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

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## Objective

The main objective of the survey was acoustic assessment of the capelin stock in the Iceland, East Greenland and Jan Mayen area, measuring mature and immature stock components at age 1 and older. The survey was conducted by the r/v Bjarni Saemundsson on behalf of MFRI and r/v Arni Fridriksson, rented by GINR.

## Methods

### Survey area and conditions

The survey area was on and along the shelf edge off East Greenland from about 64°30´N towards about 75°15´ N, also covering the Denmark Strait and the slope off northwest Iceland. The Iceland Sea, Kolbeinsey ridge and Greenland basin were only briefly scouted due to time constraints and for same reason hydrographic measurements and zooplankton sampling were limited compared to previous years.
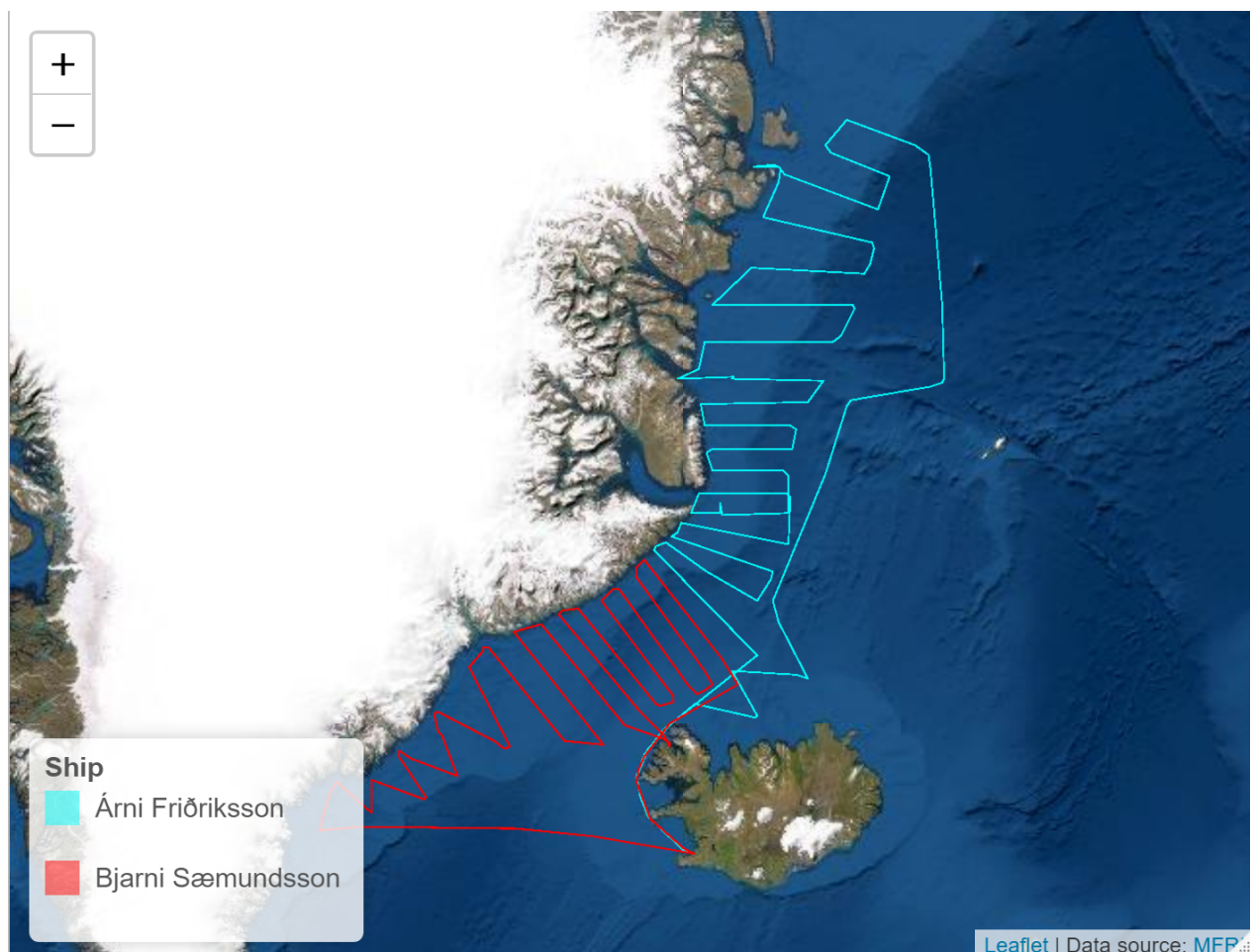


Figure 1: Tracks of the research vessels; Arni Fridriksson (blue) and Bjarni Saemundsson (red).

Both vessels departed from Hafnarfjordur harbour on 6 September and sailed towards their first parallel

transects crossing the Denmark Strait. From there Bjarni continued covering the East-Greenland shelf areas to southwest while Arni covered to northeast along the East-Greenland shelf and shelf edges.

Based on weather prospects, Bjarni skipped the 6 southern most environmental and zooplankton sampling stations along the Denmark Strait sampling transect (Transect B) to make possible additional two transect passage across the Denmark Strait before having to halt measurements due to weather. It was essential to wait in the southern Denmark Strait because wind and sea were predicted to calm much sooner in the south. The 12 September Bjarni reached the shelf edge by Isafjardardjup in heavy wind and seas and sought shelter in Isafjordur harbour for two days. Following this delay it was evident that Bjarni would not be able to finish the scheduled transects within the survey time but it was endeavored to stay as long as possible on the scheduled parallel transects while mixtures of mature and immature capelin were still observed in the Denmark Strait but eventually the region west of Kangerlussuaq Fjord had to be covered by following more widely spread diagonal transects to make it possible to reach the southwestern extent of the survey area within the survey time. During the survey an acoustic probe (Simrad WBT-Tube) was launched from Bjarni for at depth measurements of acoustic properties of capelin. Further, one humpback whale was tagged with a sattelite tag and two biopsy samples were collected from finwhales. Bjarni finished exploring the Greenlandic shelf areas on the morning of 21 September and arrived to Hafnarfjordur harbour in the afternoon of 22 September after crossing the Irminger Sea.

While covering the northeastern survey areas Arni did not have substantial delays due to weather although order of transects was adapted outside Scoresby and a few hour halt was made by Pendulum Islands. About 25 nmi east of Scoresby an oceanographic mooring was successfully retrieved for the Greenland Institute of Natural Resources (GINR). Arni finished the northern most transect east of Shannon Island in the evening of 19 September and sailed south following adapted (due to time constraints) coarse scouting zig-zag routes trough West Jan Mayen Ridge areas towards the Iceland Sea where high winds caused further delays and transects had to be adapted accordingly. Arni arrived in Hafnarfjordur harbour the 24 September.

In general, drift ice did not limit the coverage of the survey vessels although icebergs and a lack of benthic mapping occasionally limited extension of transects towards the Greenlandic coast.

**Acoustic sampling**

Acoustic data was sampled with Simrad EK80 transducer at five frequencies in Arni Fridriksson (18, 38, 70, 120 and 200 kHz) and Simrad EK60 at three frequencies in Bjarni Saemundsson (18, 38 and 120 kHz). The 38 kHz data were scrutinized using LSSS (version 2.11.0) 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. The acoustic data was scrutinized by a scientist on-board each vessel. Then, average NASC within squares of 30 minutes latitude and 1 degree longitude was calculated. Abundance in numbers was estimated using a length dependent target strength (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 of 36 pelagic trawl stations. Also, sex and maturity were estimated visually and the gonads from maturing capelin were weighted. Age was estimated from otoliths. Stomachs of 10 capelin were preserved on each station. Also 50 individual capelin were sampled on every second station for genetic analysis and further on every station 100 individuals in two size categories (above and below 14 cm) were sampled for fat content analysis.

**WP2 zooplankton net:**  Zooplankton was sampled by WP2 nets at depths down to 50 and 200 m at same location as CTD measurements if weather permitted.

**Bongo nets:**  Further Bongo samples were sampled diagonally down to 200 m at chosen transects and at targeted depths based on acoustic observations.

**Environmental measurements:**  Conductivity, Temperature and depth (CTD) measurements were made at chosen locations and surface temperature and salinity were also measured continuously during the survey.

## Results

**Distribution of capelin**

Maturing capelin was mainly observed along the East Greenlandic continental shelf and shelf edges in Denmark Strait and the Scoresby Sund areas reaching north to 73°27 N. In Denmark Strait maturing capelin was mixed with immature capelin, but mainly maturing capelin was found further north. No capelin was found by West Jan Mayen ridge or Kolbeinsey ridge. In general there were no signs of any important quantities of capelin east of Kolbeinsey ridge nor along Icelandic shelf edges. Juveniles (0-group) of various species, including capelin (although not quantified) were observed along the continental shelf north of Iceland. Immature capelin was found along the Greenlandic shelf, dominating in southwestern part of the survey area and western Denmark Strait. In general the gonad development of maturing capelin was at unusually late stage making it more challenging to distinguish between mature and immature developmental stages. Macroscopic post survey analysis of frosen subsamples from the survey indicated that there might be an overestimate of the proportion of immatures. The distribution of capelin was westerly as in recent years. Figures 1 and 2 show the cruise tracks, distribution and relative density of the capelin during the survey.
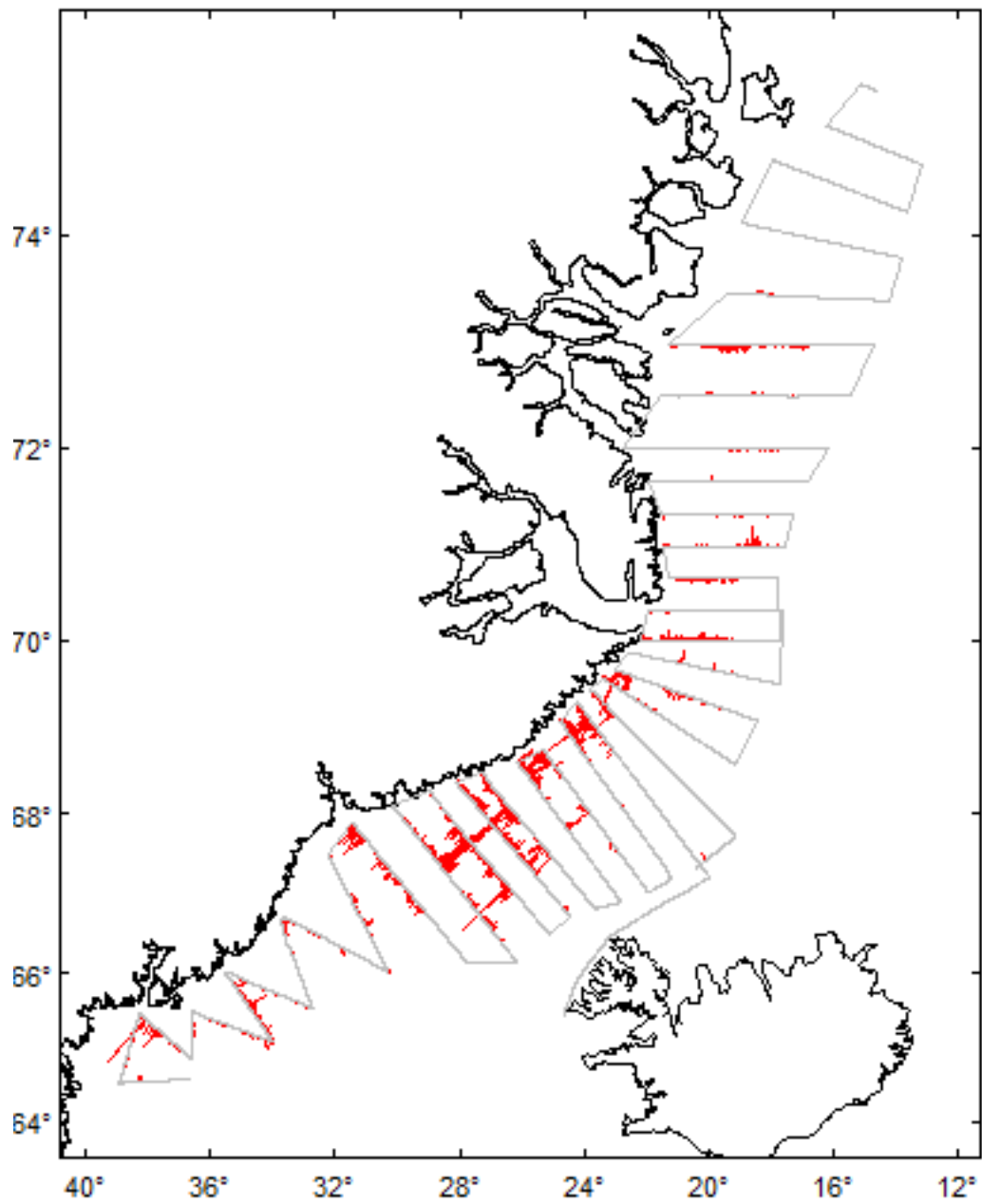
Figure 2: Capelin distribution as relative density of acoustic backscatter during the survey. Bars perpendicular to survey tracks show capelin acoustic backscatter as NASC per 0.1 nmi.
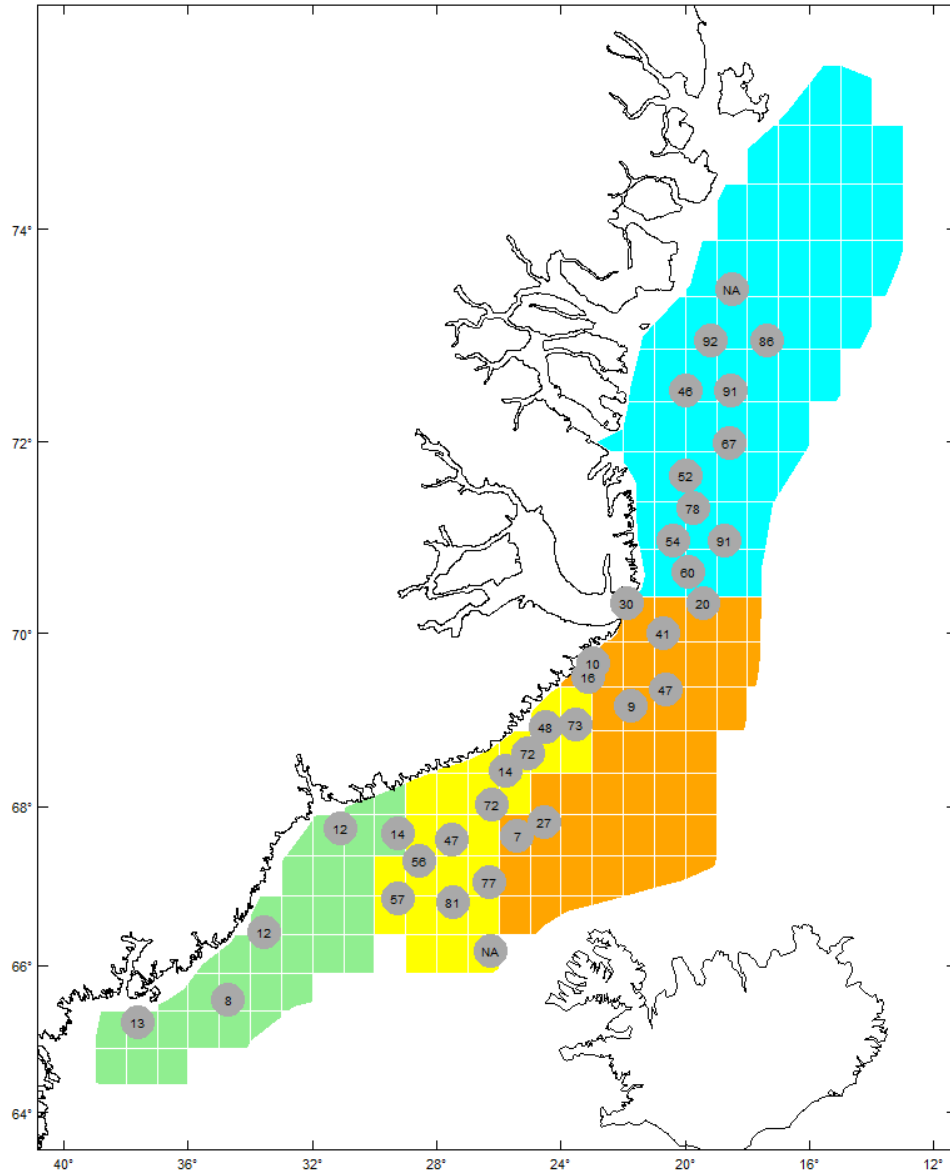
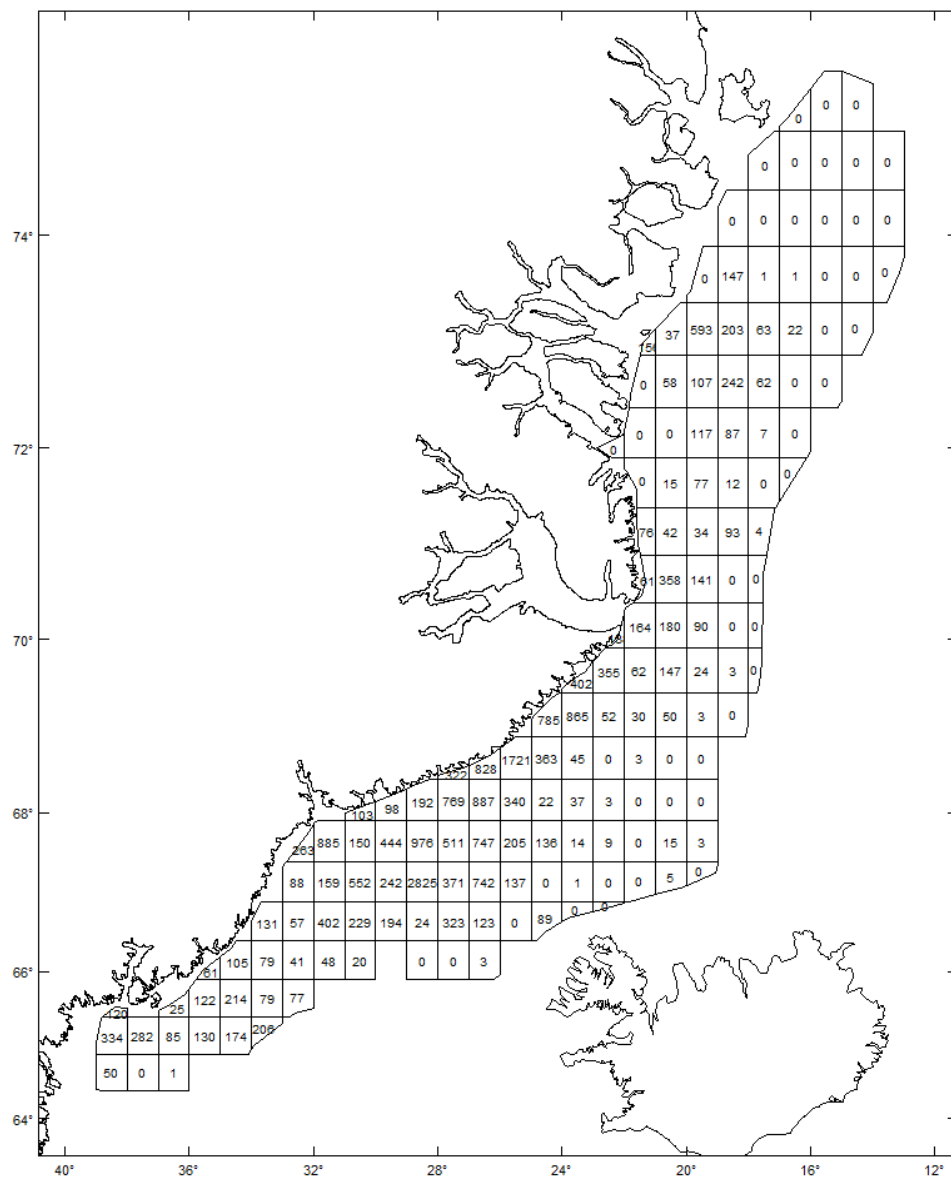Figure 3: Maturity proportion at each trawl station.

Figure 4: Average NASC within each rectangle.

**Biomass and age composition of capelin**

Age and length disaggregated biomass is shown in tables 1-6. The total number of capelin amounted to 228 billions whereof the 1-group was about 85.8 billions. The total estimate of 2 group capelin was about 133.5 billions. The total biomass estimate was 2894 000 tonnes of which about 2447 000 tonnes were 2 years and older. About 1.1 % in numbers of the 1-group was estimated to be maturing to spawn, about 65.6 % of the 2 year old and 90.8 % of the 3 year old capelin appeared to be maturing. This gives about 1834 000 tonnes of maturing 1 - 4 year old capelin. Tables 1-6 give the age disaggregate biomass, numbers and weights of the capelin stock components. Maturity proportions may be subject to revision based on examination of frozen samples, further analyses and results from additional surveys this winter.
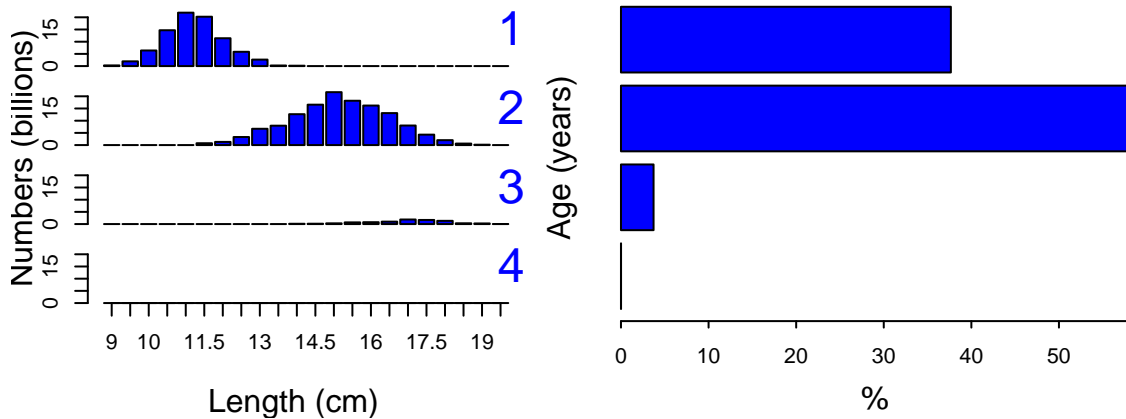
## Total stock

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 survey in 6. - 24. September 2021. Mean weight is in grams

| length | a1 | a2 | a3 | a4 | num.sampled | numbers | biomass | weight.mean |
|---|---|---|---|---|---|---|---|---|
| 9.0 | 278.40 | 0.00 | 0.00 | 0.00 | 4 | 278.40 | 680.20 | 2.44 |
| 9.5 | 1947.51 | 0.00 | 0.00 | 0.00 | 23 | 1947.51 | 5645.12 | 2.90 |
| 10.0 | 6402.20 | 0.00 | 0.00 | 0.00 | 57 | 6402.20 | 22127.16 | 3.46 |
| 10.5 | 14693.62 | 0.00 | 0.00 | 0.00 | 128 | 14693.62 | 59582.09 | 4.05 |
| 11.0 | 21904.01 | 0.00 | 0.00 | 0.00 | 208 | 21904.01 | 102991.99 | 4.70 |
| 11.5 | 20239.66 | 759.56 | 0.00 | 0.00 | 174 | 20999.21 | 116025.29 | 5.53 |
| 12.0 | 11421.02 | 1305.57 | 0.00 | 0.00 | 111 | 12726.59 | 81701.34 | 6.42 |
| 12.5 | 5861.66 | 3297.28 | 0.00 | 0.00 | 77 | 9158.94 | 67352.36 | 7.35 |
| 13.0 | 2658.49 | 6683.11 | 0.00 | 0.00 | 87 | 9341.60 | 82423.35 | 8.82 |
| 13.5 | 240.77 | 7953.21 | 0.00 | 0.00 | 102 | 8193.98 | 84927.87 | 10.36 |
| 14.0 | 148.15 | 12664.87 | 120.38 | 0.00 | 204 | 12933.40 | 153282.58 | 11.85 |
| 14.5 | 0.00 | 16566.10 | 139.20 | 0.00 | 315 | 16705.30 | 227177.83 | 13.60 |
| 15.0 | 0.00 | 21694.26 | 290.01 | 0.00 | 448 | 21984.27 | 337206.62 | 15.34 |
| 15.5 | 0.00 | 18171.02 | 691.20 | 0.00 | 386 | 18862.22 | 328679.22 | 17.43 |
| 16.0 | 0.00 | 16208.72 | 770.87 | 0.00 | 366 | 16979.60 | 338849.83 | 19.96 |
| 16.5 | 0.00 | 13113.31 | 996.95 | 0.00 | 283 | 14110.25 | 318246.40 | 22.55 |
| 17.0 | 0.00 | 8019.78 | 1871.11 | 0.00 | 201 | 9890.89 | 252825.00 | 25.56 |
| 17.5 | 0.00 | 4277.44 | 1681.98 | 16.41 | 120 | 5975.83 | 164899.73 | 27.59 |
| 18.0 | 0.00 | 2009.00 | 1323.91 | 16.41 | 67 | 3349.33 | 102753.49 | 30.68 |
| 18.5 | 0.00 | 612.85 | 319.76 | 0.00 | 25 | 932.61 | 29981.06 | 32.15 |
| 19.0 | 0.00 | 153.21 | 251.70 | 0.00 | 12 | 404.91 | 15451.63 | 38.16 |
| 19.5 | 0.00 | 0.00 | 16.41 | 0.00 | 1 | 16.41 | 788.87 | 48.06 |

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 | 85.80 | 133.49 | 8.47 | 0.03 | 227.79 |
| TSB | 446.99 | 2232.44 | 213.21 | 0.96 | 2893.60 |
| MeanW | 5.21 | 16.72 | 25.16 | 29.14 | 12.70 |
| MeanL | 11.23 | 15.15 | 16.95 | 17.75 | 13.74 |
| TSNp | 37.66 | 58.60 | 3.72 | 0.01 | 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 survey in 6. - 24. September 2021. Mean weight is in grams

| length | a1 | a2 | a3 | a4 | num.sampled | numbers | biomass | weight.mean |
|---|---|---|---|---|---|---|---|---|
| 10.5 | 120.38 | 0.00 | 0.00 | 0.00 | 7 | 120.38 | 505.62 | 4.20 |
| 11.0 | 120.38 | 0.00 | 0.00 | 0.00 | 14 | 120.38 | 650.08 | 5.40 |
| 11.5 | 240.77 | 0.00 | 0.00 | 0.00 | 25 | 240.77 | 1577.04 | 6.55 |
| 12.0 | 120.38 | 0.00 | 0.00 | 0.00 | 7 | 120.38 | 926.96 | 7.70 |
| 12.5 | 240.77 | 537.07 | 0.00 | 0.00 | 29 | 777.84 | 6156.03 | 7.91 |
| 13.0 | 120.38 | 2333.51 | 0.00 | 0.00 | 60 | 2453.89 | 21777.59 | 8.87 |
| 13.5 | 0.00 | 3406.16 | 0.00 | 0.00 | 76 | 3406.16 | 35992.16 | 10.57 |
| 14.0 | 0.00 | 5776.08 | 120.38 | 0.00 | 173 | 5896.46 | 71485.18 | 12.12 |
| 14.5 | 0.00 | 8837.80 | 120.38 | 0.00 | 299 | 8958.19 | 123979.88 | 13.84 |
| 15.0 | 0.00 | 14150.48 | 273.60 | 0.00 | 448 | 14424.08 | 223143.84 | 15.47 |
| 15.5 | 0.00 | 13634.97 | 533.18 | 0.00 | 386 | 14168.15 | 248511.01 | 17.54 |
| 16.0 | 0.00 | 12819.20 | 580.02 | 0.00 | 366 | 13399.23 | 272349.14 | 20.33 |
| 16.5 | 0.00 | 11740.04 | 959.31 | 0.00 | 283 | 12699.36 | 287744.64 | 22.66 |
| 17.0 | 0.00 | 7459.54 | 1659.04 | 0.00 | 201 | 9118.58 | 233781.66 | 25.64 |
| 17.5 | 0.00 | 4119.42 | 1625.53 | 16.41 | 120 | 5761.37 | 159264.21 | 27.64 |
| 18.0 | 0.00 | 1990.19 | 1251.05 | 16.41 | 67 | 3257.65 | 100154.88 | 30.74 |
| 18.5 | 0.00 | 612.85 | 300.94 | 0.00 | 24 | 913.80 | 29387.61 | 32.16 |
| 19.0 | 0.00 | 153.21 | 251.70 | 0.00 | 12 | 404.91 | 15451.63 | 38.16 |
| 19.5 | 0.00 | 0.00 | 16.41 | 0.00 | 1 | 16.41 | 788.87 | 48.06 |

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 | 0.96 | 87.57 | 7.69 | 0.03 | 96.26 |
| SSB | 6.63 | 1629.80 | 196.24 | 0.96 | 1833.63 |
| MeanW | 6.89 | 18.61 | 25.51 | 29.19 | 19.05 |
| MeanL | 11.81 | 15.57 | 17.00 | 17.75 | 15.65 |
| SSNp | 1.00 | 90.97 | 7.99 | 0.03 | 100.00 |
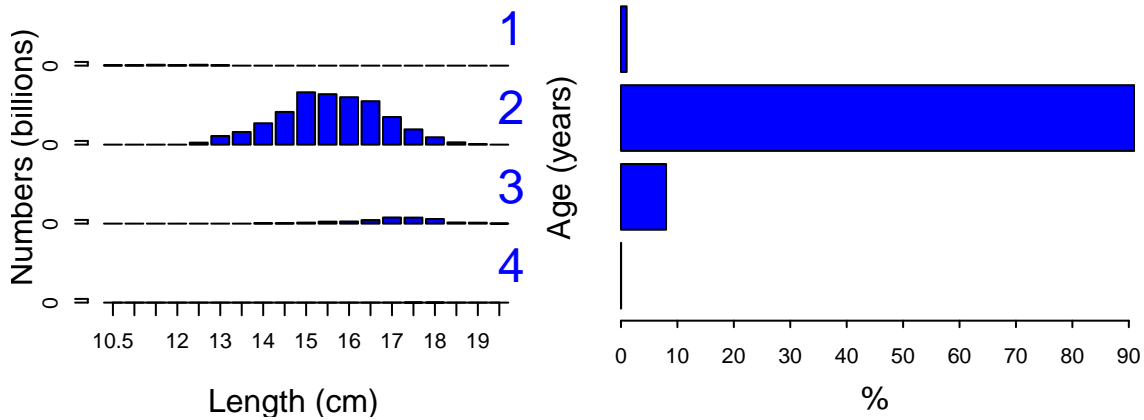
## Immature stock

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 survey in 6. - 24. September 2021. Mean weight is in grams

| length | a1 | a2 | a3 | a4 | num.sampled | numbers | biomass | weight.mean |
|---:|---:|---:|---:|---:|---:|---:|---:|---:|
| 9.0 | 278.40 | 0.00 | 0.00 | 0 | 4 | 278.40 | 680.20 | 2.44 |
| 9.5 | 1947.51 | 0.00 | 0.00 | 0 | 23 | 1947.51 | 5645.12 | 2.90 |
| 10.0 | 6402.20 | 0.00 | 0.00 | 0 | 57 | 6402.20 | 22127.16 | 3.46 |
| 10.5 | 14573.24 | 0.00 | 0.00 | 0 | 128 | 14573.24 | 59076.48 | 4.05 |
| 11.0 | 21783.63 | 0.00 | 0.00 | 0 | 208 | 21783.63 | 102341.91 | 4.70 |
| 11.5 | 19998.89 | 759.56 | 0.00 | 0 | 174 | 20758.44 | 114448.25 | 5.51 |
| 12.0 | 11300.63 | 1305.57 | 0.00 | 0 | 111 | 12606.20 | 80774.38 | 6.41 |
| 12.5 | 5620.89 | 2760.21 | 0.00 | 0 | 76 | 8381.10 | 61196.34 | 7.30 |
| 13.0 | 2538.10 | 4349.61 | 0.00 | 0 | 87 | 6887.71 | 60645.76 | 8.80 |
| 13.5 | 240.77 | 4547.05 | 0.00 | 0 | 102 | 4787.82 | 48935.71 | 10.22 |
| 14.0 | 148.15 | 6888.80 | 0.00 | 0 | 199 | 7036.94 | 81797.40 | 11.62 |
| 14.5 | 0.00 | 7728.30 | 18.82 | 0 | 309 | 7747.12 | 103197.95 | 13.32 |
| 15.0 | 0.00 | 7543.78 | 16.41 | 0 | 444 | 7560.19 | 114062.79 | 15.09 |
| 15.5 | 0.00 | 4536.05 | 158.02 | 0 | 383 | 4694.07 | 80168.21 | 17.08 |
| 16.0 | 0.00 | 3389.52 | 190.85 | 0 | 361 | 3580.37 | 66500.68 | 18.57 |
| 16.5 | 0.00 | 1373.26 | 37.63 | 0 | 232 | 1410.90 | 30501.76 | 21.62 |
| 17.0 | 0.00 | 560.24 | 212.06 | 0 | 135 | 772.31 | 19043.34 | 24.66 |
| 17.5 | 0.00 | 158.02 | 56.45 | 0 | 21 | 214.46 | 5635.51 | 26.28 |
| 18.0 | 0.00 | 18.82 | 72.86 | 0 | 24 | 91.68 | 2598.61 | 28.34 |
| 18.5 | 0.00 | 0.00 | 18.82 | 0 | 1 | 18.82 | 593.45 | 31.54 |

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 | 84.83 | 45.92 | 0.78 | 0 | 131.53 |
| ISB | 440.11 | 602.93 | 16.93 | 0 | 1059.97 |
| MeanW | 5.19 | 13.13 | 21.65 | 0 | 8.06 |
| MeanL | 11.22 | 14.34 | 16.49 | 0 | 12.34 |
| ISNp | 64.50 | 34.91 | 0.59 | 0 | 100.00 |