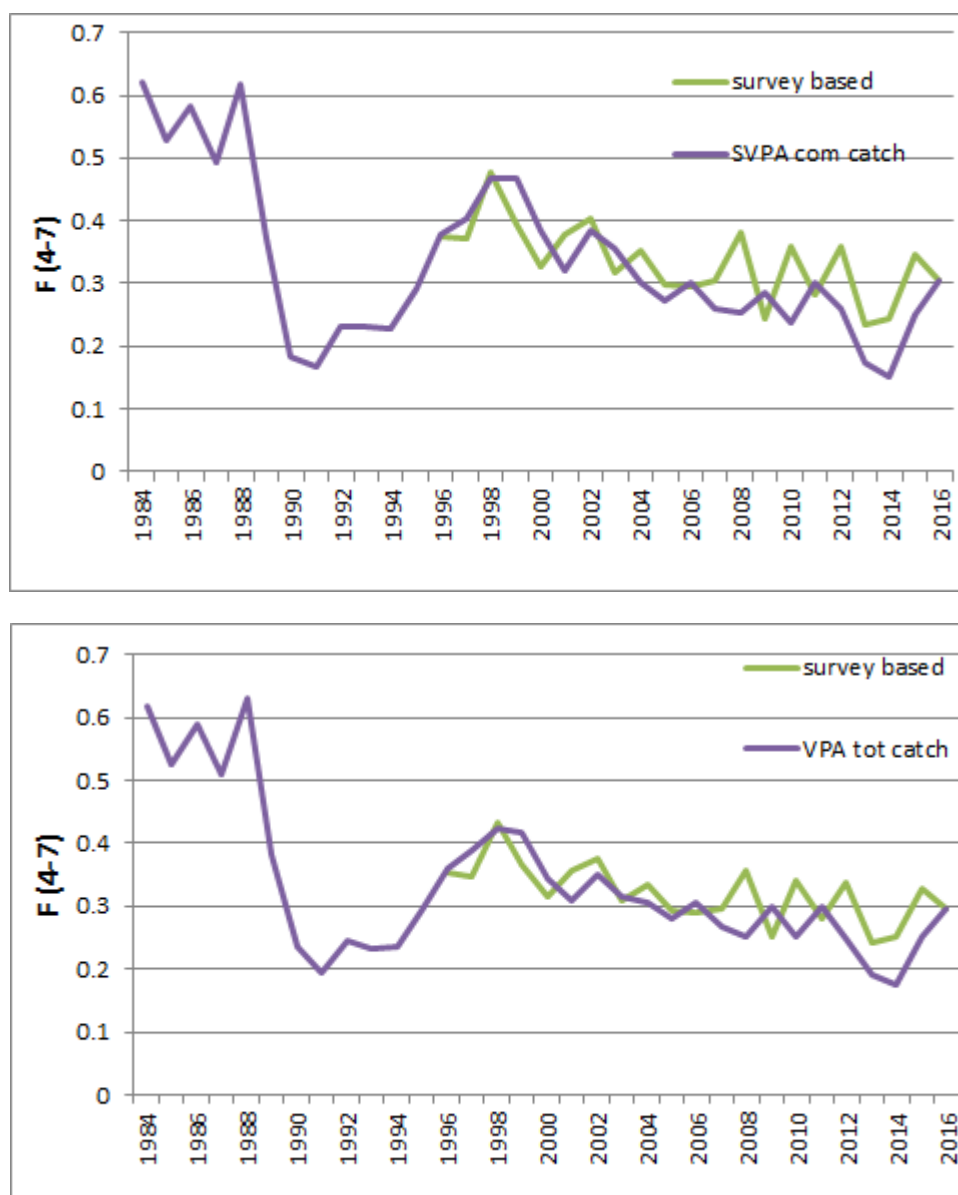


Figure 2.18. Time-series of F-estimates corresponding to commercial catch-at-age (upper) and total catch-at-age (lower). SVPA is in both cases a traditional VPA using the 2016 estimate of survey F as terminal F.