

# Preliminary cruise report: Acoustic assessment of the Iceland-East Greenland-Jan Mayen capelin stock in autumn 2020.

Birkir Bardarson, Sigurdur Thor Jonsson, Lars Heilmann and Teunis Jansen

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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 research vessel Arni Fridriksson from MFRI and the fishing vessel Eros, rented by GINR.

## Methods

### Survey area and conditions

The survey area was on and along the shelf edge off East Greenland from about 63°30'N towards about 73°20' N, also covering the Denmark Strait and the slope off west, north and east Iceland. The Iceland Sea, Kolbeinsey ridge and Greenland basin were also surveyed but with less transect density.

Eros departed from Helgúvík harbour on 7 September and sailed westwards over Irminger Sea to start surveying from the southwest end of the survey area. Eros followed preset transects covering the Greenlandic shelf areas until Tasilaq region. There, the plan was to survey Angmakssalik fjord towards Kungmiut but was aborted due to weather and ice conditions. Hence, Eros continued covering the East-Greenland shelf areas to northeast. The morning of 16 September Eros sailed to Helgúvík harbour for personnel change on 17 September. Eros was back on the research area on 18 September and surveyed, in collaboration with Arni, the preset transects in Denmark Strait until finishing his last transect early on 25 September and arriving to Helgúvík harbour on 26 September. Eros was held up for more than 2 days due to bad weather and also delayed by changing the order of transects in 3 cases to have better conditions to do hydrography and zooplankton transects.

Arni departed from Hafnarfjörður harbour on 14. September and sailed north of Iceland towards the shelf edge northeast off Langanes. From there Arni followed transects westwards covering the shelf edges north of Iceland towards Denmark Strait. Arni mainly covered the northeastern Denmark Strait in coordination with Eros which covered the remaining southeast Denmark Strait. Drift ice was distributed along the Greenlandic coast and extending into the northeast Denmark Strait. The ice hindered the coverage of Arni having to shorten transects of up to 30 nmi towards the Greenlandic coast. Then, Arni followed preset transects perpendicular to the East Greenlandic shelf edge until reaching the area east of Scoresby. There, a trial was made to launch acoustic probe (Simrad WBT-Tube) intended for estimation of acoustic properties of capelin, but the associated optical cable winch broke down and the operation was canceled. Also, the retrieval of a oceanographic mooring in the proximity of Scoresby for the Greenland Institute of Natural Resources (GINR) had to be aborted due to drift ice. In the region north of Scoresby drift ice obstructed the coverage severely and winds slowed the progress. Hence, Arni changed from the preset transects towards zik-zak strategy northeastwards along the ice edge. East of Kong Oscar Fjord, the vessel had to leave the shelf area due to heavy northern winds and seek calmer seas further east where the vessel managed to survey further northwards to 73°20'N and then return to the shelf areas off Kong Oscar Fjord as weather was getting calmer. From there Arni crossed the West Jan-Mayen Ridge and followed the Kolbeinsey Ridge southwards. In the end Arni scouted along the shelf edges east of Iceland and arrived to Hafnarfjörður harbour the 5 October.

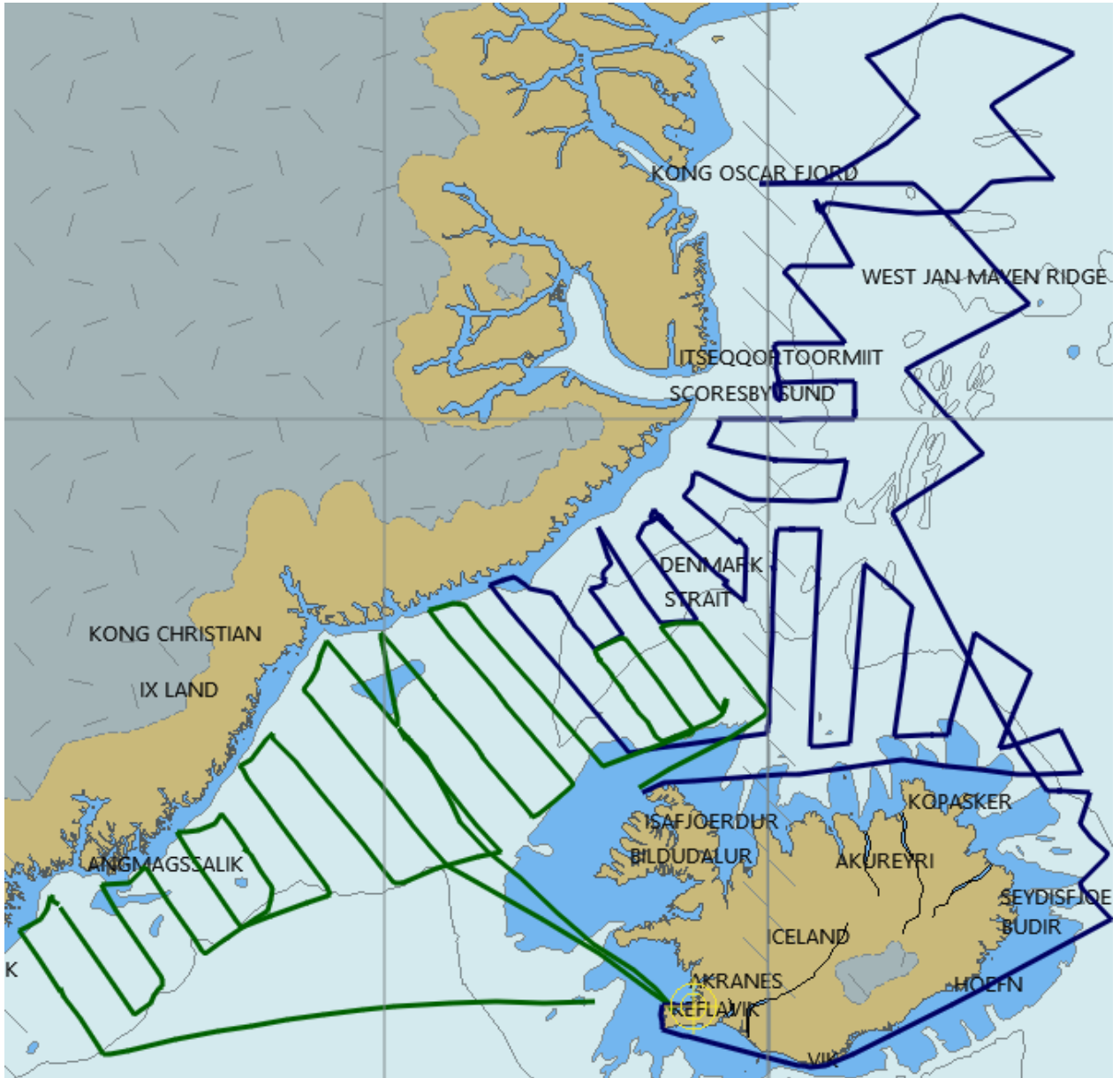


Figure 1: Tracks of the research vessels; Arni Fridriksson (blue) and Eros (green).

## Acoustic sampling

Acoustic data was sampled with Simrad EK60 transducer at five frequencies in Arni Fridriksson (18, 38, 70, 120 and 200 kHz) and five frequencies in Eros (18, 38, 70, 120 and 200 kHz). The 38 kHz data were scrutinized using LSSS (version 2.7.0) 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. EchoView live viewing was run simultaneously for an alternative view of the recordings. 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.

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

$$W_L = C_L * \overline{W_{sL}}$$

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 25 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 tissue samples were taken from 10 individuals at each station for isotope and genetics analysis. Onboard Arni, a fat content from up to 10 individuals at size of 15 cm or more was measured with fatmeter at every trawl station.

**WP2 zooplankton net:** Zooplankton was sampled by WP2 nets at depths down to 50 and 200 m at 60 stations at same location as CTD measurements

**Bongo nets:** Macro-zooplankton was sampled by Bongo nets at towdepths of the trawl at every second trawl station where capelin was caught and conditions allowed. Further Bongo samples were sampled diagonally down to 200 m at chosen transects and at targeted depths based on acoustic observations. In total 27 bongo samples were collected.

**eDNA:** Onboard Arni, eDNA samples were filtered from seawater at various depths at 29 locations to facilitate the development of methods for screening for capelin DNA in the seawater samples.

**Environmental measurements:** Conductivity, Temperature and depth (CTD) measurements were made at 68 locations and on Árni 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, but was absent in explorable areas north of Kong Oscar fjord. 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. 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. High abundances of immature capelin were found in the proximities of Angmagssalik fjord and Kangerdlugssuaq fjord. 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.

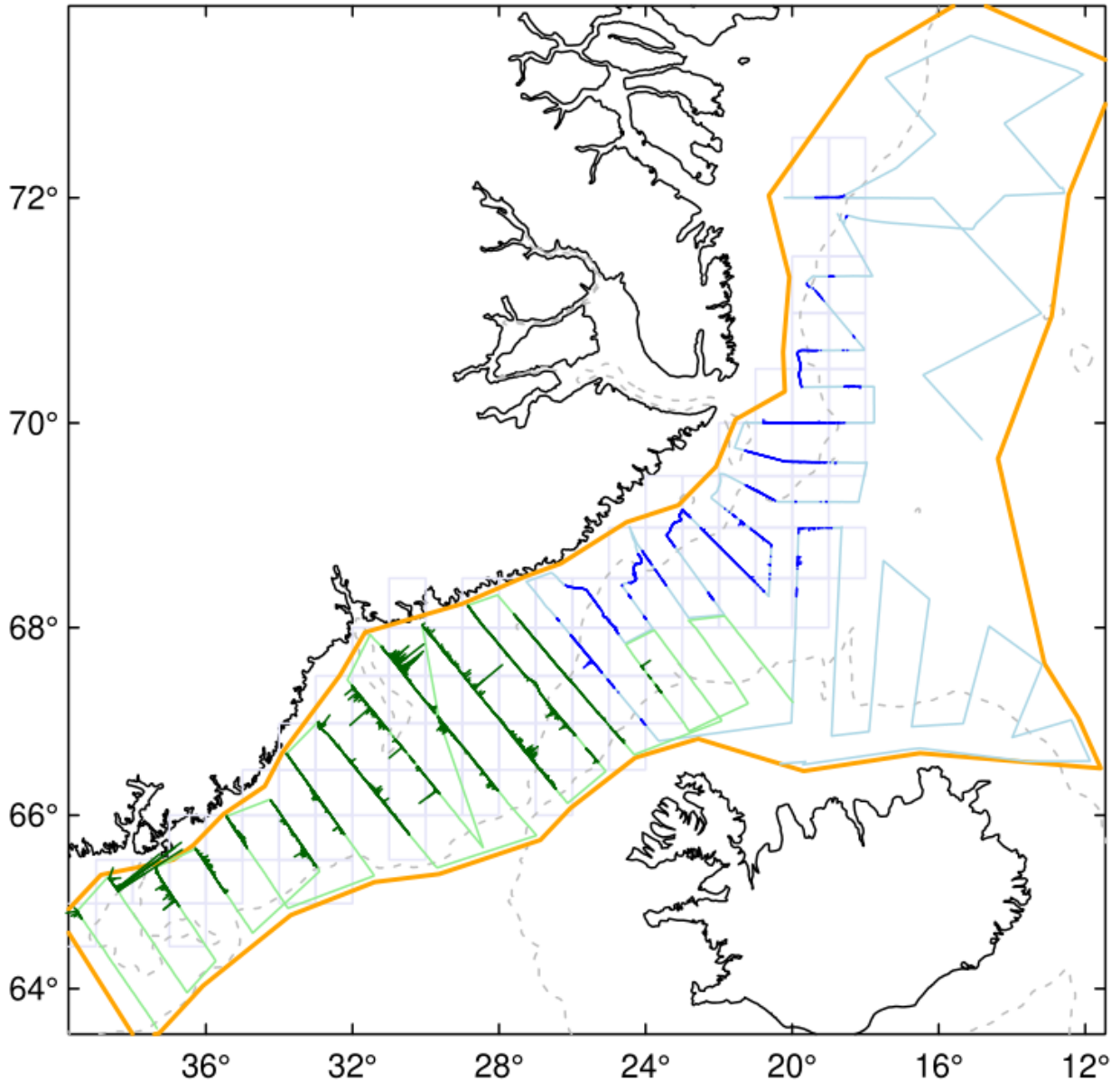


Figure 2: Capelin distribution as relative density of acoustic backscatter during the survey. Bars perpendicular to survey tracks show capelin acoustic backscatter as NASC per 0.1 nmi.

### Biomass and age composition of capelin

Age and length disaggregated biomass is shown in tables 1-6. The total number of capelin amounted to 162 billions whereof the 1-group was about 140.6 billions. The total estimate of 2 group capelin was about 20 billions. The total biomass estimate was 1078 000 tonnes of which about 406 000 tonnes were 2 years and older. About 0.6 % in numbers of the 1-group was estimated to be maturing to spawn, about 67.5 % of the 2 year old and 99.1 % of the 3 year old capelin appeared to be maturing. This gives about 344 000 tonnes of maturing 1 - 4 year old capelin. Tables 1-6 give the age disaggregate biomass, numbers and weights of the capelin stock components. High estimate of numbers immature is under further scrutiny with multi-frequency acoustic methods.

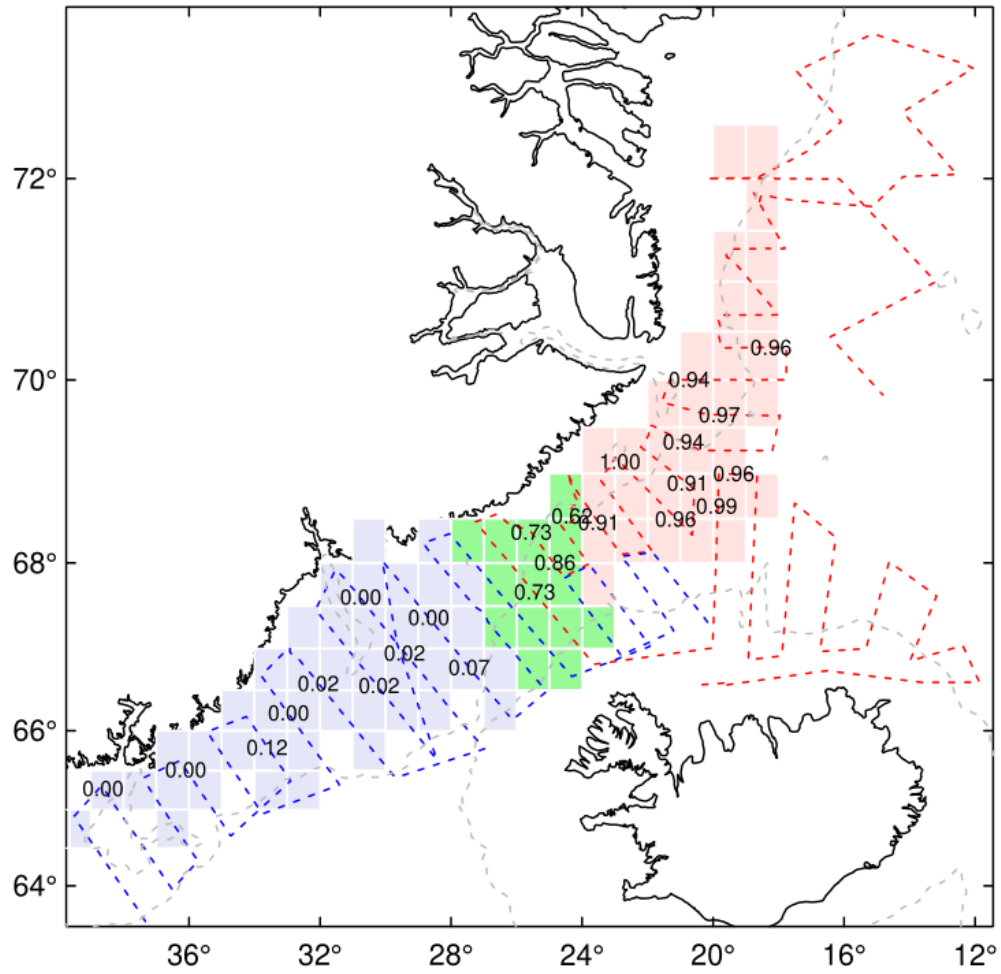


Figure 3: Maturity proportion at each trawl station.

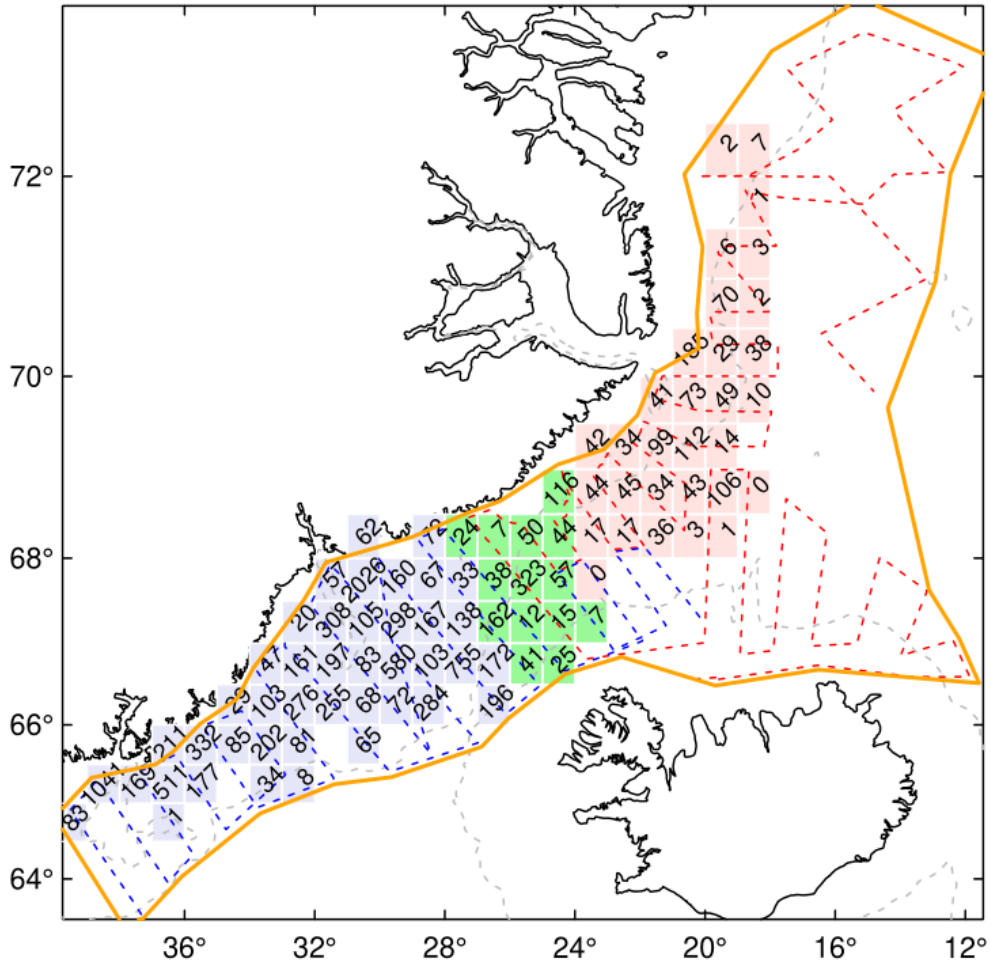


Figure 4: Average NASC within each rectangle.

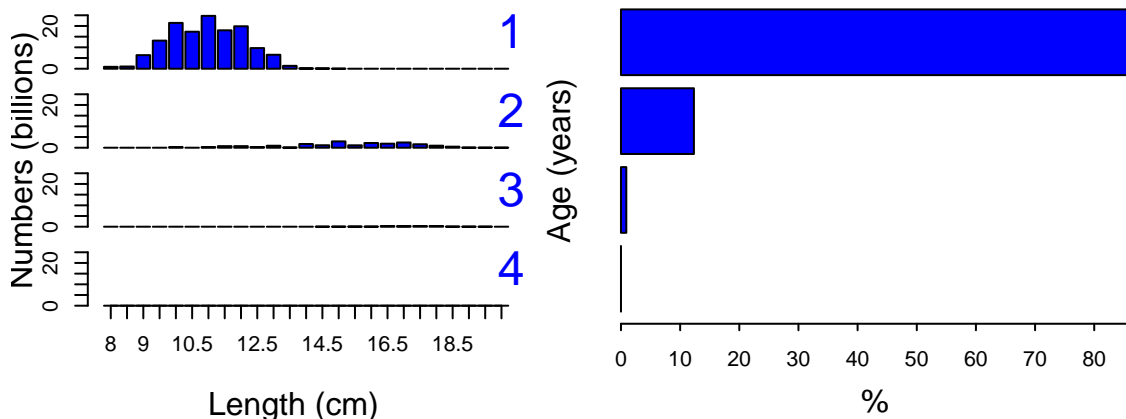
## Total stock

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 7. September – 5. October 2020. Mean weight is in grams

length	a1	a2	a3	a4	num.sampled	numbers	biomass	weight.mean
8.0	886.95	0.00	0.00	0	6	886.95	1493.03	1.68
8.5	1034.77	0.00	0.00	0	7	1034.77	1930.59	1.87
9.0	6356.45	0.00	0.00	0	43	6356.45	15206.70	2.39
9.5	13156.37	0.00	0.00	0	89	13156.37	36230.28	2.75
10.0	21434.54	295.65	0.00	0	147	21730.19	71691.88	3.30
10.5	17314.33	0.00	0.00	0	118	17314.33	67021.41	3.87
11.0	24724.43	295.65	0.00	0	171	25020.08	112589.89	4.50
11.5	17962.26	739.12	0.00	0	130	18701.38	97141.82	5.19
12.0	19849.42	739.12	0.00	0	148	20588.54	133841.13	6.50
12.5	9662.76	295.65	0.00	0	91	9958.41	75495.34	7.58
13.0	6527.54	924.70	0.00	0	72	7452.24	62638.80	8.41
13.5	1347.27	94.39	0.00	0	23	1441.66	14001.55	9.71
14.0	192.41	1728.46	0.00	0	36	1920.87	22526.20	11.73
14.5	147.82	1151.18	6.83	0	64	1305.84	18542.11	14.20
15.0	18.88	2954.37	25.71	0	115	2998.95	47257.75	15.76
15.5	0.00	1117.86	77.12	0	115	1194.98	21539.33	18.02
16.0	0.00	2209.64	47.80	0	191	2257.44	45079.92	19.97
16.5	0.00	1882.26	305.28	0	215	2187.54	50554.52	23.11
17.0	0.00	2445.45	267.53	0	227	2712.98	68105.01	25.10
17.5	0.00	1606.34	327.38	0	196	1933.71	54642.13	28.26
18.0	0.00	947.98	320.55	0	118	1268.53	38789.82	30.58
18.5	0.00	485.63	53.02	0	63	538.66	18340.30	34.05
19.0	0.00	47.80	20.49	0	10	68.29	2660.24	38.96
19.5	0.00	13.66	6.83	0	3	20.49	860.57	42.01
20.0	0.00	6.83	0.00	0	1	6.83	301.15	44.10

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	140.62	19.98	1.46	0	162.06
TSB	672.05	367.87	38.56	0	1078.48
MeanW	4.78	18.41	26.44	0	6.65
MeanL	10.95	15.34	17.16	0	11.55
TSNp	86.77	12.33	0.90	0	100.00



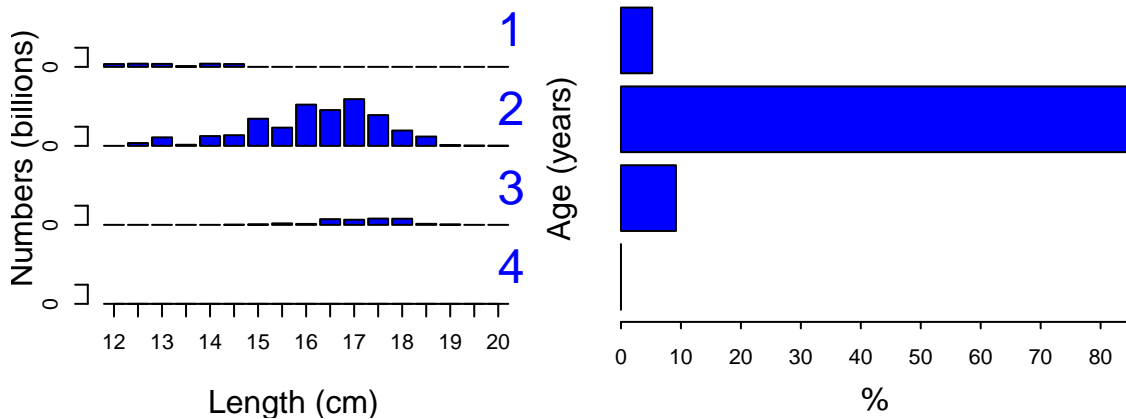
## Spawning stock

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 7. September – 5. October 2020. Mean weight is in grams

length	a1	a2	a3	a4	num.sampled	numbers	biomass	weight.mean
12.0	147.82	0.00	0.00	0	32	147.82	1056.94	7.15
12.5	166.70	147.82	0.00	0	44	314.53	2577.20	8.19
13.0	154.65	443.47	0.00	0	19	598.13	5015.90	8.39
13.5	37.76	56.63	0.00	0	12	94.39	1043.93	11.06
14.0	166.70	510.13	0.00	0	27	676.83	7943.26	11.74
14.5	147.82	557.10	6.83	0	62	711.76	10279.77	14.44
15.0	0.00	1416.69	25.71	0	108	1442.39	23717.92	16.44
15.5	0.00	949.96	77.12	0	115	1027.08	18647.70	18.16
16.0	0.00	2151.40	47.80	0	191	2199.20	43927.37	19.97
16.5	0.00	1868.60	298.45	0	215	2167.05	50121.16	23.13
17.0	0.00	2438.62	267.53	0	227	2706.15	67966.25	25.12
17.5	0.00	1606.34	327.38	0	196	1933.71	54642.13	28.26
18.0	0.00	800.15	320.55	0	117	1120.70	35499.25	31.68
18.5	0.00	485.63	53.02	0	63	538.66	18340.30	34.05
19.0	0.00	40.97	20.49	0	10	61.46	2417.55	39.34
19.5	0.00	13.66	0.00	0	2	13.66	577.72	42.30
20.0	0.00	6.83	0.00	0	1	6.83	301.15	44.10

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	0.82	13.49	1.44	0	15.76
SSB	8.23	297.33	38.51	0	344.08
MeanW	10.02	22.03	26.66	0	21.83
MeanL	13.21	16.23	17.15	0	16.15
SSNp	5.21	85.62	9.17	0	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 7. September – 5. October 2020. Mean weight is in grams

length	a1	a2	a3	a4	num.sampled	numbers	biomass	weight.mean
8.0	886.95	0.00	0.00	0	6	886.95	1493.03	1.68
8.5	1034.77	0.00	0.00	0	7	1034.77	1930.59	1.87
9.0	6356.45	0.00	0.00	0	43	6356.45	15206.70	2.39
9.5	13156.37	0.00	0.00	0	89	13156.37	36230.28	2.75
10.0	21434.54	295.65	0.00	0	147	21730.19	71691.88	3.30
10.5	17314.33	0.00	0.00	0	118	17314.33	67021.41	3.87
11.0	24724.43	295.65	0.00	0	171	25020.08	112589.89	4.50
11.5	17962.26	739.12	0.00	0	130	18701.38	97141.82	5.19
12.0	19701.60	739.12	0.00	0	148	20440.72	132784.19	6.50
12.5	9496.06	147.82	0.00	0	91	9643.88	72918.14	7.56
13.0	6372.89	481.23	0.00	0	71	6854.12	57622.90	8.41
13.5	1309.52	37.76	0.00	0	22	1347.27	12957.62	9.62
14.0	25.71	1199.45	0.00	0	33	1225.16	14368.11	11.73
14.5	0.00	594.08	0.00	0	62	594.08	8262.34	13.91
15.0	18.88	1537.68	0.00	0	99	1556.56	23539.83	15.12
15.5	0.00	167.90	0.00	0	97	167.90	2891.62	17.22
16.0	0.00	58.24	0.00	0	101	58.24	1152.55	19.79
16.5	0.00	13.66	6.83	0	81	20.49	433.36	21.15
17.0	0.00	6.83	0.00	0	40	6.83	138.76	20.32
18.0	0.00	147.82	0.00	0	1	147.82	3290.57	22.26
19.0	0.00	6.83	0.00	0	4	6.83	242.70	35.54
19.5	0.00	0.00	6.83	0	1	6.83	282.85	41.42

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	139.79	6.47	0.01	0	146.28
ISB	663.70	70.06	0.43	0	734.19
MeanW	4.75	10.83	31.29	0	5.02
MeanL	10.94	13.50	18.00	0	11.05
ISNp	95.57	4.42	0.01	0	100.00

