# Preliminary cruise report: Acoustic assessment of the Iceland-East Greenland-Jan Mayen capelin stock in January 2021.

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## Objective

The main objective of the 3 winter surveys conducted in January 2021 was acoustic assessment of the maturing part of the capelin stock. First, on 4 - 9 January, there was a coordinated collaboration of 2 research vessels and 3 fishing vessels where the stock estimate was based on combined acoustic and trawl data from all vessels. Second, on 17 - 19 January acoustic measurements and sampling were made by two fishing vessels assised by one scouting fishing vessel. Third, on 24 - 30 January acoustic measurements and sampling were undertaken by two research vessels and 3 fishing vessels assisted by 3 scouting fishing vessels. 2-3 Scientists from MFRI were on board each vessel doing acoustic measurements and all assessments were based on acoustic data from calibrated echosounders.

## Methods

### Acoustic sampling

Acoustic data was sampled with Simrad 38 kHz EK80 or ES70 and ES80 echosounders. The data were scrutinized by a scientist onboard each vessel using LSSS (version 2.9.0) software where capelin backscatter 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.

$$\sigma_L = 4 * \pi * 10^{TS_L/10}$$

$$C_L = \frac{\frac{Cs_L * \sigma_L}{\sum_L (C_L * \sigma_L)} * NASC * A}{\sigma_L}$$

$$W_L = C_L * \overline{Ws_L}$$

Where L is measured length, $\sigma$ is backscattering cross-section, C is total number, Cs is number in sample, A is surface area and Ws is average weight in sample.

### 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. Age was estimated from otoliths on board the research vessels but after the survey in samples collected on the fishing vessels.

## Results

### Coverage on 4-9 January 2021

The acoustic measurements were conducted by the research vessels Arni Friðriksson and Bjarni Sæmundsson and the fishing vessels Aðalsteinn Jónsson, Asgrimur Halldorsson and Polar Amaroq with 3 scientist from the Marine and Freshwater Research Institute onboard each vessel.

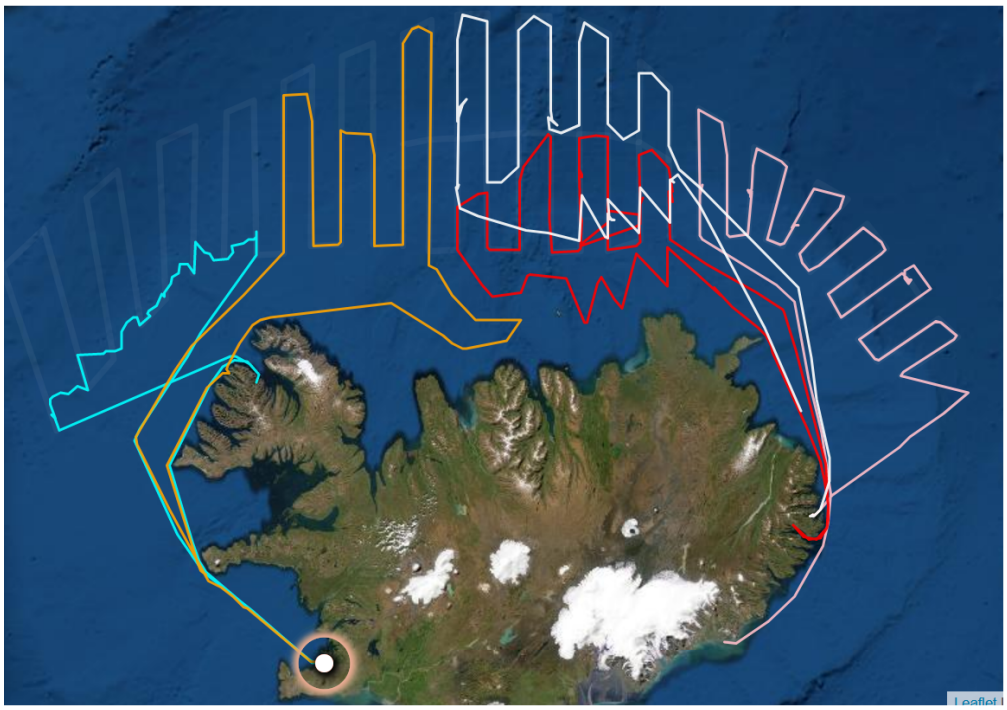


Figure 1: Routes of the participating vessels. Arni Friðriksson (cyan), Bjarni Sæmundsson (orange), Aðalsteinn Jónsson (red), Asgrimur Halldorsson (pink) and Polar Amaroq (white)

The survey area was on and along the shelf edge from Vikurall northwest of Iceland to Heradsdjup east of Iceland (Figure 1). Arni Fridriksson and Bjarni Sæmundsson started north of the Vestfirdir peninsula in the proximity of Kögurgrunn bank, Arni covering westwards and Bjarni to the east. Three vessels, Adalsteinn Jonsson, Polar Amaroq and Asgrimur Halldorsson started their transects northeast of Iceland in the proximity of Rifsbanki bank where Adalsteinn and Polar Amaroq progressed from east to west towards the coverage of Bjarni while Asgrimur progressed eastwards. During sailing to and from the research areas all vessels searched for capelin on shallower shelf areas. Before the survey, the echosounders of Adalsteinn Jonsson and Polar Amaroq were calibrated in Eskifjordur and Nordfjordur respectively, but other vessels had been previously calibrated. The vessels managed to cover the planned survey area except coverage in Denmark Strait was conciderably hindered due to sea ice.

Mature capelin dominated in main parts of the survey area although immature capelin was observed in occasional samples. Total SSB was estimated 144 000 tonnes but due to restricted coverage because of sea ice in the Denmark Strait and much lower observed abundance than in same areas in December 2020, it is likely that a good part of the population was undiscovered during this coverage.

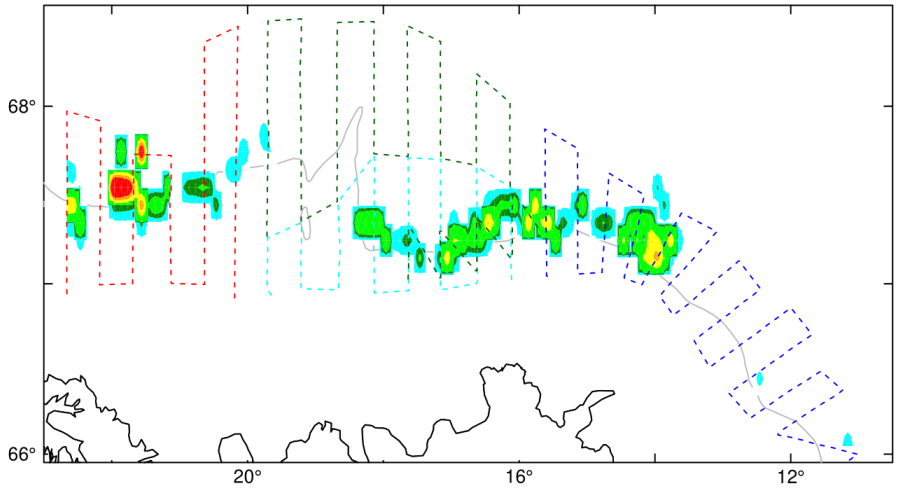



Figure 2: Capelin distribution as relative density of acoustic backscatter during the survey.

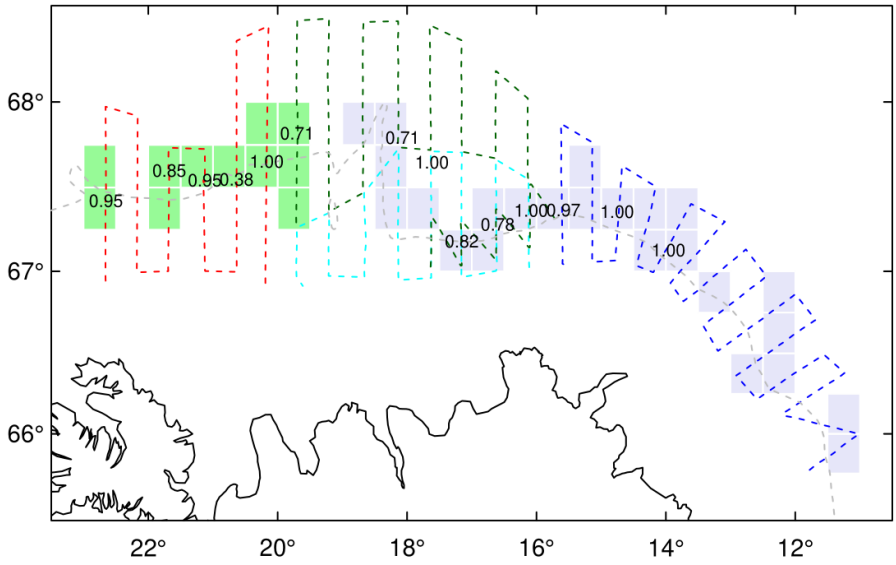



Figure 3: Maturity proportion at each trawl station.

## Coverage on 17-20 January 2021

The acoustic measurements were conducted by the fishing vessels Asgrimur Halldorsson and Polar Amaroq with 3 scientist from the Marine and Freshwater Research Institute onboard each vessel. Further, the fishing vessel Bjarni Olafsson searched for capelin with some assistanse from the fishing vessel Venus.

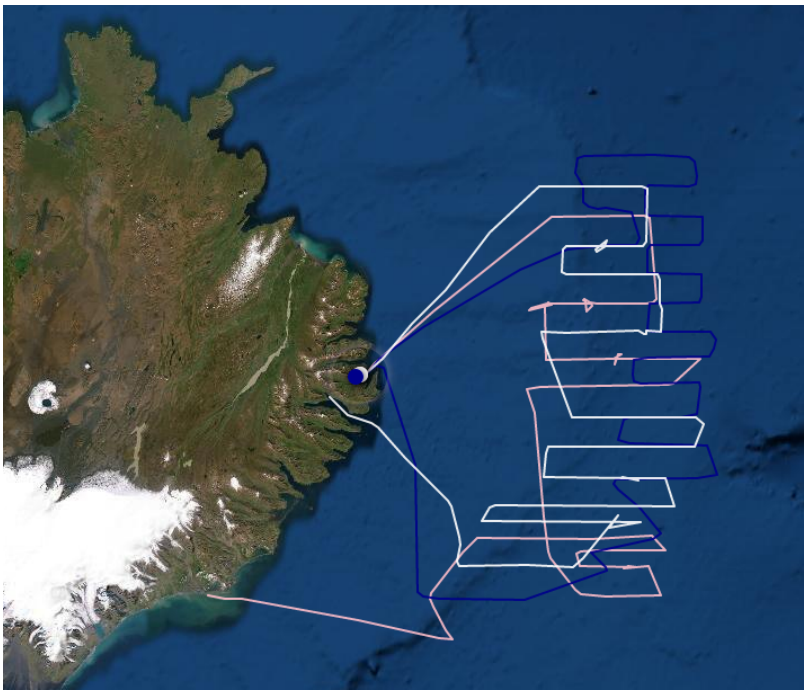


Figure 4: Routes of the participating vessels. Asgrimur Halldorsson (pink), Polar Amaroq (white) and Bjarni Olafsson (blue)

Due to very short weather window the survey area was limited to a small region along and outside the shelf edge east of Iceland extending from about 66°N southwards to about 64°15N. The initiative of this survey was based on confirmed observations of abundant capelin in the area and hence the need to measure the capelin before it migrates further south into areas less favorable for acoustic measurements. Both Asgrimur Halldorsson and Polar Amaroq were measuring along east-west transects progressing from south to north while Bjarni Olafsson mainly searched on eastern edge of the survey region. Also the fishing vessel Venus searched the shelf just west of the measured transects while passing by.

Mature capelin dominated in the region with the greatest abundance measured south of 65°N mainly 10 - 25 nmi east off the shelf edge. Total SSB was estimated 401 000 tonnes where of 325 000 tonnes were observed south of 65°N. The main part of the estimated abundance is likely to have been outside the first January survey coverage.

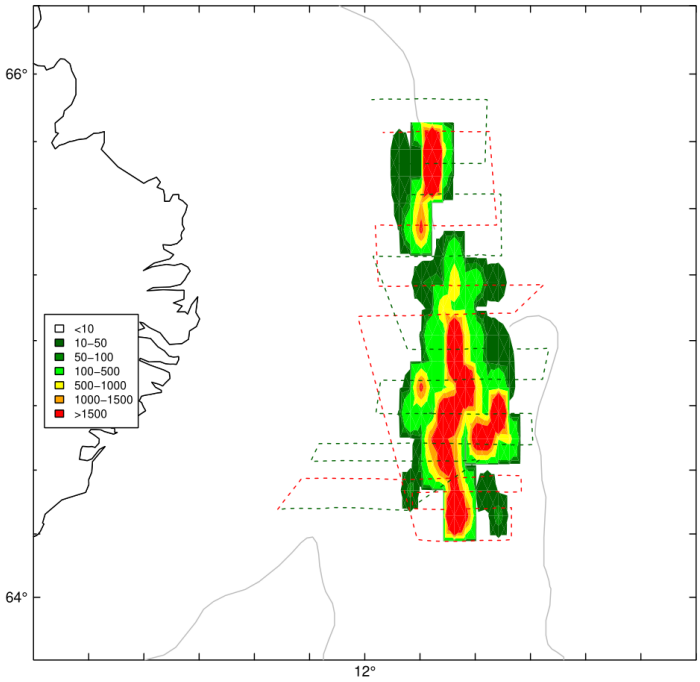



Figure 5: Capelin distribution as relative density of acoustic backscatter during the survey.

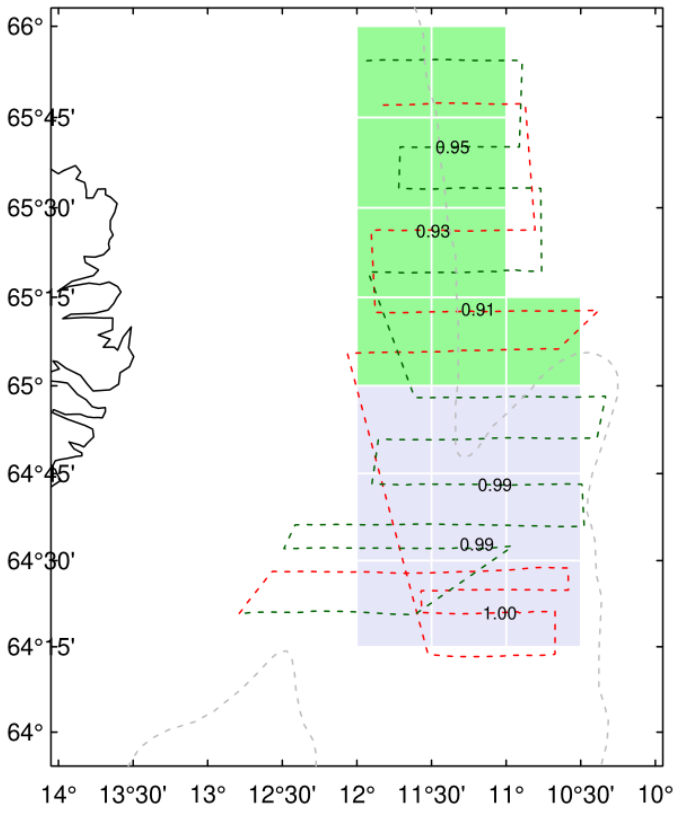



Figure 6: Maturity proportion at each trawl station.

## Coverage on 26-30 January 2021

The acoustic measurements were conducted by the research vessels Arni Friðriksson and Bjarni Sæmundsson and the fishing vessels Aðalsteinn Jónsson, Asgrimur Halldorsson and Borkur with 2-3 scientist from the Marine and Freshwater Research Institute onboard each vessel. Further, the fishing vessels Bjarni Olafsson, Hakon and Jona Edvalds searched for capelin.

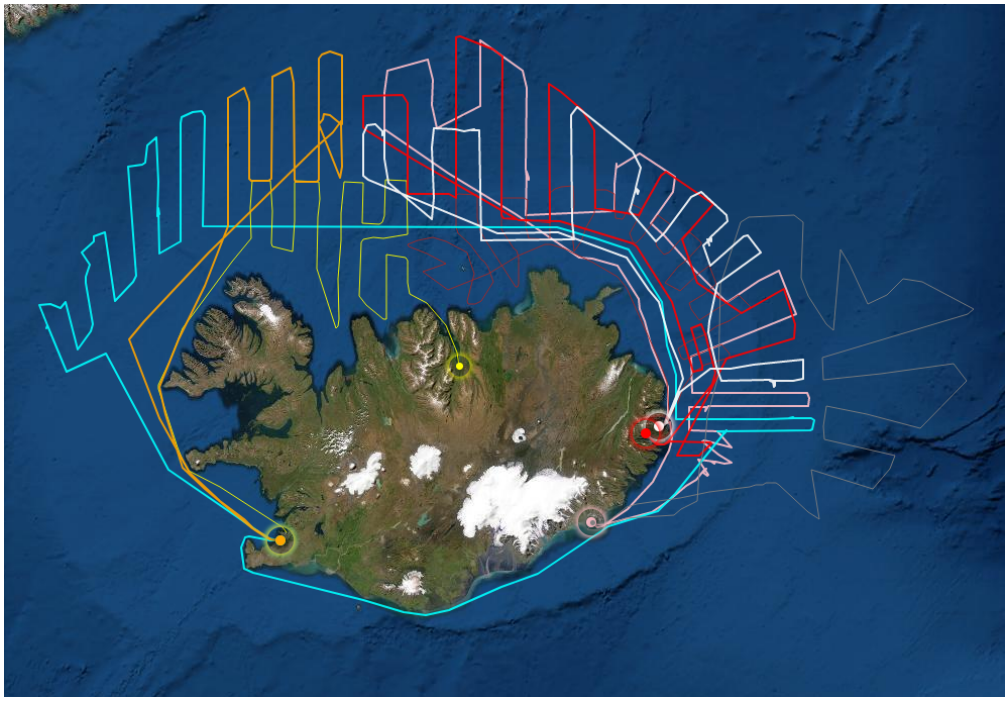


Figure 7: Routes of the participating vessels. Arni Friðriksson (cyan), Bjarni Sæmundsson (orange), Aðalsteinn Jónsson (red), Asgrimur Halldorsson (pink), Borkur (white), Bjarni Olafsson (red thin line), Hakon (yellow thin line) and Jona Edvalds (grey thin line)

The vessels Arni Fridriksson, Asgrimur Halldorsson, Adalsteinn Jonsson and Borkur started measurements in the southeast end of the survey area assisted by the scouting of Bjarni Olafsson on the shelf side while Jona Edvalds scouted deep areas east of the main survey transects. The aim was to start measuring capelin north of 65°N in the east and progressing northwards along eastfjords and then westward. When the vessels were arriving towards 65°N they observed high abundance of capelin on shelf areas just south of 65°N, hence they extended the coverage further to the south on the shelf. At the beginning of the survey there were no conditions for acoustic measurements in the Denmark Strait and other northwestern areas due to weather but consistent winds from east and northeast in Denmark Strait had caused a favorable retreat of the sea ice in that region. Hence, based on forcasted calm weather window in Denmark Strait Arni Fridriksson headed towards Denmark Strait on the evening of 26 January and the day after Bjarni Saemundsson and Hakon left harbour to also measure and search the northwestern regions. Early on the 28 January the three vessels arrived to their first transects by the shelf edge north of Straumnes and Arni Fridriksson progressed along the shelf edges westwards, Bjarni Saemundsson eastwards along the shelf edges while Hakon searched the shallower shelf areas off northwest Iceland. On the morning of 30 January, the following four vessels met about 40nmi west of Kolbeinsey, Bjarni Saemundsson approaching from the west, Adalsteinn Jonsson, Borkur and Asgrimur Halldorsson approaching from the east and hence closing the coverage gap between them. Although, Bjarni Saemundsson continued to finish unfinished transects in the north that had to be abondoned earlier due to weather and icy conditions. Further, Arni Fridriksson continued progressing westwards along unfinished transects. The whole survey was finished the 30 January. The echosounder on Borkur was calibrated after the survey, other vessels had previously calibrated echosounders.

Immature capelin dominated in Denmark Strait while mixtures of immature and mature capelin were found between Denmark Strait and Rifsbanki north of Melrakkasletta peninsula. Further to the east mature capelin dominated. Total SSB was estimated 415 000 tonnes where of 325 000 tonnes were north of 65°N.

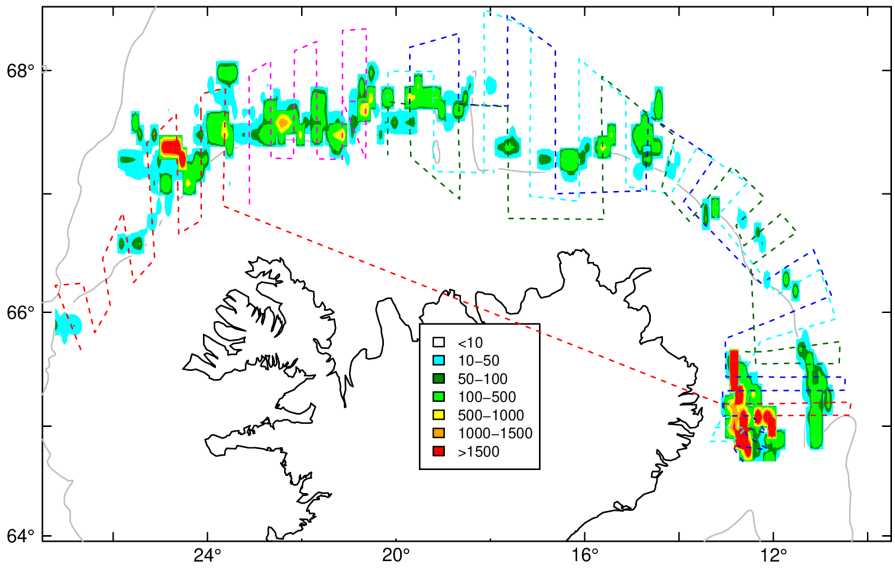



Figure 8: Capelin distribution as relative density of acoustic backscatter during the survey.

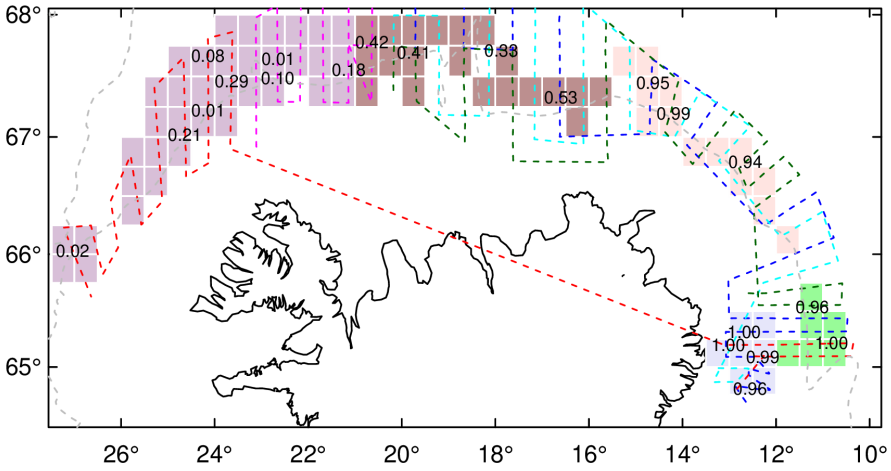



Figure 9: Maturity proportion at each trawl station.

### Combined biomass and age composition of capelin

Capelin distribution along with assumptions on southward migration directions and survey timings were the justifications for combining the measurements that were south of 65°N in the survey in 17 - 19 January with the measurements that were north of 65°N in the survey in 24 - 30 January. The combined estimate from the two partial surveys gives SSB of 649 000 tonnes.

Length disaggregated biomass is shown in tables 1-6. The total number of capelin amounted to 37 billion. The total biomass estimate was 746 000 tonnes where of about 649 000 tonnes were maturing capelin.

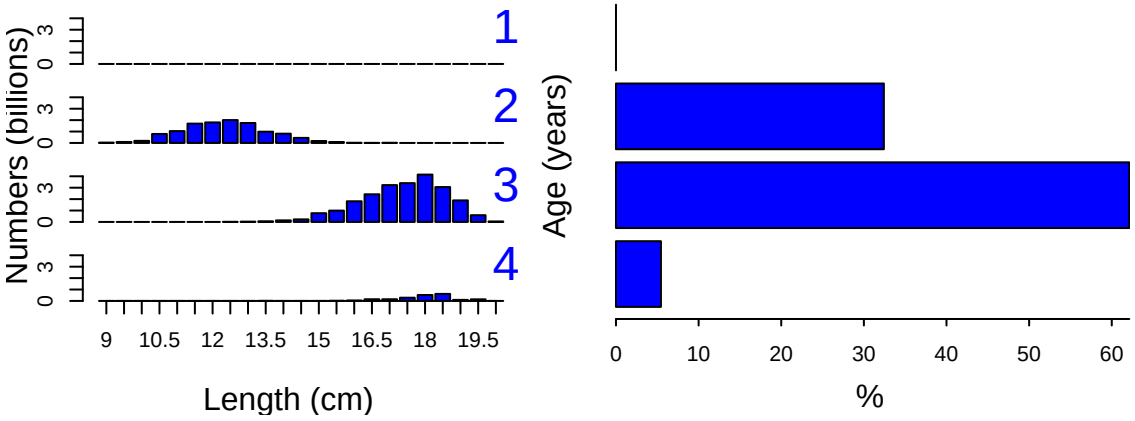
## Total stock

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 17. – 30. January 2021. Mean weight is in grams

| length | a1 | a2 | a3 | a4 | num.sampled | numbers | biomass | weight.mean |
|---|---|---|---|---|---|---|---|---|
| 9.0 | 0 | 28.43 | 0.00 | 0.00 | 2 | 28.43 | 69.65 | 2.45 |
| 9.5 | 0 | 85.29 | 0.00 | 0.00 | 6 | 85.29 | 226.01 | 2.65 |
| 10.0 | 0 | 184.78 | 0.00 | 0.00 | 13 | 184.78 | 590.88 | 3.20 |
| 10.5 | 0 | 787.60 | 0.00 | 0.00 | 54 | 787.60 | 2970.02 | 3.77 |
| 11.0 | 0 | 1039.31 | 0.00 | 0.00 | 75 | 1039.31 | 4529.80 | 4.36 |
| 11.5 | 0 | 1692.83 | 0.00 | 0.00 | 122 | 1692.83 | 8783.71 | 5.19 |
| 12.0 | 0 | 1799.37 | 0.00 | 0.00 | 136 | 1799.37 | 10798.35 | 6.00 |
| 12.5 | 0 | 2005.44 | 9.76 | 0.00 | 148 | 2015.20 | 14144.46 | 7.02 |
| 13.0 | 0 | 1748.12 | 23.97 | 0.00 | 133 | 1772.09 | 14481.92 | 8.17 |
| 13.5 | 0 | 984.87 | 53.24 | 2.52 | 83 | 1040.63 | 9660.07 | 9.28 |
| 14.0 | 0 | 813.08 | 138.19 | 0.00 | 78 | 951.27 | 10215.56 | 10.74 |
| 14.5 | 0 | 443.06 | 224.41 | 0.00 | 65 | 667.47 | 8350.40 | 12.51 |
| 15.0 | 0 | 169.52 | 765.45 | 0.00 | 87 | 934.97 | 13489.03 | 14.43 |
| 15.5 | 0 | 81.33 | 993.38 | 9.76 | 99 | 1084.46 | 17909.93 | 16.52 |
| 16.0 | 0 | 14.21 | 1809.52 | 35.77 | 157 | 1859.50 | 34906.54 | 18.77 |
| 16.5 | 0 | 4.58 | 2423.49 | 148.16 | 157 | 2576.23 | 55266.04 | 21.45 |
| 17.0 | 0 | 14.21 | 3228.05 | 148.00 | 207 | 3394.85 | 81416.96 | 23.98 |
| 17.5 | 0 | 0.00 | 3400.49 | 282.74 | 176 | 3683.22 | 98668.71 | 26.79 |
| 18.0 | 0 | 0.00 | 4149.24 | 518.67 | 216 | 4667.91 | 138373.63 | 29.64 |
| 18.5 | 0 | 0.00 | 3056.47 | 616.99 | 156 | 3673.46 | 120496.35 | 32.80 |
| 19.0 | 0 | 0.00 | 1887.82 | 92.98 | 101 | 1980.80 | 70261.60 | 35.47 |
| 19.5 | 0 | 0.00 | 590.08 | 139.87 | 28 | 729.95 | 28580.83 | 39.15 |
| 20.0 | 0 | 0.00 | 38.71 | 0.00 | 1 | 38.71 | 1703.16 | 44.00 |

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 | 11.90 | 22.79 | 2.00 | 36.69 |
| TSB | 0 | 84.24 | 602.00 | 59.55 | 745.89 |
| MeanW | 0 | 7.08 | 26.41 | 29.84 | 20.33 |
| MeanL | 0 | 12.35 | 17.37 | 18.00 | 15.78 |
| TSNp | 0 | 32.42 | 62.12 | 5.44 | 100.00 |



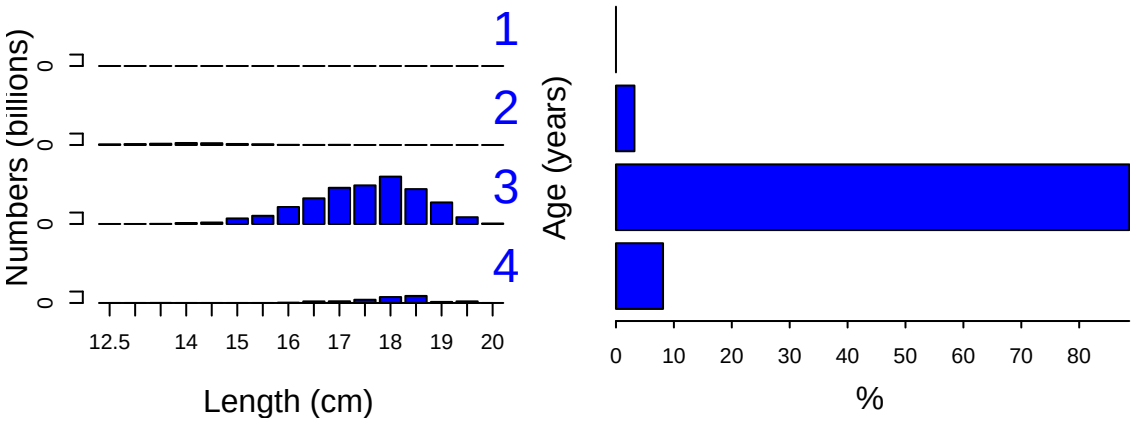
## Spawning stock

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 17. – 30. January 2021. Mean weight is in grams

| length | a1 | a2 | a3 | a4 | num.sampled | numbers | biomass | weight.mean |
|---|---|---|---|---|---|---|---|---|
| 12.5 | 0 | 57.41 | 0.00 | 0.00 | 3 | 57.41 | 411.04 | 7.16 |
| 13.0 | 0 | 81.98 | 0.00 | 0.00 | 13 | 81.98 | 717.67 | 8.75 |
| 13.5 | 0 | 112.78 | 9.76 | 2.52 | 47 | 125.05 | 1288.27 | 10.30 |
| 14.0 | 0 | 175.53 | 84.95 | 0.00 | 65 | 260.48 | 2982.79 | 11.45 |
| 14.5 | 0 | 155.42 | 127.57 | 0.00 | 62 | 282.99 | 3721.79 | 13.15 |
| 15.0 | 0 | 88.57 | 484.93 | 0.00 | 84 | 573.50 | 8489.77 | 14.80 |
| 15.5 | 0 | 67.12 | 716.24 | 0.00 | 96 | 783.36 | 13134.00 | 16.77 |
| 16.0 | 0 | 14.21 | 1486.96 | 26.01 | 157 | 1527.18 | 29157.86 | 19.09 |
| 16.5 | 0 | 4.58 | 2247.36 | 138.40 | 157 | 2390.34 | 51579.73 | 21.58 |
| 17.0 | 0 | 14.21 | 3170.24 | 148.00 | 207 | 3337.04 | 80206.19 | 24.04 |
| 17.5 | 0 | 0.00 | 3380.98 | 282.74 | 176 | 3663.71 | 98195.57 | 26.80 |
| 18.0 | 0 | 0.00 | 4149.24 | 518.67 | 216 | 4667.91 | 138373.63 | 29.64 |
| 18.5 | 0 | 0.00 | 3056.47 | 616.99 | 156 | 3673.46 | 120496.35 | 32.80 |
| 19.0 | 0 | 0.00 | 1887.82 | 92.98 | 101 | 1980.80 | 70261.60 | 35.47 |
| 19.5 | 0 | 0.00 | 590.08 | 139.87 | 28 | 729.95 | 28580.83 | 39.15 |
| 20.0 | 0 | 0.00 | 38.71 | 0.00 | 1 | 38.71 | 1703.16 | 44.00 |

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

| parameter | a1 | a2 | a3 | a4 | All |
|---|---|---|---|---|---|
| SSN | 0 | 0.77 | 21.43 | 1.97 | 24.17 |
| SSB | 0 | 9.49 | 580.66 | 59.03 | 649.30 |
| MeanW | 0 | 12.30 | 27.09 | 30.02 | 26.86 |
| MeanL | 0 | 14.16 | 17.49 | 18.03 | 17.43 |
| SSNp | 0 | 3.19 | 88.65 | 8.13 | 100.00 |



## Immature stock

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 17. – 30. January 2021. Mean weight is in grams

| length | a1 | a2 | a3 | a4 | num.sampled | numbers | biomass | weight.mean |
|---|---|---|---|---|---|---|---|---|
| 9.0 | 0 | 28.43 | 0.00 | 0.00 | 2 | 28.43 | 69.65 | 2.45 |
| 9.5 | 0 | 85.29 | 0.00 | 0.00 | 6 | 85.29 | 226.01 | 2.65 |
| 10.0 | 0 | 184.78 | 0.00 | 0.00 | 13 | 184.78 | 590.88 | 3.20 |
| 10.5 | 0 | 787.60 | 0.00 | 0.00 | 54 | 787.60 | 2970.02 | 3.77 |
| 11.0 | 0 | 1039.31 | 0.00 | 0.00 | 75 | 1039.31 | 4529.80 | 4.36 |
| 11.5 | 0 | 1692.83 | 0.00 | 0.00 | 122 | 1692.83 | 8783.71 | 5.19 |
| 12.0 | 0 | 1799.37 | 0.00 | 0.00 | 136 | 1799.37 | 10798.35 | 6.00 |
| 12.5 | 0 | 1948.03 | 9.76 | 0.00 | 145 | 1957.79 | 13733.42 | 7.01 |
| 13.0 | 0 | 1666.14 | 23.97 | 0.00 | 129 | 1690.11 | 13764.24 | 8.14 |
| 13.5 | 0 | 872.09 | 43.48 | 0.00 | 79 | 915.57 | 8371.80 | 9.14 |
| 14.0 | 0 | 637.55 | 53.24 | 0.00 | 76 | 690.79 | 7232.77 | 10.47 |
| 14.5 | 0 | 287.64 | 96.84 | 0.00 | 52 | 384.47 | 4628.61 | 12.04 |
| 15.0 | 0 | 80.95 | 280.52 | 0.00 | 65 | 361.47 | 4999.26 | 13.83 |
| 15.5 | 0 | 14.21 | 277.14 | 9.76 | 63 | 301.11 | 4775.93 | 15.86 |
| 16.0 | 0 | 0.00 | 322.56 | 9.76 | 91 | 332.31 | 5748.67 | 17.30 |
| 16.5 | 0 | 0.00 | 176.13 | 9.76 | 51 | 185.88 | 3686.31 | 19.83 |
| 17.0 | 0 | 0.00 | 57.81 | 0.00 | 29 | 57.81 | 1210.77 | 20.94 |
| 17.5 | 0 | 0.00 | 19.51 | 0.00 | 10 | 19.51 | 473.14 | 24.25 |

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 | 11.12 | 1.36 | 0.03 | 12.51 |
| ISB | 0 | 74.66 | 21.42 | 0.52 | 96.59 |
| MeanW | 0 | 6.71 | 15.74 | 17.66 | 7.72 |
| MeanL | 0 | 12.22 | 15.48 | 16.00 | 12.59 |
| ISNp | 0 | 88.89 | 10.88 | 0.23 | 100.00 |