

12 Capelin in the Iceland-East Greenland-Jan Mayen area

12.1 Stock description and management units

See stock annex.

12.2 Fishery independent abundance surveys

The capelin stock in Iceland-East Greenland-Jan Mayen area has been assessed by acoustics annually since 1978. The surveys have been conducted in autumn (September–December) and in winter (January–February). An overview is given in the stock annex.

12.2.1 Autumn survey during September and October 2019

The survey was conducted with the aim of assessing both the immature and the maturing part of the stock. Since 2010, the autumn surveys have started in September, a month earlier than in previous years because of difficulties in covering the stock due to drift ice and weather during later months. The survey was conducted on the research vessels Arni Fridriksson (21 September – 21 October) and Eros (12 September – 1 October).

The survey area was on and along the shelf edge off East Greenland from about 63° 50' N towards about 75° 00' N, also covering the Denmark Strait and the slope off west and north Iceland. The Iceland Sea, Jan Mayen ridges and Greenland basin were also surveyed but with less transect density (Bardarson et al., 2019). Survey tracks are shown on Figure 12.2.1.

Eros departed from Helgúvík harbour on 12 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 Tasiilaq region. There, the Kuumiut fjord was surveyed. Then Eros continued covering the East-Greenland shelf areas to northeast but could not cover the shallower end of four transects southwest of Kangerlussuaq fjord. Eros had to depart the shelf areas the 19. September and sail to Helgúvík harbour due to bad weather and for personnel change. Eros was back on the research area on 22 September and continued measuring in rather difficult weather conditions and had to stop measuring during the night before 23 September. In continuance, Eros surveyed the preset transect through Denmark Strait mostly in good conditions until finishing his last transect on 30 September and arriving to Akureyri harbour on 1 October. Arni departed from Reykjavík harbour on 21 September and sailed north of the West-fjords peninsula starting first transect, just off Strandagrunn bank and crossing Denmark Strait. Then, continuing from the coverage of Eros, Arni surveyed to northeast out of Denmark Strait, covering northwards along the East-Greenland shelf and shelf edges. While in the Scoresby region Arni picked up a communication cable for whaletags from Constable Pynt airport. Arni followed preset transects until reaching the edge of drift ice at 73°30'N, and then sailing by zig-zag transects northeastwards along the ice edge until reaching 74°50'N. From there, Arni sailed south to survey roughly the Jan Mayen ridges and then Iceland sea from east to west until the coverage was finished just west of Kolbeinsey ridge. Arni measured in relatively good weather conditions the whole survey. Arni arrived to Reykjavík harbour on 21 October. Maturing capelin was mainly observed along the East Greenlandic continental shelf and shelf edges in Denmark Strait and the Scoresby areas. In Denmark Strait maturing capelin was mixed with immature

capelin, but mainly maturing capelin was found further north. No capelin was found by Jan Mayen ridges but in Iceland Sea small quantities of both maturing and immature capelin were found in the proximity of Kolbeinsey ridge. Considerable quantities of 0-group 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 near Inigsalik, west of Kuumiut fjord. The distribution of capelin was westerly as in recent years. Figure 12.2.2 shows the distribution and relative density of the capelin during the survey.

The total abundance of capelin was 91 billion, 83.3 billion of these were from the 1-group. The total estimate of 2 group capelin was about 7.2 billions. The total biomass estimate was 795 000 tonnes of which about 179 000 tonnes were 2 years and older. About 2.1 % in numbers of the 1-group was estimated to be maturing to spawn, about 84.4 % of the 2 year old and 99.1 % of the 3 year old capelin appeared to be maturing. This gives about 186 000 tonnes of maturing 1 - 4 year old capelin. Table 12.2.1 gives the age disaggregated biomass, numbers and weights of the capelin.

Tables 12.2.2 and 12.2.3 show the historic time series of abundance and mean weights by age and maturity in autumn. On the basis of the estimate of the maturing part of the stock the Marine and Freshwater Research Institute recommended no fishery (intermediate TAC of 0 tonnes) for the fishing season 2019/2020 (Anon, 2019). This recommendation was in accordance with existing HCR and management plan between Iceland, Norway and Greenland.

12.2.2 Surveys in winter 2020

Winter surveys were conducted in January–February resulting in 3 separate coverages of stock components. The main objective of the winter surveys was to assess the maturing part of the stock with coverages designed for acoustic stock assessment. This was a coordinated collaboration of several research and fishing vessels where each coverage was based on combined acoustic and trawl data from 3–6 vessels. Scientists from MFRI were on board each vessel performing acoustic stock estimates and all assessments were based on acoustic data from calibrated echosounders.

12.2.2.1 Winter surveys 1. Coverage in 13–25 January 2020

The acoustic measurements were conducted by R/V Arni Fridriksson and the fishing vessels Hakon and Polar Amaroq while the fishing vessels Bjarni Olafsson and Halldor Asgrimsson assisted by scouting peripheral areas. There were 3–6 scientist from the Marine and Freshwater Research Institute based on each vessel participating in acoustic measurements.

The survey area was on and along the shelf edge from north-west of Iceland to east of Iceland (Figure 12.2.3). The survey area was covered from east to west by all vessels. In the beginning, the echosounders of Arni Fridriksson and Hakon were calibrated in Nordfjordur, but Polar Amaroq had been calibrated in previous month. In spite of difficult weather conditions, the three vessels managed to cover the area from Hvalbakshalli southeast of Iceland towards Vikurall off Vestfjords, but sea ice hindered coverage considerably in Denmark Strait.

Only very limited quantities of mature capelin were observed east and northeast of Iceland. Mature capelin was mainly found in the region north of Strandagrunn bank about 30–60 nmi west of Kolbeinsey-ridge while scattered schools of mixed mature and immature capelin were in the proximity of the sea ice edge in Denmark Strait. Total SSB was estimated 65 000 tonnes but this estimate was not used in the final stock assessment, the combination of inclement weather and sea ice with possible late arrival of capelin to the survey area making the case for discounting this effort at assessing the stock.

12.2.2.2 Winter surveys 2. Coverage in 1.–9 February 2020

The acoustic measurements were conducted by R/V Arni Fridriksson and the fishing vessels Polar Amaroq and Adalsteinn Jonsson, while the fishing vessels Borkur and Margret assisted by scouting peripheral areas.

The survey area was on and along the shelf edge from north-west of Iceland to east of Iceland (Figure 12.2.4). Arni Fridriksson measured eastwards from Denmark Strait while the fishing vessels surveyed from the east to west. The vessels met and completed the coverage by Kolbeinsey ridge, where the coverage was adapted to improve the estimation of dense concentrations in that area.

Mature capelin was most abundant by the Reykjanes ridge while capelin was also found along the continental shelf edges northeast and northwest of Iceland. Total SSB was estimated 262 000 tonnes. This was the only estimate used in the final stock assessment, as this coverage was the most comprehensive.

12.2.2.3 Winter surveys 3. Coverage in 16.–22. February 2020

The acoustic measurements were conducted by R/V Arni Fridriksson and the fishing vessels Heimaey, Hakon, Adalsteinn Jonsson, Borkur and Polar Amaroq

The survey area was on and along the shelf edge from north-west of Iceland to east of Iceland, but with special emphasis on shallow areas north of Iceland and extra coverage in Dohrn Bank (Figure 12.2.4). This multi-vessel operation was aimed at a potential short weather window as predicted by weather forecast, but weather conditions turned out to be difficult for measurements during main part of this coverage. Overall, very limited quantities were observed during this coverage resulting in much less abundance estimates than in the preceding coverage few days earlier. Very limited quantities of capelin were observed in Dohrn Bank and Denmark Strait areas and in these areas immature capelin predominated along with scarce occurrences of mature capelin. Capelin was mainly observed in shallow areas in the proximity of Eyjafjörður but it can be very difficult to measure the migrating fish in such shallow waters. Further, heavy winds and waves are likely to have considerably reduced the quality of the acoustic measurements. SSB was estimated between 50 000 and 60 000 tonnes but this estimate was not used in the final stock assessment.

12.3 The fishery (fleet composition, behaviour and catch)

No initial catch quota was recommended for the 2019/2020 fishing season, and no summer or autumn fishery took place in 2019.

The intermediate TAC advice based on the autumn survey recommended no fisheries (TAC = 0 tonnes) and based on winter surveys in 2020 this advice was not changed. Hence, there were no fisheries in the 2019/2020 fishing season.

The total catches in numbers by age during the summer/autumn since 1985 are given in Table 12.3.2 and for the winter since 1986 in Table 12.3.3.

Initial and final TAC as well as landings for the fishing seasons since 1992/93 are given in Table 12.3.4 and total catch by season is shown in Figure 12.3.1.

12.4 Biological data

12.4.1 Growth

Seasonal growth pattern, with considerably increased growth rate during summer and autumn has been observed in this capelin stock in a study of the period 1979–1992. Where immature fish had slower growth during winter, the maturing fish had faster summer growth that continued throughout the winter until spawning in March/April, followed by almost 100% spawning mortality (Vilhjalmsson, 1994). Further examination of the growth of immature capelin at age 1 in autumn to mature at age 2 in autumn the year after in the period 1979–2013 showed on average almost 4 fold weight increase during one year (Gudmundsdottir and Sigurdsson, 2014). This considerable weight increase and seasonal pattern in growth the year before spawning should be taken into account when deciding the timing of the capelin fisheries.

Immature capelin has considerably low fat content, usually less than 3–4%. The fat content rises from approximately 5% in the summer to 20% in late autumn. In the fall and winter the fat content slowly declines, until the spawning migration begins in early January where the fat content drops drastically from about 15% to 5% in mid-April (Engilbertsson *et al.*, 2012).

12.5 Methods

The objective of the HCR for the stock is to leave at least 150 000 tonnes ($= B_{lim}$) for spawning (escapement strategy). The initial (preliminary), intermediate and final TACs are based on acoustic surveys.

- a) The initial TAC advice for the subsequent fishing season is issued by ICES around 1 December. It is based on the autumn survey abundance estimate of immature 1 and 2 year old capelin. Before 2017, this advice was issued later (May/June).
- b) The intermediate TAC advice is issued by MFRI in autumn based on the biomass estimate of maturing capelin.
- c) The final TAC advice is issued by MFRI in January/February based on the biomass estimate of maturing capelin.

The initial (preliminary) quota follows a simple forecast that is based on a linear relation between historic observations of the abundance of 1 and 2 year old juveniles from the acoustic autumn surveys and the corresponding final TACs nearly 1½ year later. This rule was applied by ICES NWWG (subgroup online video conferencing meeting in November 2018) to advice the initial quota for the fishing season 2019/20. Figure 12.8.1 shows the relation and the associated precautionary initial quota.

The intermediate and final TACs are set so that there is at least 95% probability that there will be at least 150 000 tonnes ($= B_{lim}$) of mature capelin left for spawning at the spawning time (15 March). This was done for the first time in 2015/2016 by the Icelandic Marine Research Institute and was not evaluated by ICES.

These methods were endorsed by the benchmark working group WKICE in 2015. See WKICE (ICES, 2015) and the Stock Annex for the capelin in the Iceland-East Greenland-Jan Mayen area.

Previously, (since early 1980s) the stock has been managed according to an escapement strategy, leaving 400 000 tonnes to spawning (uncertainty of the estimates were not considered). To predict the TAC for the next fishing season a model was developed in the early 1990s (Gudmundsdottir and Vilhjalmsson, 2002). These models were not endorsed by the benchmark working group WKSHORT 2009.

12.6 Reference points

During WKICE, a B_{lim} of 150 000 tonnes was defined (ICES, 2015). No other reference points are defined for this stock.

12.7 State of the stock

The spawning stock biomass (SSB) was estimated to 262 000 tonnes in January–February 2019. The predation model (ICES, 2015), accounting for catches (in this case 0 t) and predation between survey and spawning by cod, saithe and haddock, estimated that 157 000 tonnes were left for spawning in spring 2019 (Table 12.7.1). Given the uncertainty estimates, there was 95% probability that at least 72 000 tonnes was left for spawning. This was below B_{lim} within the sustainable HCR.

The acoustic estimate of immature capelin at age 1 and 2 from the autumn survey in September 2018 was 82.6 billion. The estimate is above long term average (Figure 12.7.1) and the initial advice according to the HCR is 169 520 tonnes in the fishing season 2020/21 (Figure 12.7.2).

12.8 Uncertainties in assessment and forecast

The uncertainty of the assessment and forecast depends largely on the quality of the acoustic surveys in terms of coverage, conditions for acoustic measurements and the aggregation (high patchiness leads to high variance) of the capelin.

The uncertainty is estimated by bootstrapping (see stock annex). The CV for the immature abundance was estimated to 0.43 in the 2019 autumn survey. The CV for the mature biomass was estimated to 0.31 in the 2019 autumn survey but in the winter survey (February 1–9.) used for the assessment in 2020 it was 0.19.

Effort and spatial coverage in the autumn survey 2019 give reason to believe that both the immature and mature components of the stock were successfully covered. The three winter survey coverages in January–February were made in difficult weather and/or sea ice conditions and hence only one of them was deemed usable for stock estimate. The final estimate was built on only one coverage, not allowing for repeated surveying with and against the migration direction. Although some components of the stock are likely to have been measured with the survey migration and others against it, there could be some bias due to migration direction.

12.9 Comparison with previous assessment and forecast

For the fishing season 2019/2020 no initial quota was advised and intermediate and final TAC was also set to 0 tonnes. This is the second fishing season in a row with zero catch advised as a final TAC, but before that it had not happened since fishing season 2008/2009.

12.10 Management plans and evaluations

See Section 12.5.

12.11 Management considerations

The fishing season for capelin has since 1975 started in the period from late June to July/August when surveys on the juvenile part of the stock the year before have resulted in the setting of an

initial (preliminary) catch quota. During summer, the availability of plankton is at its highest and the fishable stock of capelin is feeding very actively over large areas between Iceland, Greenland and Jan Mayen, increasing rapidly in length, weight and fat content. By late September/beginning of October this period of rapid growth is over. The growth is fastest the first two years, but the weight increase is highest in the year before spawning (Vilhjálmsón, 1994).

Given the large weight increase in the summer before spawning (Section 12.4) it is likely that there will be more biomass of maturing fish in autumn than in summer, even though the level of natural mortality is not well known during this time period. This should be considered for optimal timing of fishery in relation to yield and ecological impact. This is also supported by information for the Barents Sea capelin where it has been shown that fishing during autumn would maximize the yield, but from the ecosystem point of view a winter fishery were preferable (Gjøsæter *et.al.*, 2002). As the biology and role in the ecosystem of these two capelin stocks are similar, this is considered to be valid for the capelin in the Iceland-East Greenland-Jan Mayen area as well - until it is studied for this specific stock.

During the autumn surveys, juvenile and adult capelin is often found together. This should be considered during summer fishing because the survival rate of juvenile capelin that escapes through the trawl net is unknown.

12.12 Ecosystem considerations

Capelin is an important forage fish and its dynamics are expected to have implications on the productivity of their predators (see further in Section 7.3).

The importance of capelin in East Greenlandic waters is not well documented but effort has been increased considerably during autumn surveys towards evaluation of capelin role in the ecosystem e.g. by research on feeding of capelin, estimates of prey availability, predators distributions and environmental monitoring.

In Icelandic waters, capelin is the main single item in the diet of Icelandic cod, a key prey to several species of marine mammals and seabirds and also important as food for several other commercial fish species (see e.g. Vilhjálmsón, 2002).

12.13 Regulations and their effects

Over the years, the fishery has been closed during April–late June and the season has started in July/August or later, depending on the state of the stock.

Areas with high abundances of juvenile age 1 and 2 capelin (on the shelf region off NW-, N- and NE-Iceland) have usually been closed to the summer and autumn fishery.

It is permissible to transfer catches from the purse seine of one vessel to another vessel, in order to avoid slippage. However, if the catches are beyond the carrying capacity of the vessel and no other vessel is nearby, slippage is allowed. In recent years, reporting of such slippage has not been frequent. Industrial trawlers do not have the permission to slip capelin in order to harmonize catches to the processing.

In Icelandic waters, fishing with pelagic trawl is only allowed in limited area off the NE-coast (fishing in January) to protect juvenile capelin and to reduce the risk of affecting the spawning migration route (shuttering of migrating capelin schools by pelagic trawling has been hypothesized).

Taking precautionary measures to protect juvenile capelin, the coastal states (Iceland, Greenland and Norway) have agreed that from 2021 fishing shall not start until October 15.

12.14 Changes in fishing technology and fishing patterns

No fisheries took place this fishing season, but historically a variable amounts of the catches have been taken with pelagic trawl through the fishing seasons. Discards have been considered negligible.

12.15 Changes in the environment

Icelandic and East Greenlandic waters are characterized by highly variable hydrographical conditions, with temperatures and salinities depending on the strength of Atlantic inflow through the Denmark Strait and the variable flow of polar water from the north. Since 1996 the quarterly monitoring of environmental conditions of Icelandic waters shows a rise in sea temperatures north and east of Iceland, which probably also reaches farther north and northwest, as well as on the spawning grounds at South- and Southwest Iceland. It has been put forward that this temperature increase, may have led to a spatial shift in spawning and nursery areas (Vilhjálms-son, 2007). The acoustic surveys in autumn 2010, 2012–2019 confirmed this change in distribution of immatures and maturing capelin. Fisheries data suggests that the major part of the spawning still takes place on the usual grounds by the South and Southwest coasts of Iceland and possibly to increased extent by the North coast of Iceland.

A more detailed environmental description is in Section 7.3.

12.16 Recommendations

In coming years when experience of the new HCR will be gained it is recommended that assumptions and practical operation of the HCR will be evaluated. E.g. by refining the model for the initial TAC, reviewing the predation/prey relationships and how SSB estimates from autumn and winter surveys should be weighted when final TAC is calculated. NWWG therefore recommends that the assessment of this capelin stock goes through a benchmark workshop in near future. Further, it is recommended that the option to run this benchmark jointly with a benchmark workshop for the Barents Sea capelin stock will be examined.

Studies of optimal harvesting of capelin should be conducted. These estimates should take account of ecological impact, growth, mortality and gear selection in relation to the timing of the fishery.

Profound changes in the distribution, migration and productivity of this capelin stock, likely caused by environmental changes, urge the need for further biological studies i.e. regarding life history (including changes in spawning grounds, larval drift and migration at times not observed by autumn and winter surveys) and the role of capelin (predation/prey relationships) as a key species in the ecosystem.

The assessment and advice on the final TAC for capelin based on the autumn and winter surveys are issued directly to the Coastal States by the Icelandic Marine and Freshwater Research Institute. This process is not internationally peer reviewed prior to the release of the advice. Among the reasons for using this process is the need for fast advice once the survey result is available. The ICES ACOM procedure is more time consuming. NWWG has recommended that a fast track workflow based on online meetings is established if possible. The coastal states evaluated this recommendation in 2017 and concluded that a current regime for setting intermediate and final TAC should be maintained.

When planning acoustic surveys for capelin stock assessment, allocation of effort in terms of ship time, number of ships and manpower, should be sufficient for a likely full coverage in the first attempt given the demanding weather and ice conditions during autumn and winter surveys.

12.17 References

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12.18 Tables

Table 12.2.1 Capelin. Acoustic assessment of capelin in the Iceland/Greenland/Jan Mayen area, by r/v Arni Fridriksson and r/v Bjarni Saemundsson 6/9–9/10 2017 (Numbers in billions, biomass in tonnes).

Length (cm)	Numbers at Age (10 ⁹)				Numbers (10 ⁹)	Biomass (10 ³ t)	Mean weight (g)
	1	2	3	4			
8.5	0.01	0	0	0	0.01	0.02	2.18
9	0.12	0	0	0	0.12	0.25	2.17
9.5	1.04	0	0	0	1.04	3.08	2.96
10	2.74	0	0	0	2.74	9.65	3.53
10.5	4.78	0	0	0	4.78	20.13	4.21
11	8.33	0	0	0	8.33	41.95	5.03
11.5	13.6	0	0	0	13.6	81.77	6.01
12	16.12	0.03	0	0	16.15	111.54	6.91
12.5	17.14	0.14	0	0	17.28	138.37	8.01
13	8.56	0.03	0	0	8.59	78.34	9.12
13.5	4.57	0.01	0	0	4.58	49.06	10.7
14	3.84	0.24	0	0	4.08	49.65	12.17
14.5	1.38	0.17	0	0	1.55	21.61	13.94
15	0.78	0.62	0.01	0	1.41	22.67	16.12
15.5	0.21	0.9	0.02	0	1.13	20.3	17.97
16	0.03	1.04	0.05	0	1.12	22.99	20.52
16.5	0	1.22	0.04	0	1.26	28.71	22.78
17	0	1.01	0.15	0.01	1.16	29.05	25.01
17.5	0	0.91	0.19	0	1.11	30.84	27.9
18	0.03	0.69	0.08	0.01	0.8	25.44	31.8
18.5	0	0.18	0.06	0	0.25	8.45	34.25
19	0	0.02	0	0	0.02	0.92	37.32
19.5	0	0.01	0	0	0.01	0.4	41.68
0	0.00	0.00		0.00	0.00	0.00	0.0
0	0.00	0.00		0.00	0.00	0.00	0.0

	Length (cm)	Numbers at Age (10^9)				Numbers (10^9)	Biomass (10^3 t)	Mean weight (g)
		1	2	3	4			
TSN (10^9)		83.3	7.2	0.6	0.0	91.1		
TSB (10^3 t)		616.3	162.2	16.4	0.3		795.2	
Mean W (g)		7.4	22.5	27.0	28.4			8.7
Mean L (cm)	12.5	12.1	16.3	17.3	17.5			
%TSN		91.4	7.9	0.7	0.0			
SSN (10^9)		1.8	6.1	0.6	0.0	8.5		
SSB (10^3 t)		23.7	146.1	16.3	0.3		186.4	
SMean W (g)		13.4	24.0	27.1	28.4			22.0
SMean L (cm)	16.2	14.1	16.7	17.3	17.5			
%SSN		20.9	71.9	7.1	0.1			
ISN (10^9)		81.5	1.1	0.0		82.6		
ISB (10^3 t)		592.4	16.3	0.1			608.8	
IMean W (g)		7.3	14.5	15.7				7.4
IMean L (cm)	12.1	12.0	14.6	15.0				
%ISN		98.6	1.4	0.0				

Year	Mon	Day	Age1	Age1	Age2	Age2	Age3	Age3	Age4	Age5
			Imm.	Mat.	Imm.	Mat.	Imm.	Mat	Mat.	Mat.
2006	11	6	44.7		0.3	5.2		0.4		
2007	11	7	5.7		0.1	1.3		0.0		
2008	11	17	7.5	5.1	0.4	12.1		1.8		
2009	11	24	13.0	2.4		5.0		0.7		
2010	10	1	91.6	9.6	6.3	25.8	0.1	0.8	0.02	
2011	11	29	9.0	0.6	3.6	19.9	0.05	2.1		
2012	10	3	18.5	0.9	2.0	21.2	0.07	11.4	0.1	
2013	9	17	60.1	0.6	6.9	25.0	1.3	6.9	0.1	
2014	9	16	57.0	1.0	3.3	26.5	0.2	7.6	0.1	
2015	9	16	5.0	0.4	1.2	21.2		6.7		
2016	9	10	8.7	0.5	0.7	4.5	0.0	0.9	0.01	
2017	9	7	24.6	1.3	1.5	35.5	0.0	5.1	0.05	
2018	9	6	10.3	1.5	0.4	8.8	0.0	1.0		
2019	9	12	81.5	1.8	1.1	6.1		0.6	0.0	

1987 - The number at age 1 was from survey earlier in autumn.

2005 - Scouting vessels searched for capelin. r/s $\dot{A}F$ measured. No samples taken for age determination. Estimated to be < 50 000 tonnes.

2011 - Only limited coverage of the traditional capelin distribution area.

2001–2009 and 2016 – Not full coverage of stock.

Table 12.2.3. Icelandic Capelin. Mean weight (g) of age-classes measured in acoustic surveys in autumn. (imm = immature, mat = mature). See footnotes in Table 12.2.2.

Year	Mon.	Age1	Age1	Age2	Age2	Age3	Age3	Age4	Age5
		Imm.	Mat.	Imm.	Mat.	Imm.	Mat.	Mat.	Mat.
1978	10				19.8		25.4	26.3	
1979	10	6.2			15.7		23.0	20.8	
1980	10	7.3			19.4		26.7		
1981	11	3.6		12.3	19.4		22.5		
1982	10	3.8		8.5	16.5		24.1		
1983	10	5.1		9.5	16.8		22.5	23.0	
1984	11	2.9		8.3	15.8		25.7	23.2	
1985	10	3.8		8.5	15.5		23.8	29.5	31.0
1986	10	4.0		6.1	18.1		24.1	28.8	
1987	11	2.8		8.7	17.9		25.8		
1988	10	3.0		8.0	15.4		23.4	20.9	
1989	10	3.5		8.0	12.9		24.0		
1990	11	3.9		8.4	18.0		25.5	36.0	
1991	11	4.7		7.9	16.3		25.4		
1992	10	3.7		8.6	16.5		22.6	22.0	
1993	11	3.6		8.9	16.2		23.3		
1994	11	3.3		7.9	15.9		23.6		
1995	11	3.7		7.0	14.0		20.8		
1996	11	3.1		7.4	15.8		20.6		
1997	11	3.3		8.5	14.3		20.1		
1998	11	3.5		9.9	13.7		18.8		
1999	11	3.6		8.0	15.4		19.5		
2000	11	3.9		8.5	13.4	13.0	20.8		
2001	11	3.8		8.8	16.3	15.7	23.9		
2002	11								
2003	11	7.2		14.9	17.0	22.6	23.7		
2004	11	7.4		7.6	16.0		18.0	14.5	
2005									
2006	11	3.7		7.9	15.0		16.7		
2007	11	5.5		8.6	14.9		15.8		
2008	11	6.2	11.0	6.9	18.6		22.4		
2009	11	5.1	9.8		20.0		23.8		
2010	10	5.8	12.9	12.2	19.0	12.9	24.0	21.2	
2011	11	6.8	11.4	11.1	18.7	15.8	24.4		
2012	10	6.5	16.0	15.3	22.0	22.4	28.0	26.6	
2013	9	5.8	12.6	10.9	18.0	11.2	20.9	23.6	

Year	Mon.	Age1	Age1	Age2	Age2	Age3	Age3	Age4	Age5
		Imm.	Mat.	Imm.	Mat.	Imm.	Mat.	Mat.	Mat.
2014	9	4.2	9.9	12.7	18.3	16.6	21.2	25.0	
2015	9	8.5	12.3	13.4	18.4	21.5	23.1		
2016	9	9.0	15.1	13.1	25.5	11.5	31.7	39.2	
2017	9	8.0	12.6	15.0	22.2	22.3	27.2	33.2	
2018	9	8.8	12.9	16.5	21.7	21.2	27.1		
2019	9	7.3	13.4	14.5	24.0	15.7	27.1	28.4	

Table 12.2.4. Icelandic Capelin. Assessment of mature capelin in the Iceland/East Greenland/Jan Mayen area in winter (January–February) 2020 (Numbers in billions, biomass in thousand tonnes). Based on 2nd coverage of winter surveys.

	Length	Numbers at Age (10 ⁹)					Numbers	Biomass	Mean
	(cm)	2	3	4	5	(10 ⁹)	(10 ³ t)	weight (g)	
	10	0.01	0	0	0	0.01	0.02	3	
	10.5	0.03	0	0	0	0.03	0.09	3.2	
	11	0.08	0	0	0	0.08	0.37	4.3	
	11.5	0.14	0	0	0	0.14	0.77	5.3	
	12	0.29	0	0	0	0.29	1.78	6.1	
	12.5	0.35	0	0	0	0.35	2.48	7	
	13	0.46	0.01	0	0	0.47	3.77	8	
	13.5	0.66	0.01	0	0	0.66	6.3	9.5	
	14	0.93	0.04	0	0	0.97	10.68	11.1	
	14.5	1.05	0.11	0	0	1.17	14.67	12.6	
	15	0.76	0.17	0	0	0.93	13.22	14.2	
	15.5	0.59	0.5	0.01	0	1.1	17.93	16.4	
	16	0.36	0.82	0.01	0	1.2	22.26	18.6	
	16.5	0.25	1.56	0.07	0	1.88	39.23	20.9	
	17	0.1	1.55	0.15	0	1.8	42.15	23.4	
	17.5	0.01	1.27	0.18	0	1.45	37.45	25.7	
	18	0.01	1.05	0.27	0	1.33	38.54	29	
	18.5	0	0.77	0.19	0	0.96	30.93	32.2	
	19	0	0.15	0.03	0.01	0.19	6.47	34.4	
	19.5	0	0.04	0.01	0	0.05	1.91	38.8	
TSN (10⁹)						15.06			
TSB (10³ t)		6.08	8.04	0.93	0.01				
		74.04	191.04	25.69	0.24		291.01		
Mean W (g)								19.33	
		12.18	23.76	27.63	34.36				
Mean L (cm)	15.92								
		14.2	17.01	17.75	19				
%TSN		40.39	53.39	6.18	0.05				

	Length	Numbers at Age (10 ⁹)				Numbers	Biomass	Mean
	(cm)	2	3	4	5	(10 ⁹)	(10 ³ t)	weight (g)
SSN (10⁹)		3.14	7.9	0.92	0.01	11.97		
SSB (10³ t)		47.43	189.37	25.51	0.24		262.55	
SMean W (g)		15.12	23.97	27.63	34.36			21.94
SMean L (cm)	16.57	15.03	17.05	17.75	19			
%SSN		26.2	66.02	7.72	0.06			
ISN (10⁹)		2.94	0.14	0.01		3.09		
ISB (10³ t)		26.51	1.78	0.17			28.46	
IMean W (g)		9	12.81	26.6				9.21
IMean L (cm)	13.4	13.32	14.86	18				
%ISN		95.3	4.49	0.21				

Table 12.3.1 Capelin. The international catch since 1964 (thousand tonnes).

Year	Winter Season					Summer and autumn season						
	Iceland	Norway	Faroes	Greenland	Season total	Iceland	Norway	Faroes	Greenland	EU	Season total	Total
1964	8.6	-	-		8.6	-	-	-		-	-	8.6
1965	49.7	-	-		49.7	-	-	-		-	-	49.7
1966	124.5	-	-		124.5	-	-	-		-	-	124.5
1967	97.2	-	-		97.2	-	-	-		-	-	97.2
1968	78.1	-	-		78.1	-	-	-		-	-	78.1
1969	170.6	-	-		170.6	-	-	-		-	-	170.6
1970	190.8	-	-		190.8	-	-	-		-	-	190.8
1971	182.9	-	-		182.9	-	-	-		-	-	182.9
1972	276.5	-	-		276.5		-	-		-	-	276.5
1973	440.9	-	-		440.9	-	-	-		-	-	440.9
1974	461.9	-	-		461.9	-	-	-		-	-	461.9
1975	457.1	-	-		457.1	3.1	-	-		-	3.1	460.2
1976	338.7	-	-		338.7	114.4	-	-		-	114.4	453.1
1977	549.2	-	24.3		573.5	259.7	-	-		-	259.7	833.2
1978	468.4	-	36.2		504.6	497.5	154.1	3.4		-	655	1,159.60

Year	Winter Season					Summer and autumn season						
	Iceland	Norway	Faroes	Greenland	Season total	Iceland	Norway	Faroes	Greenland	EU	Season total	Total
1979	521.7	-	18.2		539.9	442	124	22		-	588	1,127.90
1980	392.1	-	-		392.1	367.4	118.7	24.2		17.3	527.6	919.7
1981	156	-	-		156	484.6	91.4	16.2		20.8	613	769
1982	13.2	-	-		13.2	-	-	-		-	-	13.2
1983	-	-	-		-	133.4	-	-		-	133.4	133.4
1984	439.6	-	-		439.6	425.2	104.6	10.2		8.5	548.5	988.1
1985	348.5	-	-		348.5	644.8	193	65.9		16	919.7	1,268.20
1986	341.8	50	-		391.8	552.5	149.7	65.4		5.3	772.9	1,164.70
1987	500.6	59.9	-		560.5	311.3	82.1	65.2		-	458.6	1,019.10
1988	600.6	56.6	-		657.2	311.4	11.5	48.5		-	371.4	1,028.60
1989	609.1	56	-		665.1	53.9	52.7	14.4		-	121	786,1
1990	612	62.5	12.3		686.8	83.7	21.9	5.6		-	111.2	798
1991	202.4	-	-		202.4	56	-	-		-	56	258.4
1992	573.5	47.6	-		621.1	213.4	65.3	18.9	0.5	-	298.1	919.2
1993	489.1	-	-	0.5	489.6	450	127.5	23.9	10.2	-	611.6	1,101.20
1994	550.3	15	-	1.8	567.1	210.7	99	12.3	2.1	-	324.1	891.2

Year	Winter Season					Summer and autumn season						
	Iceland	Norway	Faroes	Greenland	Season total	Iceland	Norway	Faroes	Greenland	EU	Season total	Total
1995	539.4	-	-	0.4	539.8	175.5	28	-	2.2	-	205.7	745.5
1996	707.9	-	10	5.7	723.6	474.3	206	17.6	15	60.9	773.8	1,497.40
1997	774.9	-	16.1	6.1	797.1	536	153.6	20.5	6.5	47.1	763.6	1,561.50
1998	457	-	14.7	9.6	481.3	290.8	72.9	26.9	8	41.9	440.5	921.8
1999	607.8	14.8	13.8	22.5	658.9	83	11.4	6	2	-	102.4	761.3
2000	761.4	14.9	32	22	830.3	126.5	80.1	30	7.5	21	265.1	1,095.40
2001	767.2	-	10	29	806.2	150	106	12	9	17	294	1,061.20
2002	901	-	28	26	955	180	118.7	-	13	28	339.7	1,294.70
2003	585	-	40	23	648	96.5	78	3.5	2.5	18	198.5	846.5
2004	478.8	15.8	30.8	17.5	542.9	46	34	-	12		92	634.9
2005	594.1	69	19	10	692	9	-	-	-	-	9	701.1
2006	193	8	30	7	238	-	-	-	-		-	238
2007	307	38	19	12.8	376.8	-	-	-	-	-	-	376.8
2008	149	37.6	10.1	6.7	203.4	-	-	-	-	-	-	203.4
2009	15.1	-	-	-	15.1	-	-	-	-	-	-	15.1
2010	110.6	28.3	7.7	4.7	150.7	5.4	-	-	-	-	5.4	156.1

Year	Winter Season					Summer and autumn season						
	Iceland	Norway	Faroes	Greenland	Season total	Iceland	Norway	Faroes	Greenland	EU	Season total	Total
2011	321.8	30.8	19.5	13.1	385.2	8.4	58.5	-	5.2	-	72.1	457.3
2012	576.2	46.2	29.7	22.3	674.4	9	-	-	1	-	10	684.4
2013	454	40	30	17	541	-	-	-	-	-	-	541
2014	111.4	6.2	8	16.1	141.7	-	30.5	-	5.3	9.7	45.5	187.2
2015	353.6	50.6	29.9	37.9	471.9	-	-	-	2.5	-	2.5	474.4
2016	101.1	58.2	8.5	3.3	171.1	-	-	-	-	-	-	171.1
2017	196.8	60.4	15	27.4	299.8	-	-	-	-	-	-	299.8
2018	186.3	74.5	14.3	11.4	286.5	-	-	-	-	-	-	286.5
2019*	-	-	-	-	-	-	-	-	-	-	-	-
2020	-	-	-	-	-							

* Preliminary, provided by working group members.

Table 12.3.2 Icelandic capelin. The total international catch of capelin in the Iceland-East Greenland-Jan Mayen area by age group in numbers (billions) and the total catch by numbers and weight (thousand tonnes) in the autumn season (August–December) since 1985.

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Total number	Total weight
1985	0.8	25.6	15.4	0.2		42.0	919.7
1986	+	10.0	23.3	0.5		33.8	772.9
1987	+	27.7	6.7	+		34.4	458.6
1988	0.3	13.6	5.4	+		19.3	371.4
1989	1.7	6.0	1.5	+		9.2	121.0
1990	0.8	5.9	1.0	+		7.7	111.2
1991	0.3	2.7	0.4	+		3.4	56.0
1992	1.7	14.0	2.1	+		17.8	298.1
1993	0.2	24.9	5.4	0.2		30.7	611.6
1994	0.6	15.0	2.8	+		18.4	324.1
1995	1.5	9.7	1.1	+		12.3	205.7
1996	0.2	25.2	12.7	0.2		38.4	773.7
1997	1.8	33.4	10.2	0.4		45.8	763.6
1998	0.9	25.1	2.9	+		28.9	440.5
1999	0.3	4.7	0.7	+		5.7	102.4
2000	0.2	12.9	3.3	0.1		16.5	265.1
2001	+	17.6	1.2	+		18.8	294.0
2002	+	18.3	2.5	+		20.8	339.7
2003	0.3	11.8	1	+		14.3	199.5
2004	+	5.3	0.5	-		5.8	92.0
2005	-	0.4	+	-		0.4	9.0
2006	-	-	-	-		-	-
2007	-	-	-	-		-	-
2008	-	-	-	-		-	-
2009	-	-	-	-		-	-
2010	0.01	0.23	0.02	-		0.25	5.4
2011	-	2.45	1.61	-	0.08	4.13	72.1

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Total number	Total weight
2012	-	0.2	0.2	-	-	0.4	10.4
2013	-	-	-	-	-	-	-
2014	0.01	2.22	0.6	0.02	-	2.8	45.5
2015	0.03	0.08	0.03			1.4	2.5
2016	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-
2018	-	-	-	-	-	-	-
2019	-	-	-	-	-	-	-

Table 12.3.3 Icelandic capelin. The total international catch of capelin in the Iceland-East Greenland-Jan Mayen area by age group in numbers (billions) and the total catch by numbers and weight (thousand tonnes) in the winter season (January–March) since 1986.

Year	age 1	age 2	age 3	age 4	age 5	Total number	Total weight
1986		0.1	9.8	6.9	0.2	17.0	391.8
1987		+	6.9	15.5	-	22.4	560.5
1988		+	23.4	7.2	0.3	30.9	657.2
1989		0.1	22.9	7.8	+	30.8	665.1
1990		1.4	24.8	9.6	0.1	35.9	686.8
1991		0.5	7.4	1.5	+	9.4	202.4
1992		2.7	29.4	2.8	+	34.9	621.1
1993		0.2	20.1	2.5	+	22.8	489.6
1994		0.6	22.7	3.9	+	27.2	567.1
1995		1.3	17.6	5.9	+	24.8	539.8
1996		0.6	27.4	7.7	+	35.7	723.6
1997		0.9	29.1	11	+	41.0	797.6
1998		0.3	20.4	5.4	+	26.1	481.3
1999		0.5	31.2	7.5	+	39.2	658.9
2000		0.3	36.3	5.4	+	42.0	830.3
2001		0.4	27.9	6.7	+	35.0	787.2
2002		0.1	33.1	4.2	+	37.4	955.0
2003		0.1	32.2	1.9	+	34.4	648.0

Year	age 1	age 2	age 3	age 4	age 5	Total number	Total weight
2004		0.6	24.6	3	+	28.3	542.9
2005		0.1	31.5	3.1	-	34.7	692.0
2006		0.1	10.4	0.3	-	10.8	230.0
2007		0.3	19.5	0.5	-	20.3	376.8
2008		0.5	10.6	0.4	-	11.5	202.4
2009		0.1	0.6	0.1	-	0.7	15.1
2010		0.7	5.3	0.9	0.01	6.9	150.7
2011		0.1	16.2	0.6	-	17.0	385.2
2012	0.02	0.6	25.0	6.1	0.02	31.8	674.4
2013	-	0.3	12.1	9.7	0.2	22.3	541.0
2014	-	0.1	4.8	1.3	+	6.1	141.8
2015	-	0.3	17.5	4.7	0.1	22.7	471.9
2016		0.4	5.5	2.0	0.02	8.0	171.1
2017		0.4	5.4	4.1	0.1	10.0	299.8
2018		0.6	10.4	0.9	0.01	11.91	286.5
2019	-	-	-	-	-	0	0
2020	-	-	-	-	-	-	-

Table 12.3.4. Initial quota and final TAC and landings by seasons.

Fishing season	Initial advice	Final TAC	Landings
1992/93 ¹	500	900	788
1993/94 ¹	900	1250	1179
1994/95	950	850	842
1995/96 ¹	800	1390	930
1996/97 ¹	1100	1600	1571
1997/98	850	1265	1245
1998/99	950	1200	1100
1999/00	866	1000	934
2000/01	650	1090	1065
2001/02	700	1300	1249
2002/03	690	1000	988
2003/04 ²	555	900	741
2004/05 ³	335	985	783
2005/06	No fishery	235	238
2006/07	No fishery	385	377
2007/08	207	207	202
2008/09 ⁴	No fishery		15
2009/10	No fishery	150	151
2010/11	No fishery	390	391
2011/12	366	765	747
2012/13	No fishery	570	551
2013/14 ¹	No fishery	160	142
2014/15	225 ⁵	580	517
2015/16	No fishery ⁵	173	174
2016/17 ⁶	No fishery ⁵	299	300
2017/18 ⁶	No fishery ⁵	285	287
2018/19	No fishery ⁵	0	0
2019/20	No fishery	0	0

1) The final TAC was set on basis of autumn surveys in the season.

2) Indices from April 2003 were projected back to October 2002.

3) The initial quota was set on a basis of an acoustic survey in June/July 2004

4) No fishery was allowed, 15 000 t was assigned to scouting vessels.

5) Initial advice based on low probability of exceeding final TAC.

6) Preliminary landings.

Table 12.7.1 Icelandic capelin in the Iceland-East Greenland-Jan Mayen area since the fishing season 1978/79. (A fishing season e.g. 1978/79 starts in summer 1978 and ends in March 1979). Recruitment of 1 year old fish (unit 10⁹) as measured in autumn survey. Spawning stock biomass ('000 t) is given at the time of spawning at the end of the fishing season. Landings ('000 t) are sum of total landings in the season.

Season (Summer/winter)	Recruitment	Landings	Spawning stock biomass
1978/79	-	1195	600
1979/80	22	980	300
1980/81	23.5	684	170
1981/82	21	626	140
1982/83	68	0	260
1983/84	44.1	573	440
1984/85	73.8	896	460
1985/86	33.8	1312	460
1986/87	58.6	1334	420
1987/88	2.6	1116	400
1988/89	43.9	1036	440
1989/90	29.2	807	115
1990/91	27.2	313	330
1991/92	60	677	475
1992/93	104.6	788	499
1993/94	100.4	1178	460
1994/95	119	864	420
1995/96	165	930	830
1996/97	111.9	1570	430
1997/98	66.8	1246	492
1998/99	121	1100	500
1999/00	89.8	932	650
2000/01	103.7	1071	450
2001/02	101.8	1249	475
2002/03	-	988	410
2003/04	4.9	742	535
2004/05	7.9	784	602
2005/06	-	247	400
2006/07	44.7	377	410
2007/08	5.7	203	406
2008/09	12.6	150	328
2009/10	15.4	151	410
2010/11	101.2	391	411
2011/12	9.6	747	418
2012/13	19.4	551	417
2013/14	60.7	142	424

Season (Summer/winter)	Recruitment	Landings	Spawning stock biomass
2014/15	58	518	460
2015/16	5.4	174	304*
2016/17	9.4	300	361*
2017/18	25.9	287	352*
2018/19	10.3	0	127*
2019/20	81.5	0	157

* Based on predation model in current HCR.

12.19 Figures

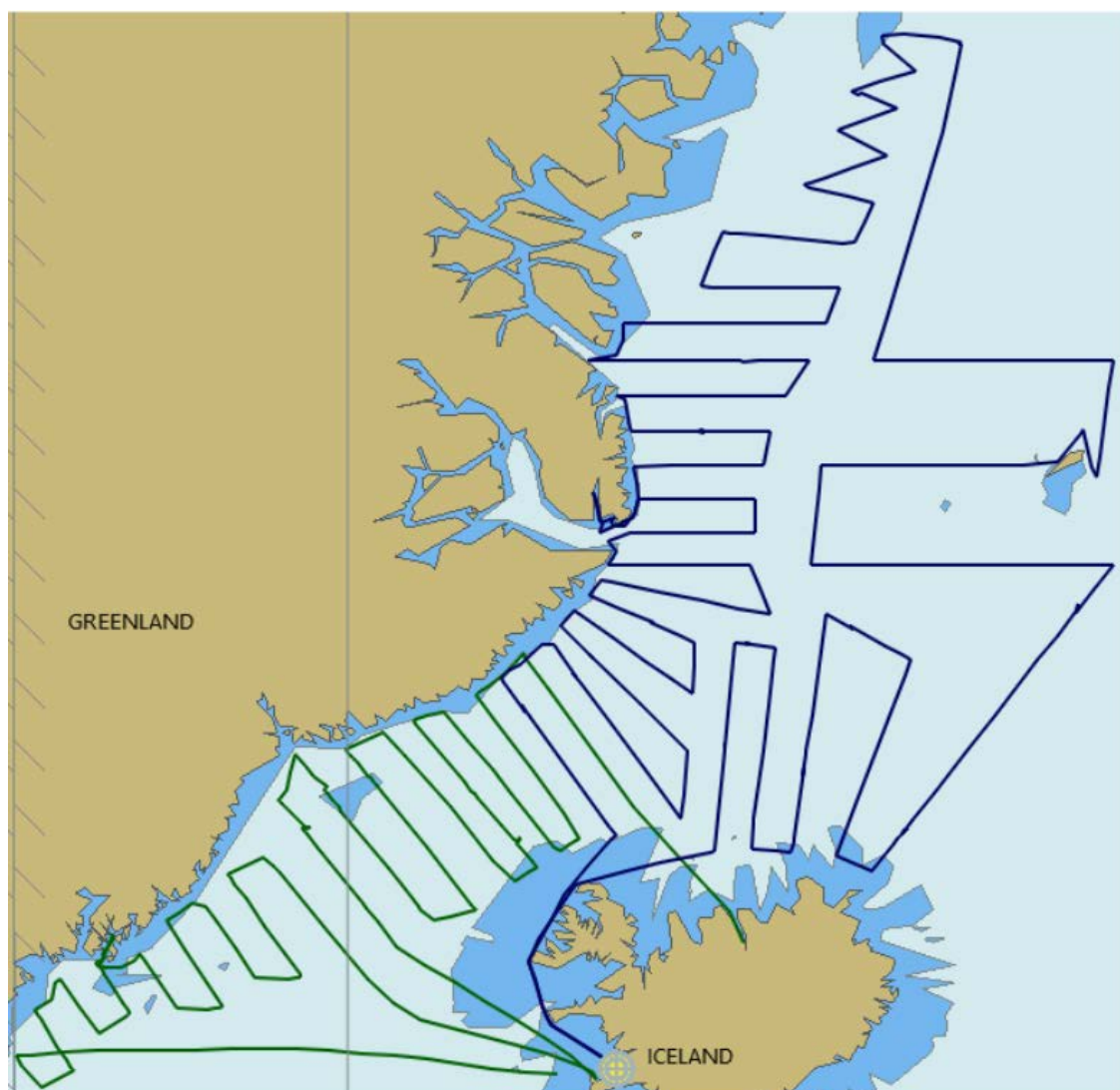


Figure 12.2.1. Icelandic capelin. Cruise tracks during an acoustic survey by r/v Arni Fridriksson (blue) and Eros (GREEN) during 12 September – 21 October 2019.

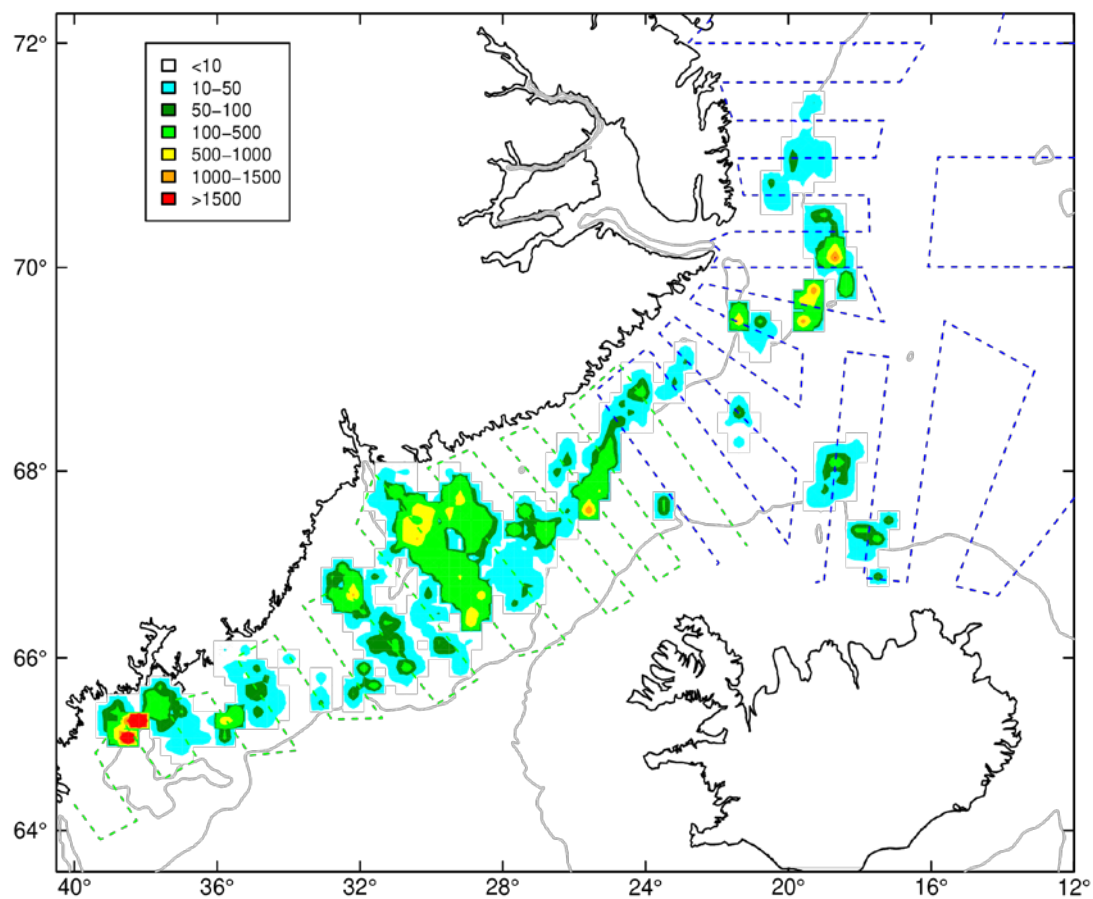


Figure 12.2.2. Icelandic capelin. Relative density and distribution of capelin during an acoustic survey by r/v Arni Fridriksson Eros during 12 September – 21 October 2019.

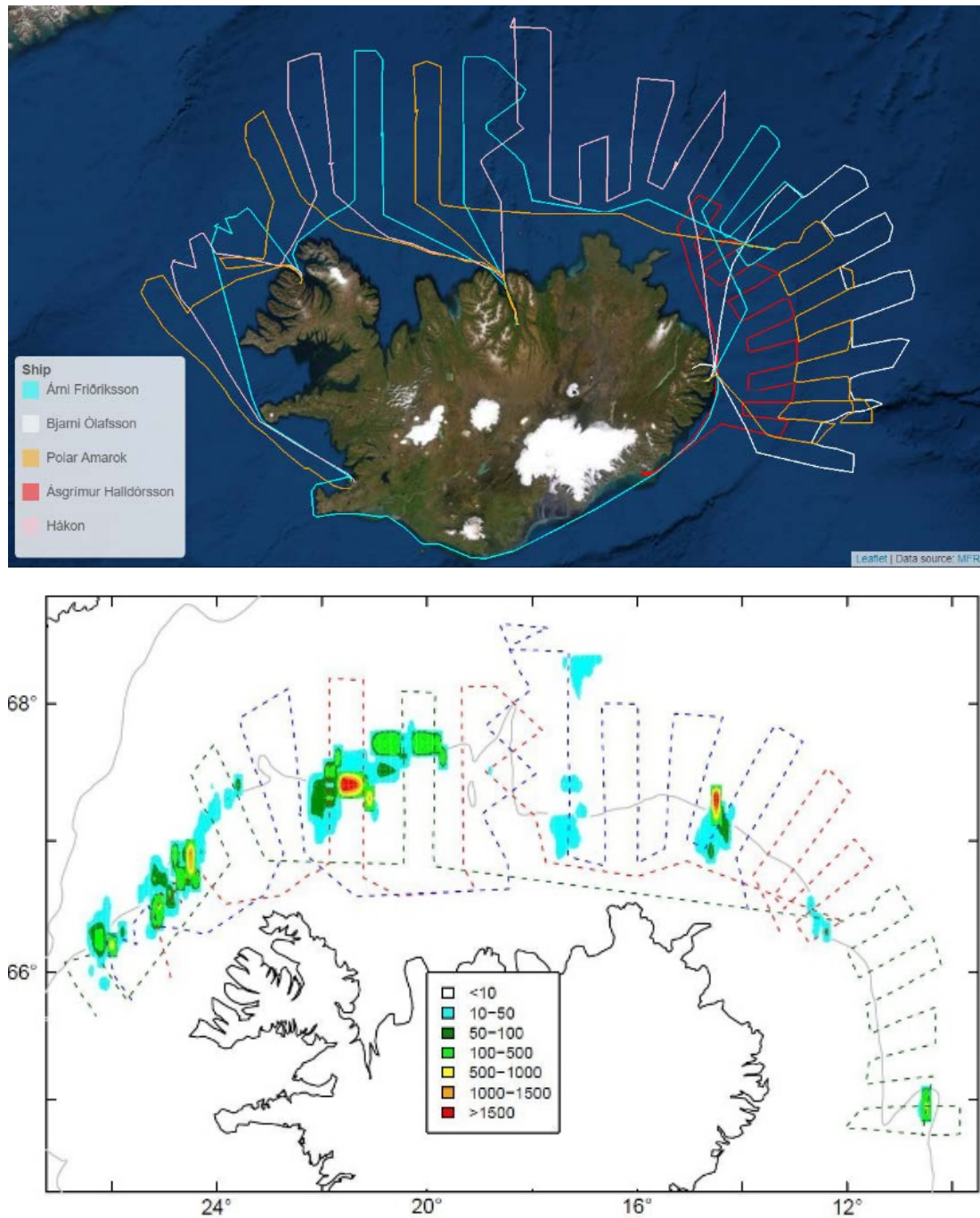


Figure 12.2.3. Icelandic capelin. Survey tracks (A) of the participating vessels during 13-25 January 2020 and distribution (B) of capelin.

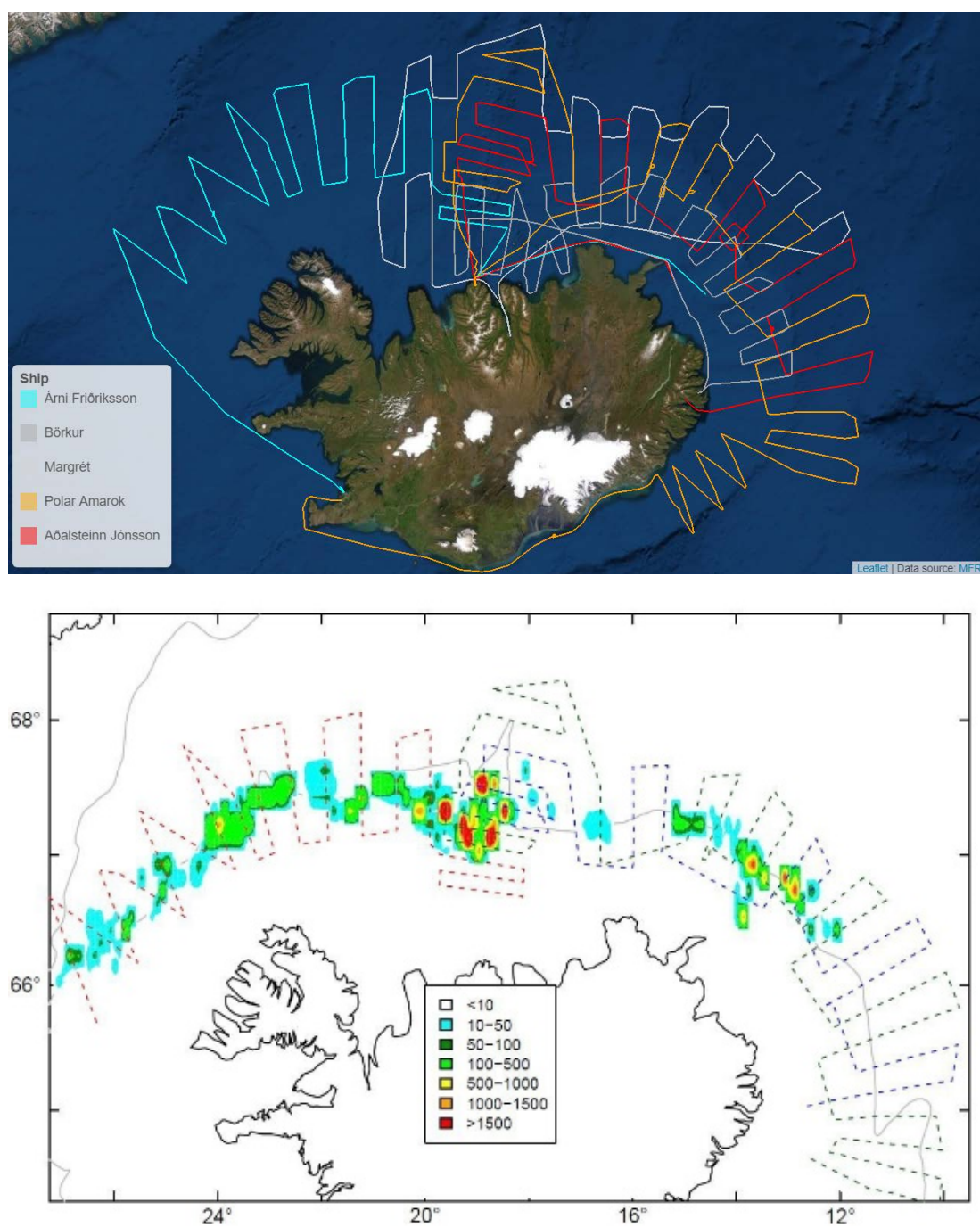


Figure 12.2.4. Icelandic capelin. Survey tracks (A) of participating vessels during 1-9 February 2020 and distribution (B) of capelin.

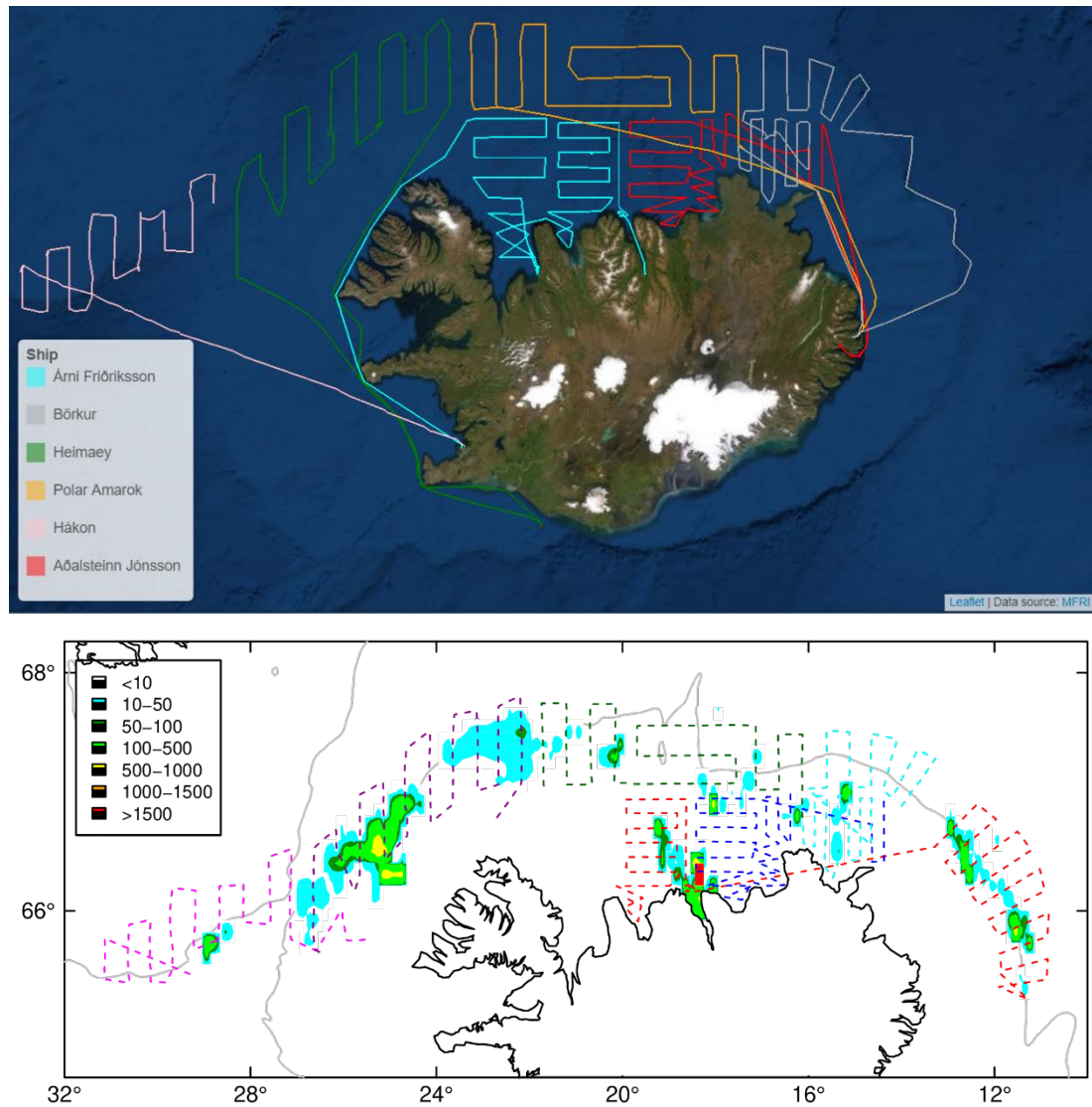


Figure 12.2.5. Icelandic capelin. Survey tracks (A) of participating vessels during 16-22 February 2020 and distribution (B) of capelin.

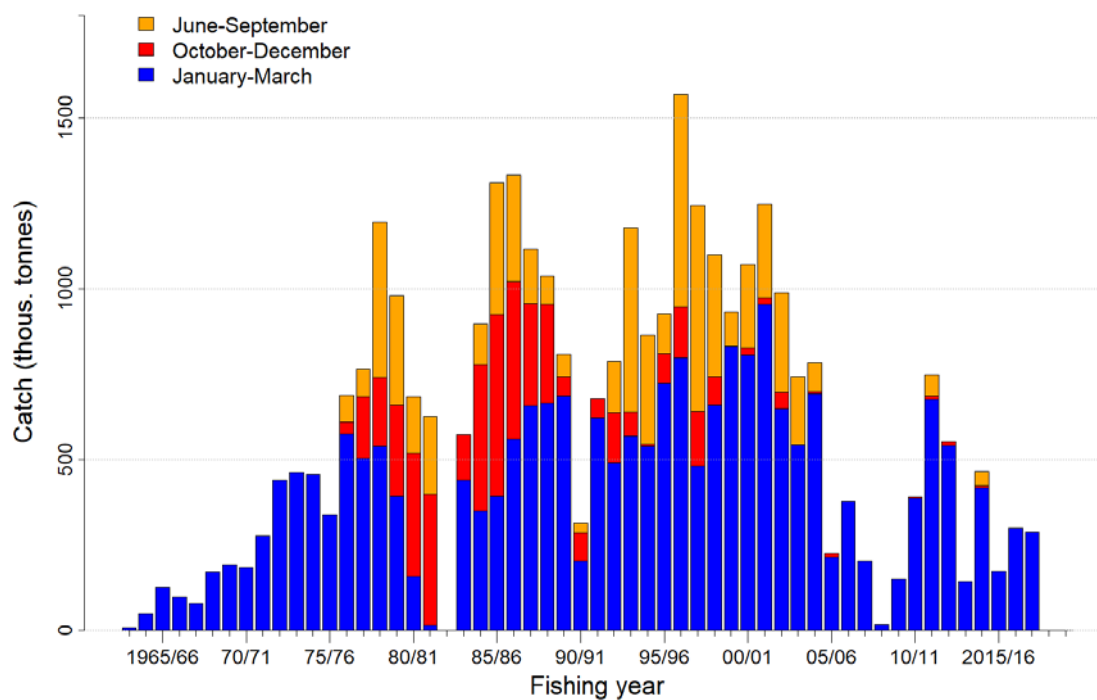


Figure 12.3.1. Icelandic capelin. The total catch (in thousand tonnes) of the Icelandic capelin since 1963/64 by season.

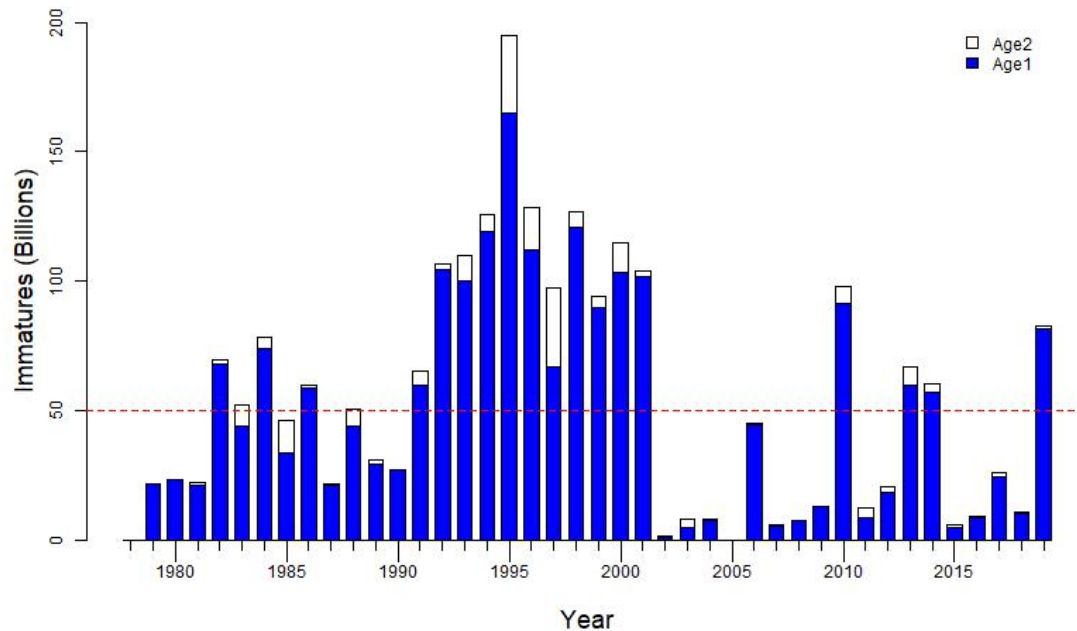


Figure 12.7.1. Icelandic capelin. Indices of immature 1 and immature 2 years old capelin from acoustic surveys in autumn since 1979.

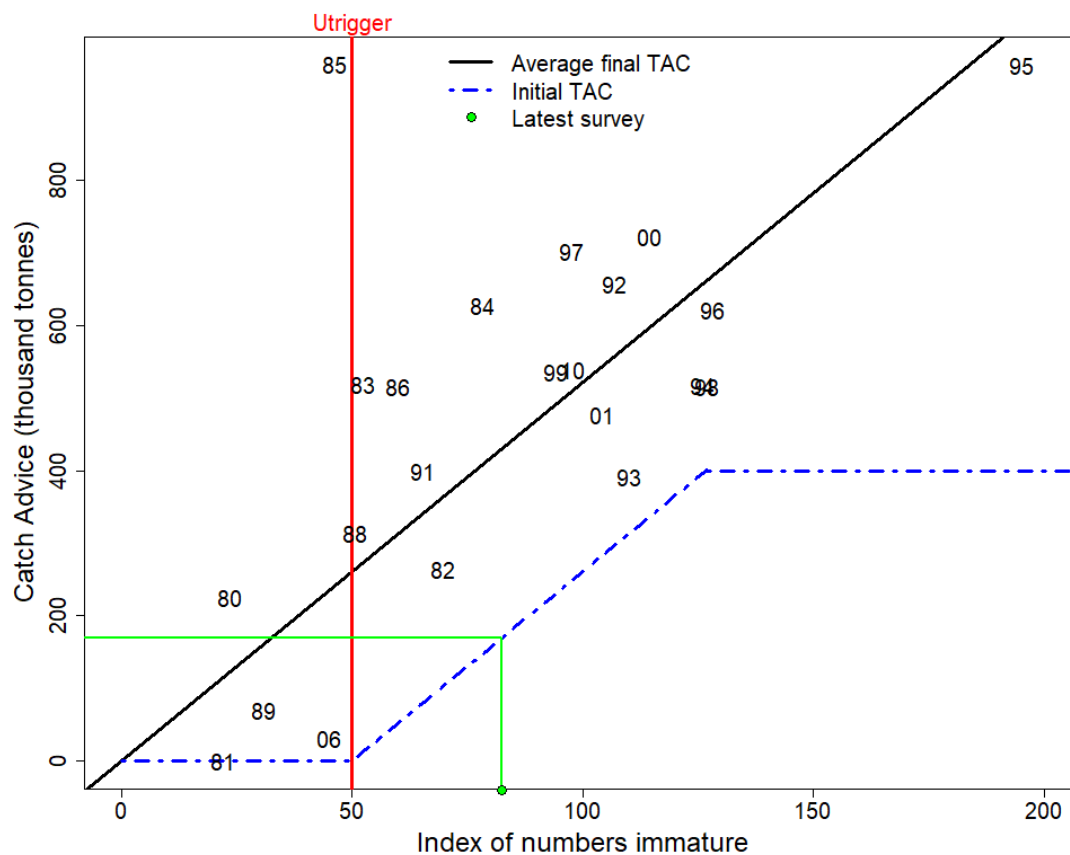


Figure 12.7.2 Capelin in Subareas 5 and 14 and Division 2.a west of 5°W. Catch advice according to the proposed stochastic HCR, based on the measured number of immature capelin about 15 months earlier. The figure shows the estimated final TAC (black unbroken line) and the initial (preliminary) TAC (blue dashed line). The latter is set using a Utrigger (red vertical line) of 50 billion immature fish, with a cap on the initial (preliminary) TAC of 400 kt. The green lines show the index value from the autumn survey 2019, with the corresponding initial TAC for 2020/2021 shown on the y-axis. (The figure adapted from stock-annex, WKICE 2015).