9 Barents Sea Capelin

As decided by the Arctic Fisheries Working Group at its 2017 meeting (ICES C.M. 2017/ACOM:06), the assessment of Barents Sea capelin was left to the parties responsible for the autumn survey, i.e. IMR in Bergen and PINRO in Murmansk. In accordance with this, the assessment was made during a meeting in Murmansk, Russia 5-6 October 2017. The assessment was an update assessment, without changes in the methodology.

Therefore the information in this annex overrides section 9 of the AFWG 2017 report.

Participants:

Jaime Alvarez	Norway
Bjarte Bogstad (Chair of meeting)	Norway
Anatoly Chetyrkin	Russia
Stine Karlson	Norway
Yuri Kovalev	Russia
Tatiana Prokhorova	Russia
Georg Skaret	Norway

9.1 Regulation of the Barents Sea Capelin Fishery

Since 1979, the Barents Sea capelin fishery has been regulated by a bilateral fishery management agreement between Russia (former USSR) and Norway. A TAC has been set separately for the winter fishery and for the autumn fishery. From 1999, no autumn fishery has taken place, except for a small Russian experimental fishery in some years. A minimum landing size of 11 cm has been in force since 1979. AFWG strongly recommends capelin fishery only on mature fish during the period from January to April.

9.2 TAC and Catch Statistics (Table 9.1)

The Joint Russian-Norwegian Fishery Commission set a zero quota for 2017. The international historical catch by country and season in the years 1965-2017 is given in Table 9.1.

9.3 Sampling

The capelin sampling from the Barents Sea ecosystem survey used in the 2017 capelin assessment is summarised below:

Investigation	No. of trawl hauls	Length measurements	Aged individuals
Ecosystem survey in autumn 2017 (Norway)	155	11742	3316
Ecosystem survey in autumn 2017 (Russia)	86	9645	799

9.4 Stock Size Estimates

9.4.1 Acoustic stock size estimates in 2017 (Table 9.2)

The geographical survey coverage of the Barents Sea capelin stock during the ecosystem survey in 2017 was considered to be almost complete. At the time of the assessment (6 October) the survey is still ongoing, but only low concentrations are expected to be found in the yet uncovered area in the northeast. The geographical distribution of capelin in 2017 is shown in Figure 9.1a. For comparison, the distribution in 2016 is shown in Fig 9.1b.

The stock estimate from the area covered by the 2017 survey was 2.51 million tonnes (Table 9.2). This is more than seven times the estimate from last year. About 74% (1.72 million tonnes) of the estimated stock biomass consisted of maturing fish (> 14.0 cm). The estimated amount of maturing fish was approximately nine times as high as in 2016. This large difference between the 2016 and 2017 estimates is discussed in Section 9.5 Comments to the assessment. The weight at age in the 2017 survey was very similar to 2016 for all age groups (Fig. 9.2).

As decided during last years' assessment meeting, the capelin abundance was estimated using the software StoX (http://www.imr.no/stox) applying agreed settings, replacing the previous estimate procedure done with the software BEAM.

A fixed sampling Coefficient of Variance (CV) of 0.2 per age group has been applied as input for Captool in the capelin assessment and was also used this year. The CV is based on an average CV from several years from estimates presented in Tjelmeland (2002). CV per age group for the present years survey was estimated in StoX to 0.14, 0.1, 0.09 and 0.25 for the age groups 1,2,3 and 4 respectively. The StoX CV estimate is based on bootstrapping of acoustic and biological data and thus provides an estimate of sampling error which can be viewed as a proxy for the quality of the survey. The procedures for estimation of CV applied in Tjelmeland (2002) and StoX are similar, but also differ in some aspects, and it was recommended that comparisons between the two procedures be made and presented for AFWG before StoX estimation of CV is implemented in the capelin assessment. The group also noted that this CV only reflects sampling error, and not other potential sources of uncertainty and bias which might influence the estimate.

9.4.2 Recruitment estimation in 2017 (Table 9.3)

A swept volume index (Dingsør, 2005; Eriksen *et al.*, 2009) of abundance of 0-group capelin in August-September is given in Table 9.3. This index is calculated both without correction and with correction for catching efficiency (Keff). The 0-group index in 2017 (preliminary estimate) is around average. Table 9.3 also shows the number of fish in the various year classes, and their survey mortality from age one to age two.

9.4.3 Assessment results

Estimates of stock in number by age group and total biomass for the historical period are shown in Table 9.4. Other data which describe the stock development are shown in Table 9.5. Probabilistic projections of the maturing stock to the time of spawning at 1 April 2018 were made using the spreadsheet model CapTool (implemented in the @RISK add-on for EXCEL, 20 000 simulations were used). The settings were the same as last year. The projection was based on a maturation and predation model with parameters estimated by the model Bifrost and data on cod abundance and size at age in 2018 from the 2017 Arctic Fisheries Working Group (ICES C. M. 2017/ACOM:06).

The methodology is described in the 2009 WKSHORT report (ICES C.M. 2009/ACOM:34) and the WKARCT 2015 report (ICES C.M. 2015/ACOM:31). The natural mortality M for the months October to December is drawn among a set of M-values estimated for different years based on historical data. The same set of M-values was used in 2017 as in 2016 (ICES 2011/ACOM:05, Annex 12). Based on the monthly distribution of catches in 2009—2013, the monthly distribution used in the prediction was set to 0% in January, 30% in February and 70% in March. These values were used in the predictions in 2012—2016.

With no catch, the estimated median spawning stock size in 2018 is 636 000 tonnes (Fig 9.3). With a catch of 205 000 tonnes, the probability for the spawning stock in 2018 to be below 200 000 t, the B_{lim} value used by ACFM in recent years, is 5 % (Fig. 9.4). The median spawning stock size in 2018 will then be 462 000 tonnes, and the corresponding median modelled consumption by immature cod in the period January-March 2018 will then be 597 000 tonnes. Figure 9.4 shows the probabilistic forecast from 1 October 2017 to 1 April 2018 conditional on a quota of 205 000 tonnes, while Fig 9.5 shows the probability of SSB < B_{lim} as a function of the catch.

Summary plots are given in Figure 9.6.

9.4.4 Recruitment

The 1-group abundance in 2017 was 86.4 billion which is close to the long-term average, and much lower than could be expected based on the 0-group index in 2016 (Fig 9.7). The 1-group vs. 0-group regression shown in Fig 9.5 predicts about 153 billion 1-group capelin in 2018 based on the 0-group estimate for 2017, which is close to the long term average. The most recent evaluation of the spawning stock and recruitment time series was made by Gjøsæter *et al.* (2016).

Future recruitment conditions: High abundance of young herring (mainly age groups 1 and 2) has been suggested to be a necessary but not a single factor causing recruitment failure in the capelin stock (Hjermann *et al.*, 2010; Gjøsæter *et al.* 2016). At present the abundance of young herring based on the BESS 2017 has not been estimated.

9.4.5 Comments to the assessment

The abundance of age 2 and older capelin in the 2017 survey is much higher than could be expected from the 2016 survey. The age 2 abundance in 2017 is almost 4 times higher than the age 1 abundance in 2016, while the age 3 abundance in 2017 is twice the age 2 abundance in 2016. Usually there is a high survey mortality especially from age 2 to 3, but also from age 1 to 2 (Fig 9.8). The discrepancies between the 2016 and 2017 surveys are the highest observed in the time series (discrepancies for age 1 to 2 in the 1970s are likely related to known issues of incomplete area coverage of age 1 capelin).

The reasons for the discrepancies are not known. They could be due to underestimation of the stock in 2016, overestimation in 2017, or both. There are some data sources in addition to the acoustic survey which can be used to shed light on this.

The main capelin distribution areas were well covered by the survey in both years (Fig 9.1a-b), so only very abnormal capelin distribution could have caused discrepancies due to uncovered areas. The survey intensity in the main capelin area was higher in 2017 than in 2016 with approximately half the distance between the survey transects (see Fig. 9.1a-b), likely resulting in a higher precision of the 2017 than the 2016 survey estimate.

There are three factors which indicate an underestimation of capelin in the 2016 survey:

- The allocation of acoustic backscatter to capelin versus other species/groups was particularly challenging in some areas during the 2016 survey (ICES C.M. 2017/ACOM:06), and this might have caused underestimation of capelin in 2016.
- The 2015 year class was observed to be somewhat above the long-term average both at age 0 and 2, but weak at age 1.
- The amount of capelin found in cod stomachs in 2017 indicates a higher maturing capelin stock in winter 2017 than the acoustic survey autumn 2016 shows. (Fig 9.9)

9.4.6 Ecological considerations

The number of young herring in the Barents Sea can be an important factor that affects the capelin recruitment. It is not currently taken into account in the assessment model. The benchmark for capelin stocks in the Barents Sea (WKARCT, ICES C.M. 2015/ACOM:31) noted the need for further study of this effect as well as better monitoring of the young herring abundance.

The amount of other food than capelin for cod and other predators may also have changed in recent years. This may also indirectly have affected the predation pressure on capelin. A more detailed discussion of interactions between capelin and other species is given in the 2016 and 2017 WGIBAR reports (ICES C.M. 2016/SSGIEA:04, ICES C.M. 2017/SSGIEA:04).

9.4.7 Further work on survey and assessment methodology

Survey

Since the only source of information about the capelin stock abundance and composition comes from the BESS, it is crucial for the assessment that the survey results are reliable. The survey results of the last two years reveal inconsistencies, in particular strong negative survey mortality between age 1 and 2 and age 2 and 3 from 2016 to 2017, which can only be related to monitoring issues including sampling methodology, coverage and/or survey design.

The effect of survey direction on the estimate is not known, but feeding capelin during autumn are believed to be either rather stationary or moving northwards. A general northwards migration direction of the stock will cause a positive bias on the survey estimate when the survey moves in its typical direction from south to north, and negative when in opposite direction like in 2016. The speed and direction of capelin movement during monitoring can be investigated using sonar data, which exist for several years, but have not been analysed.

The allocation of acoustic backscatter to target groups can be challenging in some years, in particular when two groups with similar acoustic properties are abundant, and trawl samples give ambiguous answers about their proportions. This was the case in 2016. There are tools under implementation which can provide valuable help in the interpretation of acoustic data. DeepVision is a stereocamera system which can be mounted on a frame and pulled after the vessel and automatically classify fish to species as well as measure length. Broadband acoustic systems which are now mounted on Norwegian research vessels can use frequency response to discriminate between targets much more accurately than discrete frequency systems. Both these tools are highly relevant candidates for improving the quality of the survey.

Assessment model

In the present capelin assessment model, the only species interaction in the Barents Sea taken explicitly into account is predation by cod on mature capelin. The model does not take into account possible changes in capelin stock dynamics (e.g. maturation), the current state of the environment and stock status of other fish species and mammals in the Barents Sea. The ICES working group of Integrated Assessment of the Barents Sea (WGIBAR) has addressed some of these issues.

Consumption of pre-spawning capelin by mature cod in winter-spring season and autumn season is still not included in the assessment model. It may have a significant impact on capelin SSB calculations.

Gjøsæter *et al*. (2015) calculated what the quota advice and spawning stock would have been in the period 1991—2013, given the present assessment model and knowledge about the cod stock. By exchanging that cod forecast with the actual amount of cod from the cod assessment model run later in time and rerunning the model, they showed that considerably smaller annual quotas would have been advised if the amount of cod had been known and the present assessment model had been used when the capelin quota was set. Following this work, a retrospective analysis of the capelin assessment as well as of the assessment performance should be included annually. This is a feature which so far has been missing from the capelin assessment, and is needed especially in light of this year's considerable revision of the cod assessment and thus cod abundance in recent years.

The further research should include improvement of the Bifrost model for calculation and inclusion interactions between capelin and other species for calculation new target reference point for capelin B_{target}.

In 2015 there was an increased proportion of small mature capelin catches in the spring period. This may call for a revision of the capelin maturation sub-model in Bifrost.

9.5 Reference points

A B_{lim} (SSB_{lim}) management approach has been suggested for this stock (Gjøsæter *et al.*, 2002). In 2002, the JRNFC agreed to adopt a management strategy based on the rule that, with 95% probability, at least 200 000 tonnes of capelin should be allowed to spawn. Consequently, 200 000 tonnes was used as a B_{lim}. Alternative harvest control rules of 80, 85 and 90% probability of SSB > B_{lim} were suggested by JNRFC and evaluated by ICES (WKNEAMP-2, ICES C. M. 2016/ACOM:47). ICES considers these rules not to be precautionary. At its 2016 meeting, JNRFC decided not to change the adopted management strategy.

9.6 References

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Table 9.1 Barents Sea CAPELIN. International catch ('000 t) as used by the Working Group.

Year	Winter				Summer–Autumn			Total
	Norway	Russia	Others	Total	Norway	Russia	Total	
1965	217	7	0	224	0	0	0	224
1966	380	9	0	389	0	0	0	389
1967	403	6	0	409	0	0	0	409
1968	460	15	0	475	62	0	62	537
1969	436	1	0	437	243	0	243	680
1970	955	8	0	963	346	5	351	1314
1971	1300	14	0	1314	71	7	78	1392
1972	1208	24	0	1232	347	13	360	1591
1973	1078	34	0	1112	213	12	225	1337
1974	749	63	0	812	237	99	336	1148
1975	559	301	43	903	407	131	538	1441
1976	1252	228	0	1480	739	368	1107	2587
1977	1441	317	2	1760	722	504	1226	2986
1978	784	429	25	1238	360	318	678	1916
1979	539	342	5	886	570	326	896	1782
1980	539	253	9	801	459	388	847	1648
1981	784	429	28	1241	454	292	746	1986
1982	568	260	5	833	591	336	927	1760
1983	751	373	36	1160	758	439	1197	2357
1984	330	257	42	629	481	368	849	1477
1985	340	234	17	591	113	164	277	868
1986	72	51	0	123	0	0	0	123
1987	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0
1991	528	159	20	707	31	195	226	933
1992	620	247	24	891	73	159	232	1123
1993	402	170	14	586	0	0	0	586
1994	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	1	1	1
1998	0	2	0	2	0	1	1	3
1999	50	33	0	83	0	22	22	105
2000	279	94	8	381	0	29	29	410
2001	376	180	8	564	0	14	14	578
2002	398	228	17	643	0	16	16	659
2003	180	93	9	282	0	0	0	282
2004	0	0	0	0	0	0	0	0
2005	1	0	0	1	0	0	0	1
2006	0	0	0	0	0	0	0	0
2007	2	2	0	4	0	0	0	4
2008	5	5	0	10	0	2	0	12
2009	233	73	0	306	0	1	1	307
2010	246	77	0	323	0	0	0	323
2011	273	87	0	360	0	0	0	360
2012	228	68	0	296	0	0	0	296
2013	116	60	0	177	0	0	0	177
2014	40	26	0	66	0	0	0	66
2015	71	44	0	115	0	0	0	115
2016	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0

Table 9.2. Barents Sea CAPELIN. Stock size estimation table. Estimated stock size (10^9) by age and length, and biomass (10^3 tonnes) from the acoustic survey in August-September 2017. TSN: Total stock number. TSB: Total stock biomass. SSN: Spawning stock number. SSB: Spawning stock biomass.

Length	Age 1	Age 2	Age 3	Age 4	Sum	Biomass	MeanW
cm	ycl 2016	ycl 2015	ycl 2014	ycl 2013	(10^9)	10^3 t	g
7.0-7.5	0.253	0	0	0	0.253	0.00	1.0
7.5-8.0	0.410	0	0	0	0.410	0.67	1.6
8.0-8.5	1.327	0	0	0	1.327	2.26	1.7
8.5-9.0	5.646	0	0	0	5.646	13.04	2.3
9.0-9.5	13.332	0	0	0	13.332	36.80	2.8
9.5-10.0	14.841	0	0	0	14.841	46.75	3.2
10.0-10.5	16.392	0.565	0	0	16.957	62.91	3.7
10.5-11.0	11.707	0.651	0	0	12.358	54.50	4.4
11.0-11.5	10.004	1.239	0	0	11.243	56.89	5.1
11.5-12.0	4.079	2.790	0	0	6.869	41.42	6.0
12.0-12.5	3.105	6.808	0	0	9.913	71.28	7.2
12.5-13.0	1.613	10.864	0	0	12.476	103.43	8.3
13.0-13.5	1.414	14.585	0.018	0	16.017	151.52	9.5
13.5-14.0	0.435	12.575	0.123	0.001	13.133	141.57	10.8
14.0-14.5	1.020	15.045	0.339	0	16.404	202.75	12.4
14.5-15.0	0.343	14.520	0.154	0	15.016	215.63	14.4
15.0-15.5	0.180	14.339	0.596	0	15.116	247.19	16.3
15.5-16.0	0.224	12.442	1.877	0	14.543	268.46	18.5
16.0-16.5	0.077	8.318	2.648	0.082	11.125	234.33	21.1
16.5-17.0	0	4.115	2.718	0.094	6.927	160.13	23.4
17.0-17.5	0	3.077	3.460	0.010	6.547	174.59	26.7
17.5-18.0	0	1.031	1.835	0.055	2.921	84.92	29.4
18.0-18.5	0	0.618	1.819	0.015	2.451	79.36	32.6
18.5-19.0	0	0.099	0.927	0.111	1.137	35.49	34.6
19.0-19.5	0	0.058	0.206	0.038	0.302	10.18	38.6
19.5-20.0	0	0	0.049	0.000	0.049	1.94	39.4
TSN(10^9)	86.403	123.738	16.769	0.165	227.323		
TSB (10^3 t)	369.7	1708.1	417.4	11.1		2506.37	
Mean length	10.15	14.14	16.69	17.39			
Mean weight (g)	4.28	13.8	24.89	27.27	11.03		
SSN (10^9)	1.844	73.661	16.628	0.405	92.538		
SSB (10^3 t)	26.23	1267.63	417.63	11.6		1723.09	

Table 9.3 Barents Sea CAPELIN. Recruitment and natural mortality table. Larval abundance estimate in June, 0-group indices and acoustic estimate in August-September, total mortality from age 1+ to age 2+.

Year class	Larval abundance	0-group Index (10^9 ind.)		Acoustic estimate (10^9ind.)		Mortality survey(1—2)
	(10^{12})	Without Keff	With Keff	1 (Y+1)	2 (Y+2)	%
1980	-	197.3	740	402.6	147.6	63
1981	9.7	123.9	477	528.3	200.2	62
1982	9.9	168.1	600	514.9	186.5	64
1983	9.9	100.0	340	154.8	48.3	69
1984	8.2	68.1	275	38.7	4.7	88
1985	8.6	21.3	64	6.0	1.7	72
1986	0.0	11.4	42	37.6	28.7	24
1987	0.3	1.2	4	21.0	17.7	16
1988	0.3	19.6	65	189.2	177.6	6
1989	7.3	251.5	862	700.4	580.2	17
1990	13.0	36.5	116	402.1	196.3	51
1991	3.0	57.4	169	351.3	53.4	85
1992	7.3	1.0	2	2.2	3.4	--
1993	3.3	0.3	1	19.8	8.1	59
1994	0.1	5.4	14	7.1	11.5	--
1995	0.0	0.9	3	81.9	39.1	52
1996	2.4	44.3	137	98.9	72.6	27
1997	6.9	54.8	189	179.0	101.5	43
1998	14.1	33.8	113	156.0	110.6	29
1999	36.5	85.3	288	449.2	218.7	51
2000	19.1	39.8	141	113.6	90.8	20
2001	10.7	33.6	90	59.7	9.6	84
2002	22.4	19.4	67	82.4	24.8	70
2003	11.9	94.9	341	51.2	13.0	75
2004	2.5	16.7	54	26.9	21.7	19
2005	8.8	41.8	148	60.1	54.7	9
2006	17.1	166.4	516	221.7	231.4	--
2007	-	157.9	480	313.0	166.4	46
2008	-	288.8	995	124.0	127.6	--
2009	-	189.8	673	248.2	181.1	27
2010	-	91.7	319	209.6	156.4	25
2011	-	175.8	594	145.9	216.2	-
2012	-	310.5	989	324.5	106.6	67
2013	-	94.7	316	105.1	40.5	62
2014	-	49.0	164	39.5	8.1	79
2015	-	148.0	456	31.6	123.7	-
2016	-	274.0	779	86.4		
2017	-	104.2	694			
Average	9.0	94.2	324	178.0	105.0	

Table 9.4 Barents Sea CAPELIN. Stock size in numbers by age, total stock biomass, biomass of the maturing component at 1. October.

Year	Stock in numbers (10^9)						Biomass (10^3 tonnes)	
	Age 1	Age 2	Age 3	Age 4	Age 5	Total	Total	Maturing
1973	528	375	40	17	0	961	5144	1350
1974	305	547	173	3	0	1029	5733	907
1975	190	348	296	86	0	921	7806	2916
1976	211	233	163	77	12	696	6417	3200
1977	360	175	99	40	7	681	4796	2676
1978	84	392	76	9	1	561	4247	1402
1979	12	333	114	5	0	464	4162	1227
1980	270	196	155	33	0	654	6715	3913
1981	403	195	48	14	0	660	3895	1551
1982	528	148	57	2	0	735	3779	1591
1983	515	200	38	0	0	754	4230	1329
1984	155	187	48	3	0	393	2964	1208
1985	39	48	21	1	0	109	860	285
1986	6	5	3	0	0	14	120	65
1987	38	2	0	0	0	39	101	17
1988	21	29	0	0	0	50	428	200
1989	189	18	3	0	0	209	864	175
1990	700	178	16	0	0	894	5831	2617
1991	402	580	33	1	0	1016	7287	2248
1992	351	196	129	1	0	678	5150	2228
1993	2	53	17	2	2	75	796	330
1994	20	3	4	0	0	28	200	94
1995	7	8	2	0	0	17	193	118
1996	82	12	2	0	0	96	503	248
1997	99	39	2	0	0	140	911	312
1998	179	73	11	1	0	263	2056	931
1999	156	101	27	1	0	285	2776	1718
2000	449	111	34	1	0	595	4273	2099
2001	114	219	31	1	0	364	3630	2019
2002	60	91	50	1	0	201	2210	1290
2003	82	10	11	1	0	104	533	280
2004	51	25	6	1	0	82	628	294
2005	27	13	2	0	0	42	324	174
2006	60	22	6	0	0	88	787	437
2007	222	55	4	0	0	280	1882	844
2008	313	231	25	2	0	571	4427	2468
2009	124	166	61	0	0	352	3756	2323
2010	248	128	61	1	0	438	3500	2051
2011	209	181	55	8	0	454	3707	2115
2012	146	156	88	2	0	392	3586	1997
2013	324	216	59	7	0	610	3956	1471
2014	105	107	39	2	0	253	1949	873
2015	40	40	13	1	0	94	842	375
2016	32	8	3	0	0	43	328	181
2017	86	124	17	0	0	227	2506	1723

Table 9.5 Barents Sea CAPELIN. Summary stock and data for prognoses table. Recruitment and total biomass (TSB) are survey estimates back-calculated to 1 August (before the autumn fishing season) for 1985 and earlier; for 1986 and later it is the survey estimate. Maturing biomass (MSB) is the survey estimate of fish above length of maturity (14.0 cm). SSB is the median value of the modelled stochastic spawning-stock biomass (after the winter/spring fishery). * - indicates a very small spawning stock.

Year	Estimated stock by autumn acoustic survey (10^3 t) 1 October		SSB, assessment model, April 1 year+1 (10^3 t)	SSB, by winter acoustic survey (10^3 t)	Recruitment Age 1, survey assessment 1 October 10^9 sp.	Young herring numbers age 1+2 (10^9 ind.) WGWIDE data	Herring 0-group index (10^9 sp) corr. for catching efficiency	Capelin Landing (10^3 t)
	TSB	MSB						
1972	6600	2727			152			1591
1973	5144	1350	33		529			1337
1974	5733	907	*		305			1148
1975	7806	2916	*		190			1441
1976	6417	3200	253		211			2587
1977	4796	2676	22		360			2986
1978	4247	1402	*		84			1916
1979	4162	1227	*		12			1782
1980	6715	3913	*		270		0.08	1648
1981	3895	1551	316		403		0.04	1986
1982	3779	1591	106		528		2.52	1760
1983	4230	1329	100		515		195.45	2357
1984	2964	1208	109		155		27.35	1477
1985	860	285	*		39		20.08	868
1986	120	65	*		6		0.09	123
1987	101	17	34	4	38		0.05	0
1988	428	200	*	10	21	3.53	60.78	0
1989	864	175	84	378	189	11.79	17.96	0
1990	5831	2617	92	94	700	32.50	15.17	0
1991	7287	2248	643	1769	402	56.86	267.64	933
1992	5150	2228	302	1735	351	139.70	83.91	1123
1993	796	330	293	1498	2	194.20	291.47	586
1994	200	94	139	187	20	96.95	103.89	0
1995	193	118	60	29	7	29.34	11.02	0
1996	503	248	60		82	10.57	549.61	0
1997	909	312	85		99	28.40	463.24	1
1998	2056	932	94	414	179	26.73	476.07	3
1999	2775	1718	382		156	88.55	35.93	105
2000	4273	2098	599	700	449	105.69	469.63	410
2001	3630	2019	626		114	58.20	10.01	578
2002	2210	1291	496	1417	60	28.45	151.51	659
2003	533	280	427		82	153.79	177.68	282
2004	628	294	94	105	51	121.73	773.89	0
2005	324	174	122		27	136.62	125.93	1
2006	787	437	72		60	76.12	294.65	0
2007	2119	844	189		222	56.03	144.00	4
2008	4428	2468	330	469	313	34.49	201.05	12
2009	3765	2323	517	180	124	17.19	104.23	307
2010	3500	2051	504	452	248	49.66	117.09	323
2011	3707	2115	487	160	209	31.14	83.05	360
2012	3586	1997	504		146	27.05	177.19	296
2013	3956	1471	479		324	23.46	289.39	177
2014	1949	873	504		105	41.03	136.01	66
2015	842	375	82		40	27.57	89.204	115
2016	328	181	37		32	29.74	75.047	0
2017	2506	1723	462		124	38.34		0

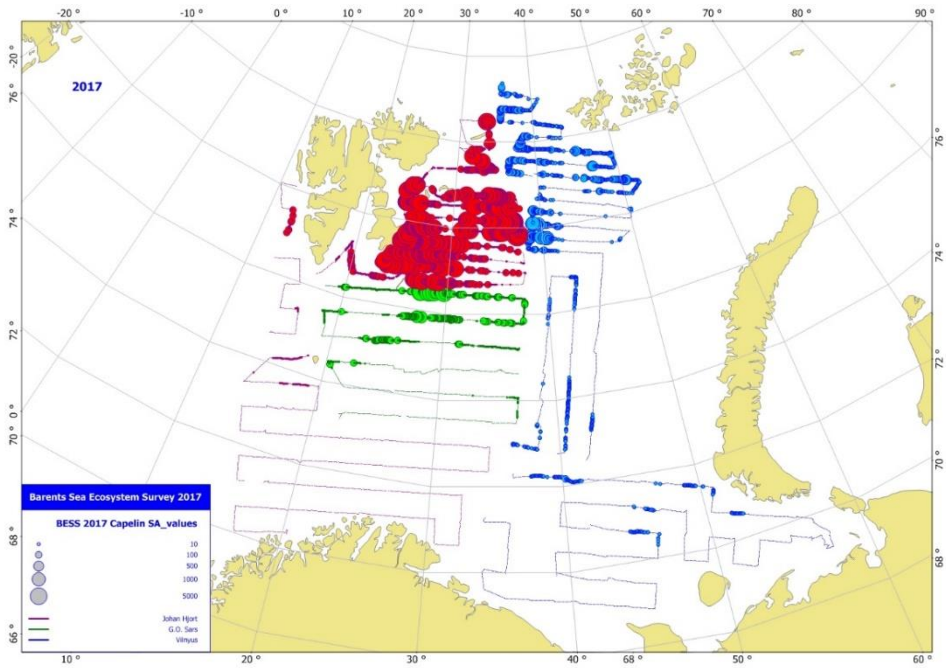

Figure 9.1a. Geographical distribution of capelin in autumn 2017.

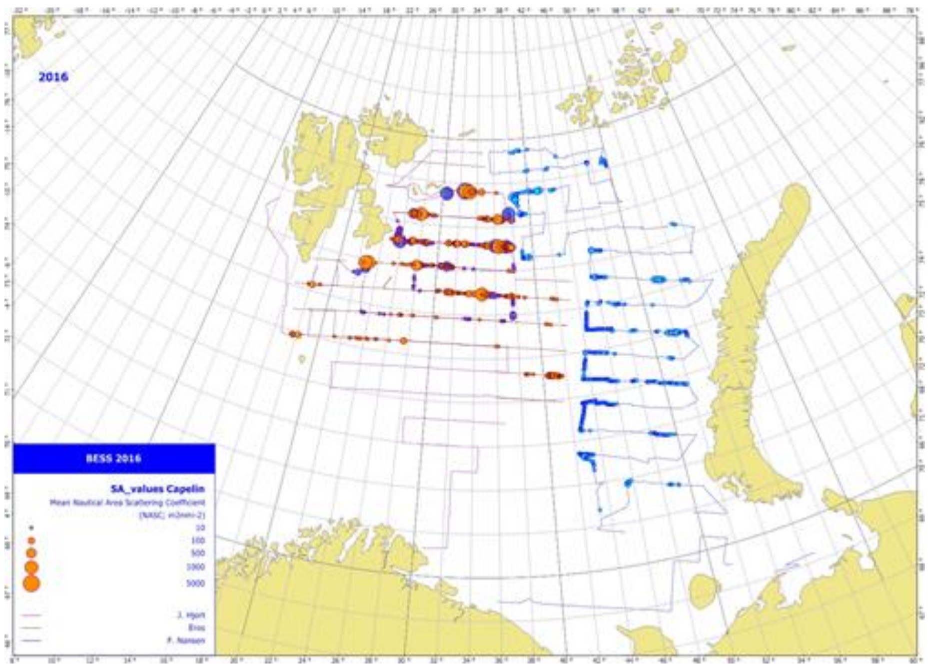

Figure 9.1b. Geographical distribution of capelin in autumn 2016.

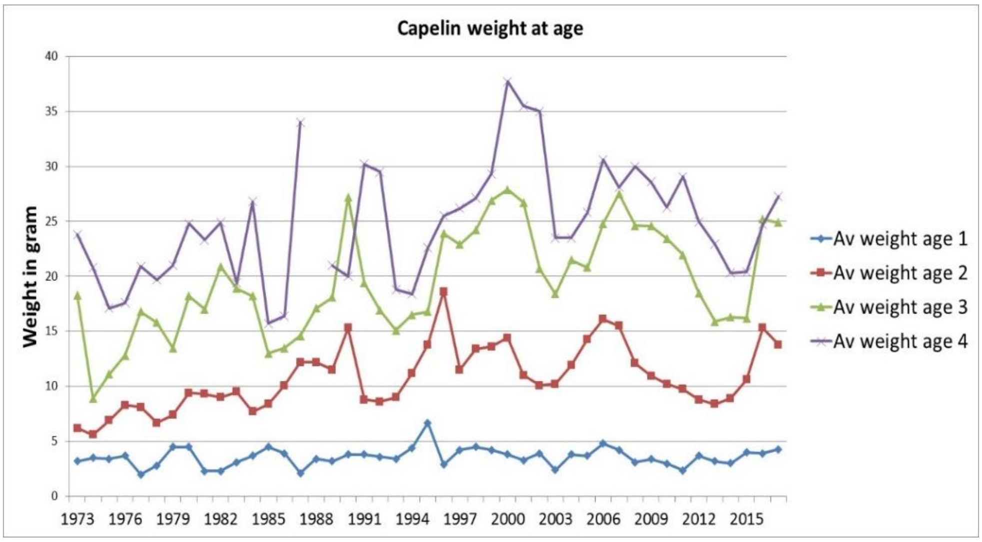

Figure 9.2 Weight at age (grams) for capelin from the autumn survey.

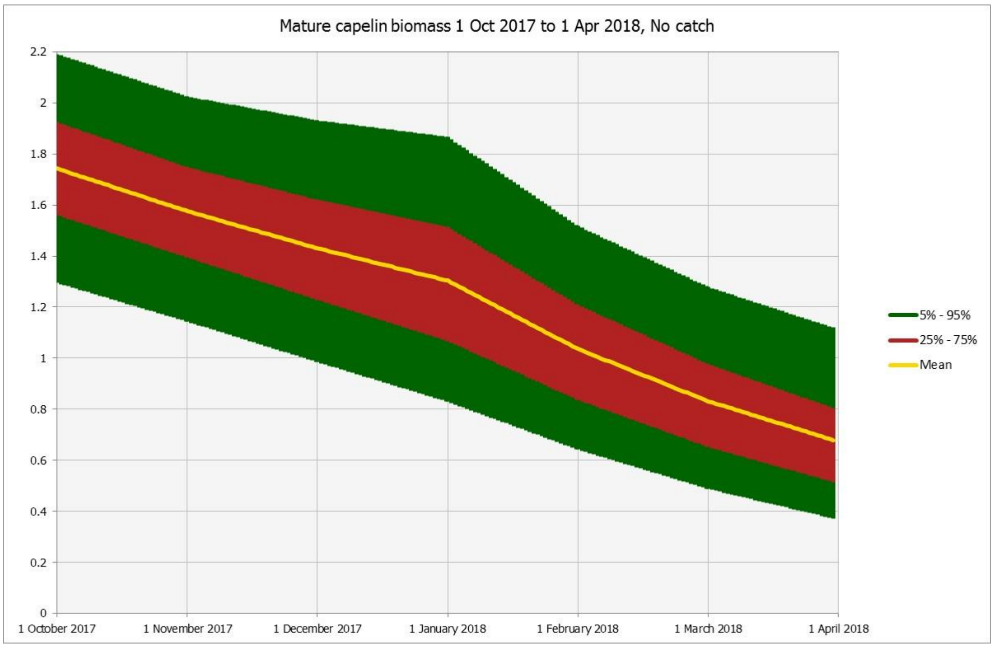

Figure 9.3. Probabilistic prognosis 1 October 2017—1 April 2018 for Barents Sea capelin maturing stock, with no catch (model CapTool, 20 000 simulations).

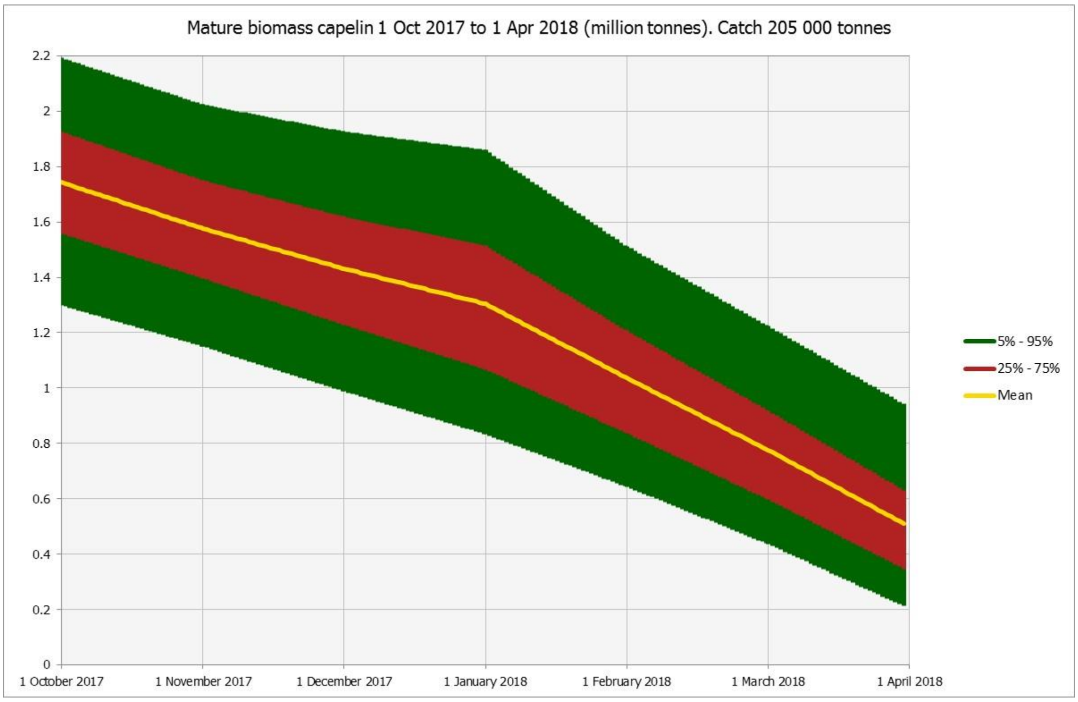

Figure 9.4. Probabilistic prognosis 1 October 2017—1 April 2018 for Barents Sea capelin maturing stock, with TAC = 205 000 tonnes (model CapTool, 20 000 simulations).

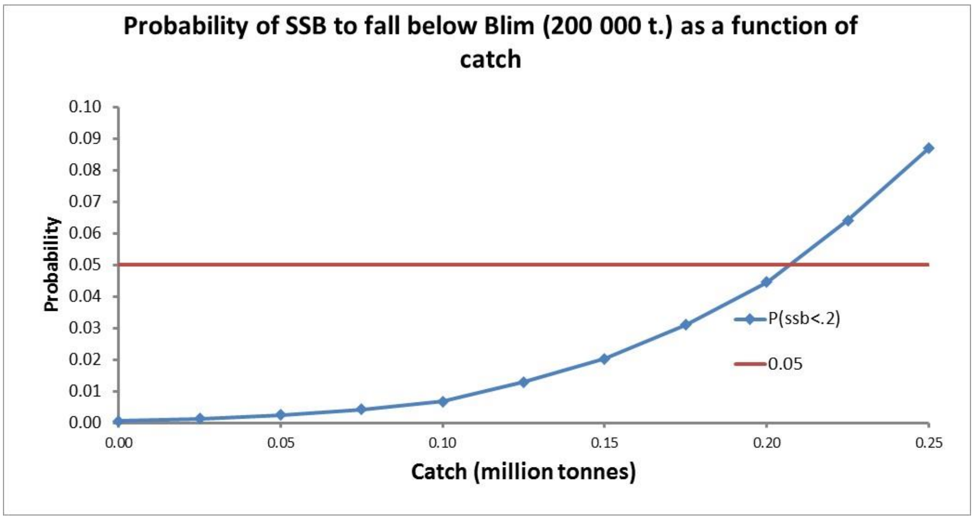

Figure 9.5. Probability of spawning biomass of capelin (1 April 2018) being below B_{lim} (200 000 tonnes), as a function of catch.

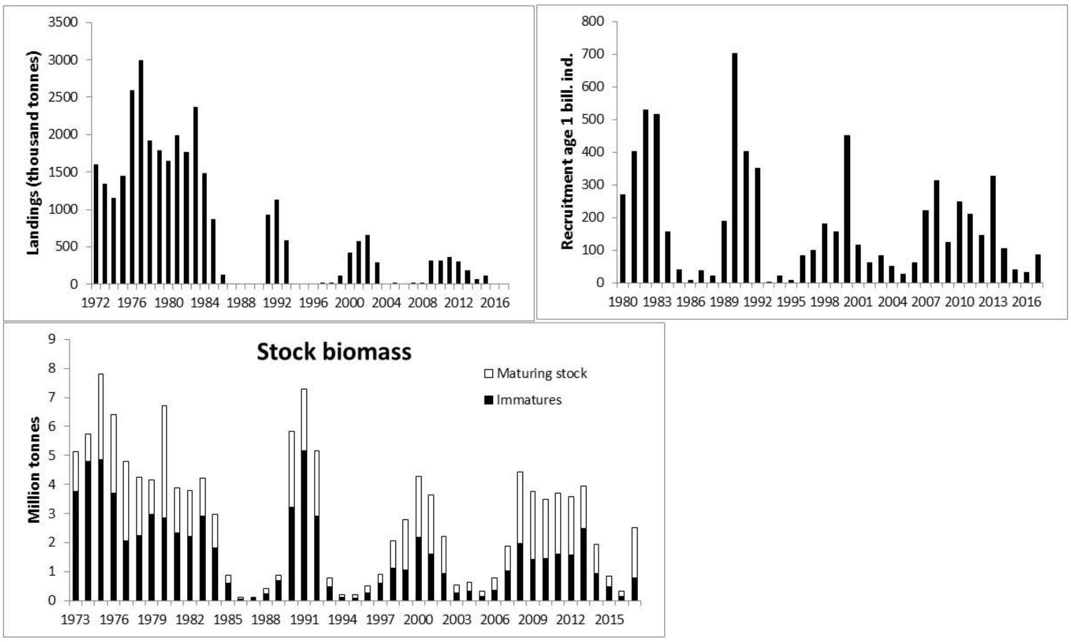

Figure 9.6. Capelin in Subareas I and II, excluding Division IIa west of 5°W (Barents Sea capelin). Landing and summary of stock assessment (mature and immature stock biomass).

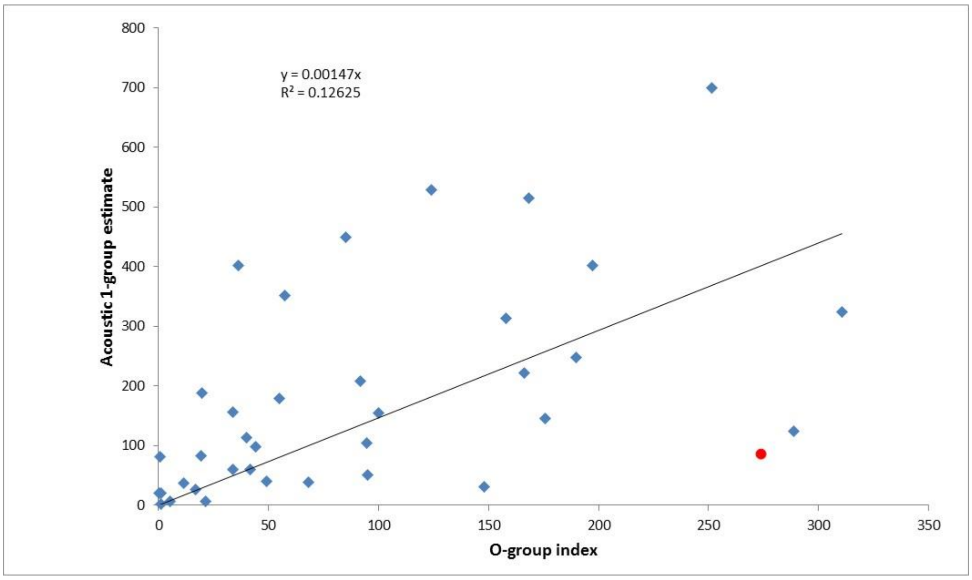

Figure 9.7. Regression of abundance of capelin at age 0 (0-group index without K_{eff}) and age 1 for cohorts 1980—2016. The red point shows the 2016 year class.

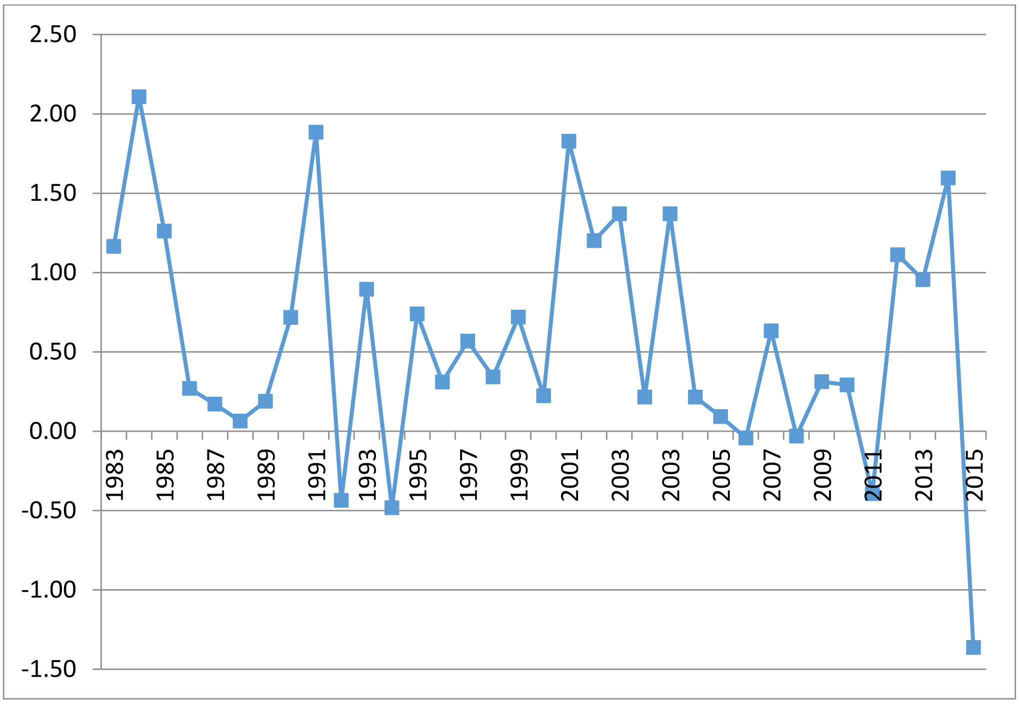

Figure 9.8. Capelin survey mortality from age 1-2.

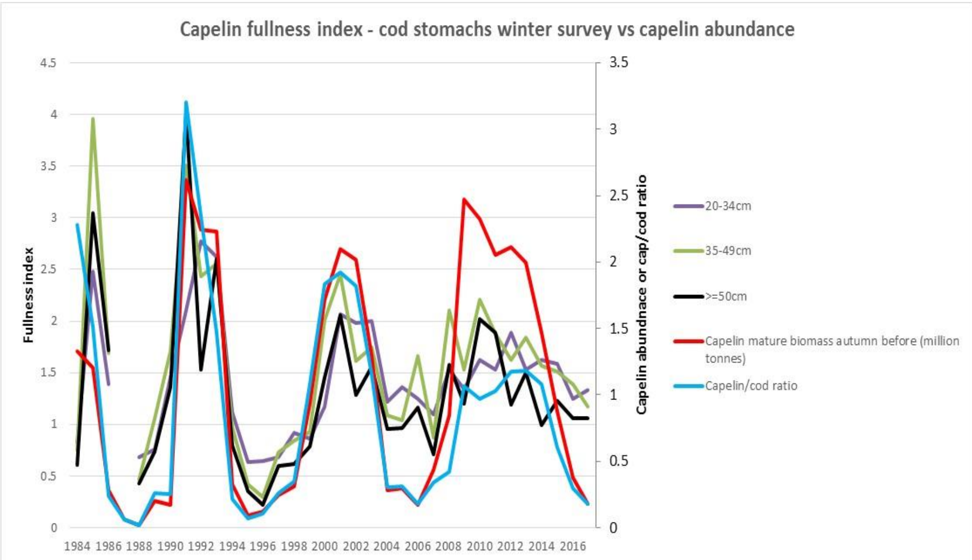

Figure 9.9. Fullness index for capelin in cod stomachs for different cod length groups during the Joint winter survey for demersal fish (Mehl et al. 2017) vs. abundance of maturing capelin the previous autumn (red line). The ratio of maturing capelin to immature cod is also shown (blue line).