

Preliminary cruise report: Acoustic assessment of the Iceland-East Greenland-Jan Mayen capelin stock in February 2023.

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Objective

The main objective of this winter survey in February 2023 was acoustic assessment of the maturing part of the capelin stock with main emphasis on quantifying stock components that potentially were unmeasured, due to hindered coverage caused by sea ice, during the acoustic survey conducted 23 - 31 January. 3 Scientists from MFRI were on board Arni Fridriksson. Echosounders had been calibrated in December.

Methods

Survey area and conditions

The survey area was along and outside shelf slopes from Vikurall northwest of Iceland towards Kolbeinsey ridge north of Iceland. Further, capelin occurrences in the coverage north and northeast of Strandagrunn and reported capelin by fishing vessels in Reykjafjardarall indicated possible migration into shelf areas in that region. Hence, the survey area was extended to shelf areas north of Hunafloi (Figure 1). The acoustic measurements and pelagic trawl sampling were conducted by rv Arni Friðriksson while rv Bjarni Saemundsson was conducting a hydrographic survey around Iceland at the same time and acoustic data from Bjarni was also used for the stock assessment in the survey area. Arni left harbor in Hafnarfjörður the 12 February and while waiting for weather and sea state to calm down in Denmark Strait, Arni started measurements north of Kogurgrunn north of Vestfirðir peninsula. Then as weather calmed down in Denmark Strait Arni measured westwards in a zig-zag manner along and outside the shelf edge in area that was hindered by sea ice in earlier surveys. Following the coverage of Denmark Strait, Arni measured eastwards towards Kolbeinseyridge and then after a stop due to bad weather the shelf areas north of Hunafloi were measured. While the weather was challenging during periods of the survey, all abundant areas were measured in good weather conditions. Arni came back to harbor in Hafnarfjörður the 23 February.

Acoustic sampling

Acoustic data was sampled with Simrad EK80 echosounders at five frequencies. The data were scrutinized by a scientist onboard the vessel using LSSS (version 2.14.0) software where capelin backscatter at 38 kHz was defined and its Nautical Area Scattering Coefficient (NASC) in SA units (m^2/nmi^2) calculated at 0.1 nmi integration intervals. Then, average NASC within squares of 15 minutes latitude and 30 minutes longitude was calculated. Abundance in numbers was estimated using a length dependent target strength relationship (TS; in dB re $1m^2$)

$$TS = 19.1 * \log(L) - 74.5$$

Total length of the capelin was measured to nearest mm. For each length interval within the length distribution of capelin in the samples the following parameters were calculated: backscattering proportion, number and weight.

$$\sigma_L = 4 * \pi * 10^{TS_L/10}$$
$$C_L = \frac{\sum_L \frac{C_{sL} * \sigma_L}{(C_L * \sigma_L)} * NASC * A}{\sigma_L}$$
$$W_L = C_L * \overline{W_{sL}}$$

Where L is measured length, σ is backscattering cross-section, C is total number, C_s is number in sample, A is surface area and W_s is average weight in sample. Further, for ongoing project studying capelin backscatter (target strength), the backscatter was measured at chosen locations by a TS-probe(WBT-Tube) that was lowered to depths in the proximity of capelin schools.

Biological sampling:

Pelagic trawl: Total length and weight of up to 100 individual capelin fish was measured for a subsample from the catch at each trawl station. Also, sex and maturity were estimated visually and the roe from maturing capelin were weighted. Samples were processed onboard the vessel and age was estimated from otoliths.

Results

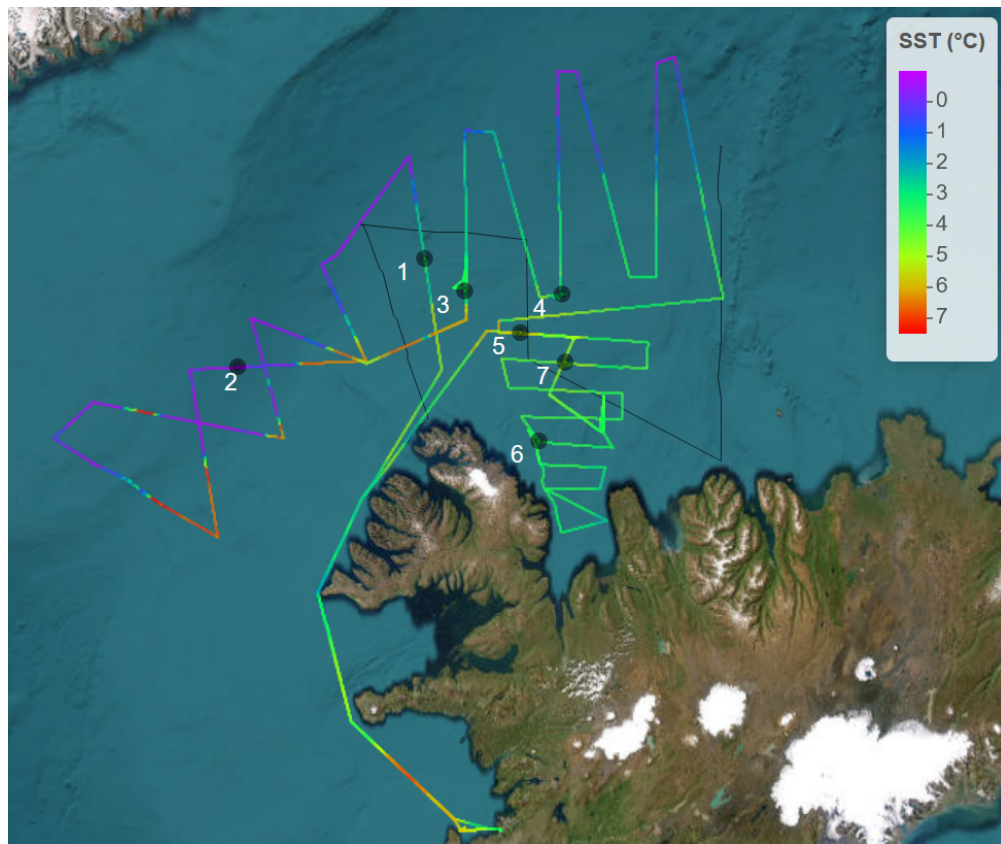


Figure 1: Routes of the participating vessels. Route of rs Arni Friðriksson with sea surface temperature (SST) color scale as measured onboard and route of rs Bjarni Saemundsson in the research area shown as black line. Pelagic trawl stations are shown as black circles labelled in chronological order

Distribution, biomass and age composition of capelin

In the Denmark Strait area (region 1), there was low abundance of capelin with distributed capelin schools of low densities (Figure 2). This capelin was mainly 3 years old but gonads were in general not far in development. 48-61 % of the capelin in this area was immature (Figure 3) and gonads that were by maturity stage analyzed as maturing were often not far enough developed to be candidates for spawning this year. Hence, the capelin from the western area will not be considered as part of the spawning stock this year. Further east there was not much capelin found along the shelf slope towards Kolbeinseyridge. On the other hand high quantities of maturing capelin were found migrating into shelf areas north of Hunafloi. This stock component (region 2) was concluded to be unmeasured in earlier stock estimate in January. Based on the condition and distribution of capelin described above the survey area was split into two assessment regions where only capelin in the eastern region (region 2), north of Hunafloi, was considered as an addition to earlier measurements of the spawning stock in current fishing year. Hence, disaggregated biomass is shown separately for the two regions.

The survey results in region 2 give capelin SSB of 427 000 tonnes.

Length disaggregated biomass is shown in tables 1-12. The total number of capelin amounted to 20 billion

where of 19 billion was in region 2. The total biomass estimate was 444 000 tonnes where of about 432 000 tonnes was in region 2 with 427 000 tonnes of maturing capelin in region 2.

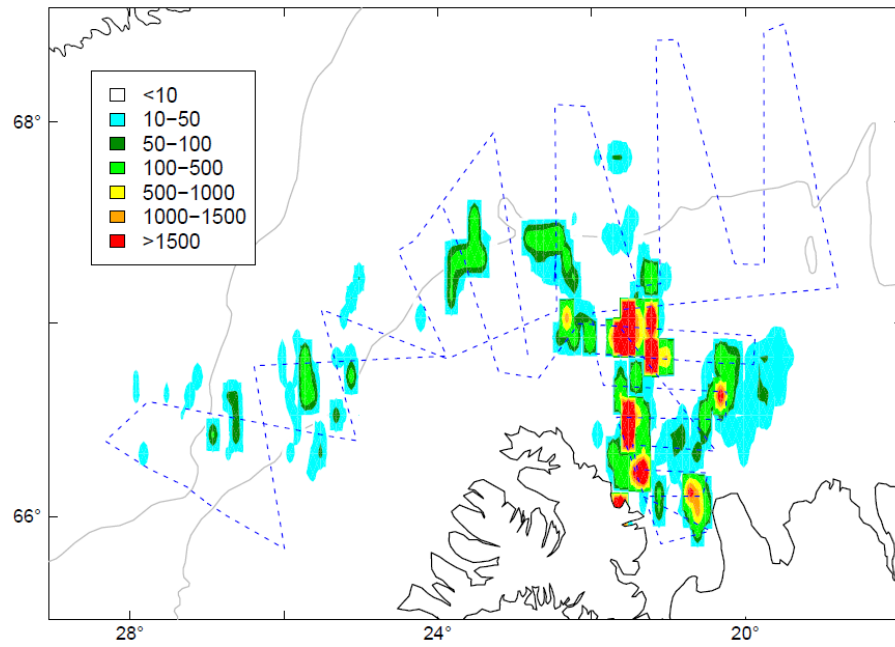


Figure 2: Capelin distribution as relative density of acoustic backscatter during the survey.

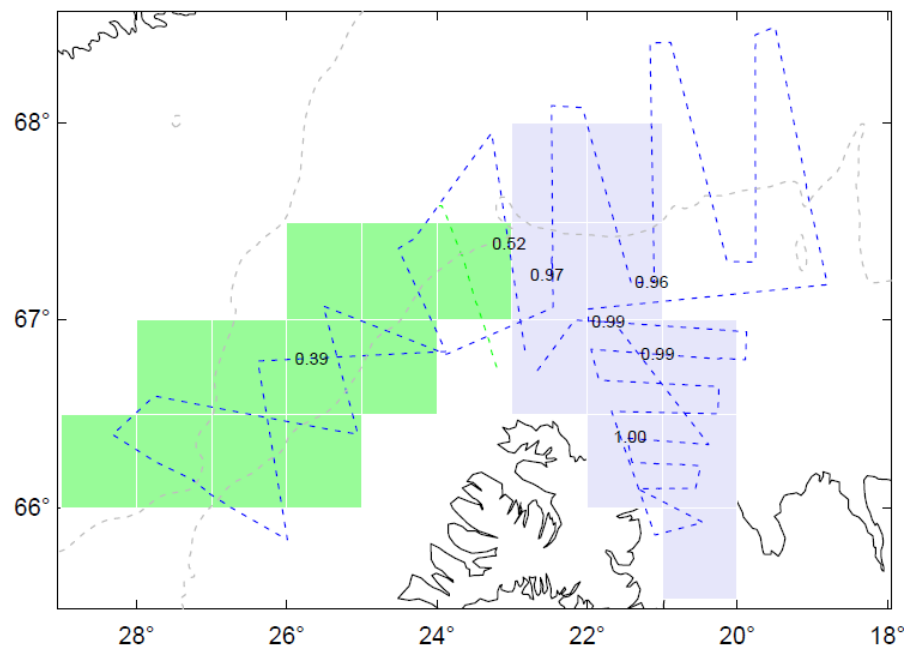


Figure 3: Maturity proportion at each trawl station.

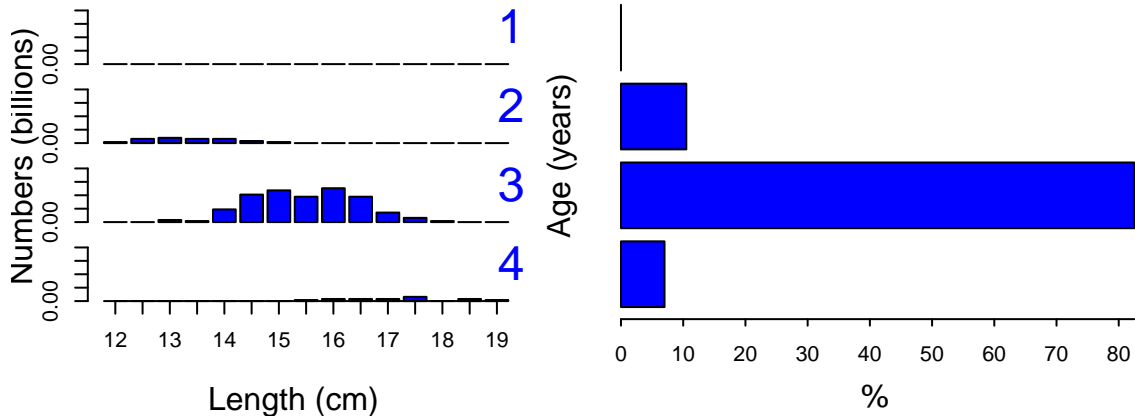
Total stock Region 1

Table 1: Estimated stock size of Iceland-Greenland-Jan Mayen capelin total stock in numbers (millions) by age (years) and length (cm), and biomass (thous. tonnes) from the acoustic surveys in 12. – 23. February 2023. Mean weight is in grams

length	a1	a2	a3	a4	num.sampled	numbers	biomass	weight.mean
12.0	0	3.94	0.00	0.00	1	3.94	21.86	5.54
12.5	0	15.78	0.00	0.00	4	15.78	108.57	6.88
13.0	0	19.72	7.89	0.00	7	27.61	220.60	7.99
13.5	0	15.78	3.94	0.00	5	19.72	181.07	9.18
14.0	0	15.78	47.34	0.00	16	63.12	658.73	10.44
14.5	0	7.89	102.57	0.00	28	110.46	1293.79	11.71
15.0	0	3.94	118.35	0.00	31	122.29	1639.92	13.41
15.5	0	0.00	94.68	3.94	25	98.62	1478.10	14.99
16.0	0	0.00	126.24	7.89	34	134.13	2260.23	16.85
16.5	0	0.00	94.68	7.89	26	102.57	1914.41	18.66
17.0	0	0.00	35.50	7.89	11	43.39	922.25	21.25
17.5	0	0.00	15.78	15.78	8	31.56	787.73	24.96
18.0	0	0.00	3.94	0.00	1	3.94	107.70	27.30
18.5	0	0.00	0.00	7.89	2	7.89	268.02	33.97
19.0	0	0.00	0.00	3.94	1	3.94	139.57	35.38

Table 2: Age (years) aggregated total stock summary. T = Total, S = Stock, N = Numbers(billions), W = Weight(grams), L = Length(Cm), p = %

parameter	a1	a2	a3	a4	All
TSN	0	0.08	0.65	0.06	0.79
TSB	0	0.74	9.95	1.31	12.00
MeanW	0	8.97	15.29	23.69	15.21
MeanL	0	13.38	15.49	17.18	15.38
TSNp	0	10.50	82.50	7.00	100.00



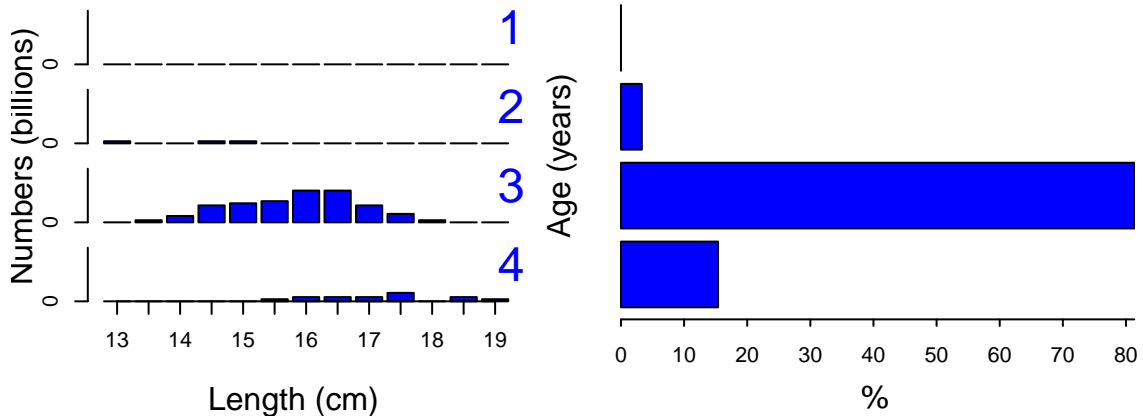
Spawning stock Region 1

Table 3: Estimated stock size of the Iceland-Greenland-Jan Mayen capelin spawning stock component in numbers (millions) by age (years) and length (cm), and biomass (thous. tonnes) from the acoustic surveys in 12. – 23. February 2023. Mean weight is in grams

length	a1	a2	a3	a4	num.sampled	numbers	biomass	weight.mean
13.0	0	3.94	0.00	0.00	2	3.94	33.30	8.44
13.5	0	0.00	3.94	0.00	2	3.94	42.84	10.86
14.0	0	0.00	11.83	0.00	10	11.83	134.76	11.39
14.5	0	3.94	31.56	0.00	26	35.50	440.89	12.42
15.0	0	3.94	35.50	0.00	31	39.45	554.74	14.06
15.5	0	0.00	39.45	3.94	25	43.39	665.59	15.34
16.0	0	0.00	59.17	7.89	34	67.06	1157.06	17.25
16.5	0	0.00	59.17	7.89	26	67.06	1277.14	19.04
17.0	0	0.00	31.56	7.89	11	39.45	845.17	21.42
17.5	0	0.00	15.78	15.78	8	31.56	787.73	24.96
18.0	0	0.00	3.94	0.00	1	3.94	107.70	27.30
18.5	0	0.00	0.00	7.89	2	7.89	268.02	33.97
19.0	0	0.00	0.00	3.94	1	3.94	139.57	35.38

Table 4: Age (years) aggregated spawning stock component summary. T = Total, S = Stock, N = Numbers(billions), W = Weight(grams), L = Length(Cm), p = %

parameter	a1	a2	a3	a4	All
SSN	0	0.01	0.29	0.06	0.36
SSB	0	0.14	5.00	1.32	6.45
MeanW	0	11.64	17.13	23.85	17.98
MeanL	0	14.17	15.85	17.18	16.00
SSNp	0	3.30	81.32	15.38	100.00



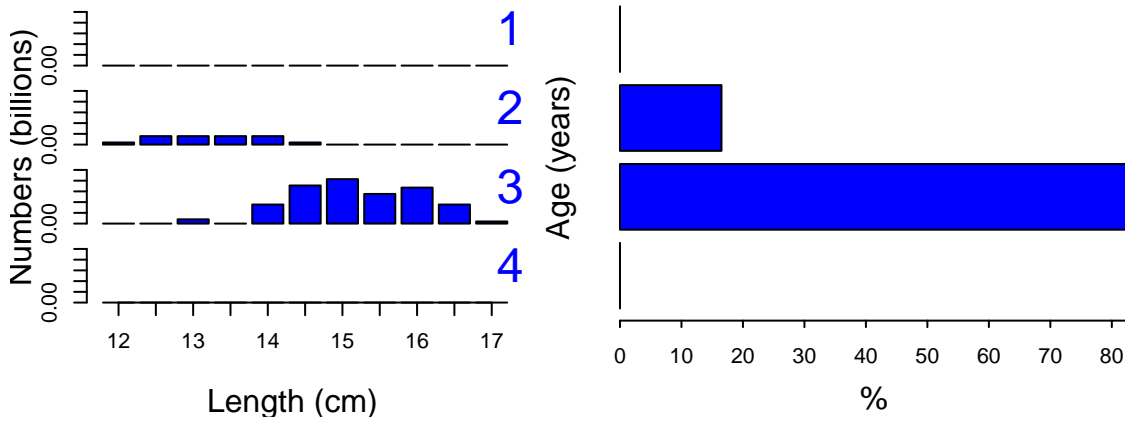
Immature stock Region 1

Table 5: Estimated stock size of the Iceland-Greenland-Jan Mayen capelin immature stock component in numbers (millions) by age (years) and length (cm), and biomass (thous. tonnes) from the acoustic surveys in 12. – 23. February 2023. Mean weight is in grams

length	a1	a2	a3	a4	num.sampled	numbers	biomass	weight.mean
12.0	0	3.94	0.00	0	1	3.94	21.86	5.54
12.5	0	15.78	0.00	0	4	15.78	108.57	6.88
13.0	0	15.78	7.89	0	7	23.67	187.31	7.91
13.5	0	15.78	0.00	0	5	15.78	138.23	8.76
14.0	0	15.78	35.50	0	16	51.28	523.97	10.22
14.5	0	3.94	71.01	0	25	74.95	852.90	11.38
15.0	0	0.00	82.84	0	31	82.84	1085.18	13.10
15.5	0	0.00	55.23	0	22	55.23	812.50	14.71
16.0	0	0.00	67.06	0	34	67.06	1103.17	16.45
16.5	0	0.00	35.50	0	23	35.50	637.27	17.95
17.0	0	0.00	3.94	0	3	3.94	77.08	19.54

Table 6: Age (years) aggregated immature stock component summary. T = Total, S = Stock, N = Numbers(billions), W = Weight(grams), L = Length(Cm), p = %

parameter	a1	a2	a3	a4	All
ISN	0	0.07	0.36	0	0.43
ISB	0	0.60	4.95	0	5.55
MeanW	0	8.44	13.78	0	12.90
MeanL	0	13.25	15.19	0	14.87
ISNp	0	16.51	83.49	0	100.00



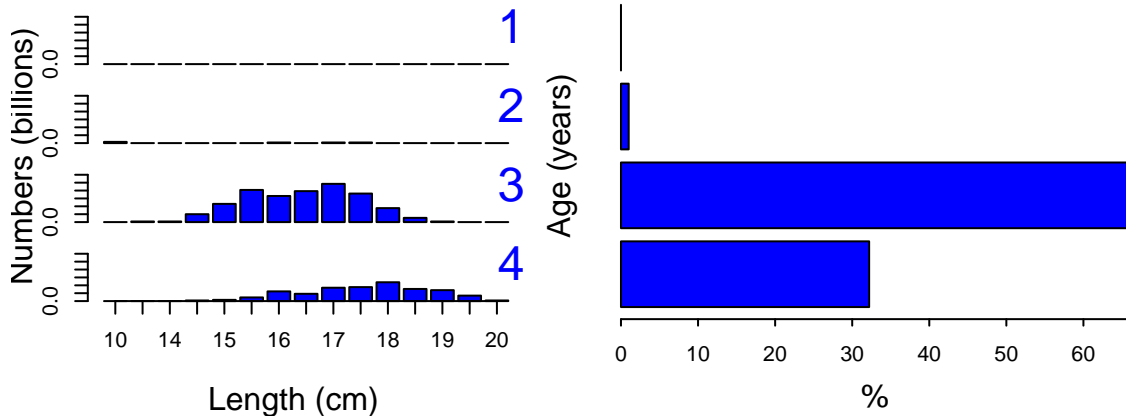
Total stock Region 2

Table 7: Estimated stock size of Iceland-Greenland-Jan Mayen capelin total stock in numbers (millions) by age (years) and length (cm), and biomass (thous. tonnes) from the acoustic surveys in 12. – 23. February 2023. Mean weight is in grams

length	a1	a2	a3	a4	num.sampled	numbers	biomass	weight.mean
10.0	0	76.95	0.00	0.00	2	76.95	273.94	3.56
13.5	0	0.00	38.47	0.00	1	38.47	326.26	8.48
14.0	0	0.00	38.47	0.00	1	38.47	440.15	11.44
14.5	0	0.00	500.16	38.47	14	538.64	6756.07	12.54
15.0	0	0.00	1154.23	76.95	32	1231.18	17469.61	14.19
15.5	0	0.00	2039.13	230.85	59	2269.98	36322.36	16.00
16.0	0	38.47	1654.39	615.59	60	2308.45	42395.90	18.37
16.5	0	0.00	1962.19	461.69	63	2423.88	49055.40	20.24
17.0	0	38.47	2423.88	846.43	86	3308.78	75947.73	22.95
17.5	0	38.47	1808.29	884.91	71	2731.67	71058.04	26.01
18.0	0	0.00	884.91	1192.70	54	2077.61	59014.84	28.41
18.5	0	0.00	269.32	769.48	28	1077.28	33172.09	30.79
19.0	0	0.00	38.47	692.54	19	731.01	25106.74	34.35
19.5	0	0.00	0.00	346.27	9	346.27	13303.62	38.42
20.0	0	0.00	0.00	38.47	1	38.47	1565.13	40.68

Table 8: Age (years) aggregated total stock summary. T = Total, S = Stock, N = Numbers(billions), W = Weight(grams), L = Length(Cm), p = %

parameter	a1	a2	a3	a4	All
TSN	0	0.19	12.81	6.19	19.24
TSB	0	2.86	263.57	164.59	432.21
MeanW	0	14.89	20.57	26.57	22.47
MeanL	0	14.10	16.44	17.60	16.79
TSNp	0	1.00	66.60	32.20	100.00



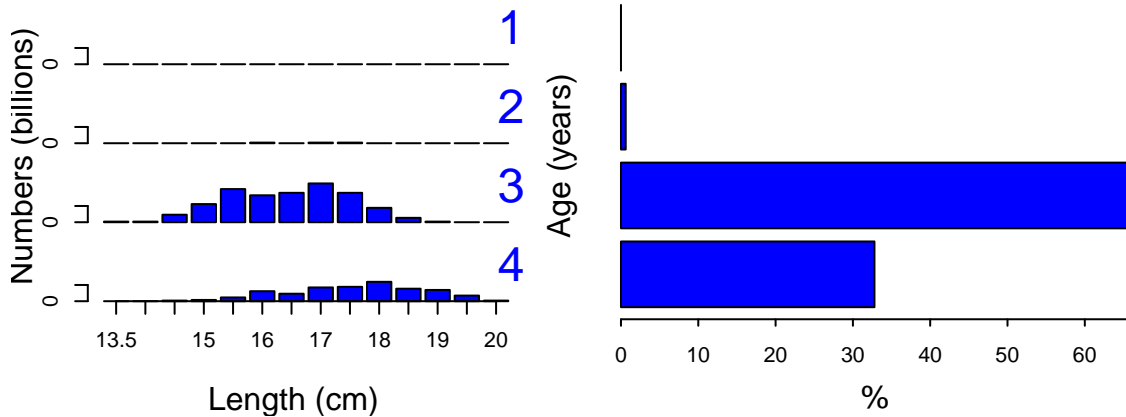
Spawning stock Region 2

Table 9: Estimated stock size of the Iceland-Greenland-Jan Mayen capelin spawning stock component in numbers (millions) by age (years) and length (cm), and biomass (thous. tonnes) from the acoustic surveys in 12. – 23. February 2023. Mean weight is in grams

length	a1	a2	a3	a4	num.sampled	numbers	biomass	weight.mean
13.5	0	0.00	38.47	0.00	1	38.47	326.26	8.48
14.0	0	0.00	38.47	0.00	1	38.47	440.15	11.44
14.5	0	0.00	461.69	38.47	14	500.16	6270.53	12.54
15.0	0	0.00	1115.75	76.95	32	1192.70	16982.52	14.24
15.5	0	0.00	2039.13	230.85	59	2269.98	36322.36	16.00
16.0	0	38.47	1654.39	615.59	60	2308.45	42395.90	18.37
16.5	0	0.00	1808.29	461.69	63	2269.98	46219.08	20.36
17.0	0	38.47	2385.40	846.43	86	3270.31	75234.42	23.01
17.5	0	38.47	1808.29	884.91	71	2731.67	71058.04	26.01
18.0	0	0.00	884.91	1192.70	54	2077.61	59014.84	28.41
18.5	0	0.00	269.32	769.48	28	1077.28	33172.09	30.79
19.0	0	0.00	38.47	692.54	19	731.01	25106.74	34.35
19.5	0	0.00	0.00	346.27	9	346.27	13303.62	38.42
20.0	0	0.00	0.00	38.47	1	38.47	1565.13	40.68

Table 10: Age (years) aggregated spawning stock component summary. T = Total, S = Stock, N = Numbers(billions), W = Weight(grams), L = Length(Cm), p = %

parameter	a1	a2	a3	a4	All
SSN	0	0.12	12.54	6.19	18.89
SSB	0	2.59	258.94	164.70	427.41
MeanW	0	22.46	20.64	26.59	22.63
MeanL	0	16.83	16.44	17.60	16.83
SSNp	0	0.61	66.40	32.79	100.00



Immature stock Region 2

Table 11: Estimated stock size of the Iceland-Greenland-Jan Mayen capelin immature stock component in numbers (millions) by age (years) and length (cm), and biomass (thous. tonnes) from the acoustic surveys in 12. – 23. February 2023. Mean weight is in grams

length	a1	a2	a3	a4	num.sampled	numbers	biomass	weight.mean
10.0	0	76.95	0.00	0	2	76.95	273.94	3.56
14.5	0	0.00	38.47	0	5	38.47	485.54	12.62
15.0	0	0.00	38.47	0	7	38.47	487.08	12.66
16.5	0	0.00	153.90	0	44	153.90	2836.32	18.43
17.0	0	0.00	38.47	0	25	38.47	713.31	18.54

Table 12: Age (years) aggregated immature stock component summary. T = Total, S = Stock, N = Numbers(billions), W = Weight(grams), L = Length(Cm), p = %

parameter	a1	a2	a3	a4	All
ISN	0	0.08	0.27	0	0.35
ISB	0	0.27	4.52	0	4.80
MeanW	0	3.56	16.79	0	13.85
MeanL	0	10.00	16.07	0	14.72
ISNp	0	22.22	77.78	0	100.00

